10

LIGHTWAVE, OPTICAL TEST EQUIPMENT

8163/64/
66B

Modular Test and Measurement Platform for Optical Networks and Components

Flexible

Free combination of Agilent modules to generate the best fit for each application

Scalable

The right form factor for each setup in R&D and manufacturing

Efficient

Plug&Play drivers and the Photonic Foundation Library from Agilent provide a variety of application functions for increased measurement performance

Fast

Modules and controllers optimized for high test speed and data throughput

Ergonomic

Comfortable color, high contrast displays for enhanced benchtop usability

Tunable laser modules
(Use with 8164B mainframe)

Compact tunable laser modules

Distributed feedback (DFB) laser modules

Fabry-Perot laser modules

Attenuator modules

Switch modules

Return loss modules

Power sensor modules

Optical heads

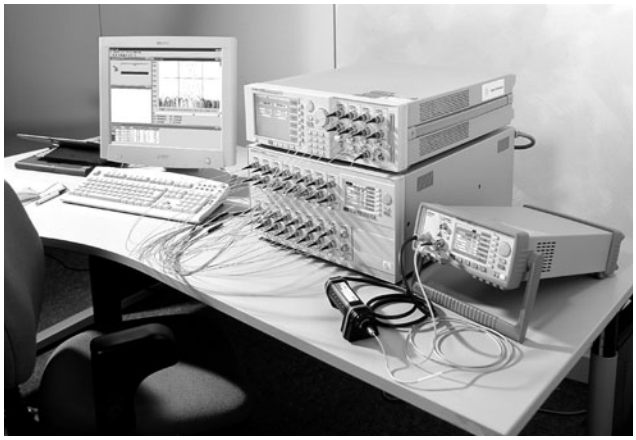
Lightwave Platform Application Portfolio

Enabling Service Innovation Manufacturing Integration Test Speed, Accuracy Automation

Optical Component Test	Passive Component Test													Optical Amplifier Test			Bit Error Ratio Test		
	Mux/DeMux/V-Mux	TFF Test	FBG Filter Test	Connector Test	Switch Test	TFF Align-/Adjustment	Fiber to AWG Alignment/AWG Chip Test	Coupler/Splitter/Combiner	Isolator/Circulator	Variable Optical Attenuator	Gain Flattening Filter	Dispersion Compensators	Interleaver	EDFA	Raman Amplifiers	SOA	Rx/Tx	Line Card	System Test
Tunable Laser 81600B OPT 200, 160, 150, 140, 130	•	•	•		•	•	•	•	•	•	•	•	•						
High Power Tunable Laser OPT 142, 132					•			•	•	•	•	•	•	•	•	•			
Compact Tunable Laser 81980A/81940A/ 81689A/81949A					•			•	•	•	•	•	•	•	•	•	•	•	•
Fabry-Perot Laser 81650A/51A/54A 81655A/56A/57A				•	•	•	•	•	•										
Power Meter 81630B/34B/35B/36B	•	•	•	•	•	•	•			•	•	•	•	•	•		•	•	•
Optical Heads 81623B/24B/26B/28B						•		•	•	•	•	•	•				•	•	•
Return Loss Modules 81610A/81613A			•	•	•	•	•	•	•	•	•	•	•	•					
Attenuator 81670A/71A/76A/77A/78A														•	•	•			
Switches 81591B/94B/95B	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Polarization Controller 8169A	•	•	•		•		•	•	•	•	•	•	•	•		•			
Mainframes 8163B 8164B 8166B	• •	•	•	•	• •	•	• •	• •	• •	• •	• •			• •	• •	• •	• •	• • •	• • •
All Parameter Test 86038B	•	•	•						•	•	•	•	•						
Photonic Foundation Library N4150A	•	•	•		•	•	•	•	•	•	•		•						

For further information, please visit **www.agilent.com/comms/lightwave**

- **Fast – modules and controllers optimized for high test speed and data throughput**
- **Flexible – free combination of Agilent modules to generate the best fit for each application**
- **Scalable – the right form factor for each setup in R&D and manufacturing**



The Agilent Lightwave Solution Platform – the right choice of modules, controllers, and software for your application

From simple standalone connector testing, fully automated high-channel count test stations, optical amplifier test at high power levels to BERT testing on a complete transmission system – the modular Lightwave Solution Platform from Agilent Technologies always provides the combination of modules for your optical domain test needs.

Controllers and Software

The 8163B, 8164B and 8166B mainframes, together with the *Plug&Play* drivers and the Photonic foundation library from Agilent, form the backbone of your optical measurement application. The high data throughput rate of the controllers, the PFL's pre-tested ready-to-use software routines, and the enhanced displays make them the optimal team for remotely controlled and standalone setups.

Laser Modules for All Purposes

Four different families of laser source modules are available for the Lightwave Solution Platform – tunable laser sources (TLS), distributed feedback laser sources (DFB), compact tunable laser sources (CTLS), and Fabry-Perot (FP) laser sources.

The Agilent high performance tunable laser source are used for precise and fast swept measurements, mainly for testing critical passive components and for calibration purpose.

The Agilent compact tunable laser sources are flexibly fit for both cost effective passive component application as well as amplifier test solution.

The Agilent DFB laser sources are offered at all ITU wavelengths on a 100 GHz grid across the C- and L-bands, mainly used as simulating transmission signal on DWDM and optical amplifier test.

The Agilent FP laser sources are available for testing single or dual fix wavelength point. They are insensitive to back reflections and are stabilized for short and long term test application.

Signal Conditioning

The Agilent optical attenuator and optical switch modules feature excellent repeatability and can handle high input power levels. Combined with their low insertion loss, they are ideal for optical amplifier test, such as characterization of EDFA and Raman amplifier, as well as for other multi-wavelength applications, such as DWDM transmission system test. Availability of single mode and multi mode fiber option fits the need of testing transceiver, receiver, and transponder for Giga Bit Ethernet and Fibre Channel to characterize such parameter as sensitivity in conjunction with oscilloscope or bit error tester.

Power Meters and Optical Heads

The Agilent optical power meters and optical heads provide various selections of power range, wavelength, measurable dynamic range, and size of photo detector to fit various applications including multi-channel device characterization and free space optic test. Superior accuracy, high linearity, low polarization dependent loss (PDL) ensure excellent measurement results. High power up to 40 dBm can be measured to meet ever increasing high power test demand in amplifier and multiple channel mux/demux tests. The measurement speed can be decreased to 25 us, which further optimizes the power measurement. Each power sensor and each optical head are individually calibrated over its complete wavelength range and is traceable to NIST and PTB for precise optical power measurement. A broad variety of advanced interfaces and adapters make it easy to connect the test devices.

Return Loss Solution

Return loss test from Agilent is cost-effective and easy operation using single small mainframe with built-in application software for guided operation. Its modules offer high precision and high accuracy test capability with one-touch operation. Due to the excellent stability of the build-in laser source, the return loss modules also provide the convenience of self-calibration.

8163/64/66B Mainframes – Specification

Mainframes

8163B Lightwave Multimeter, 2 slot mainframe
8164B Lightwave Measurement System, 4 slot plus 1 slot for tunable laser
8166B Lightwave Multichannel System, 17 slot mainframe

Software

N4150A Photonic Foundation Library, single-user license

Full-Size Tunable Laser Sources

81600B-200 Tunable Laser Module, Low-SSE, 1440 – 1640 nm
81600B-160 Tunable Laser Module, Low-SSE, 1495 – 1640 nm
81600B-140 Tunable Laser Module, Low-SSE, 1370 – 1495 nm
81600B-150 Tunable Laser Module, Low-SSE, 1450 – 1590 nm
81600B-130 Tunable Laser Module, Low-SSE, 1260 – 1375 nm
81600B-142 High-Power Tunable Laser Module, 1370 – 1495 nm
81600B-132 High-Power Tunable Laser Module, 1260 – 1375 nm

Compact Tunable Laser Source Modules

81940A 1520 – 1630 nm, >+10 dBm, resolution @1 pm
81980A 1465 – 1575 nm, >+10 dBm, resolution @1 pm
81949A 1520 – 1630 nm, >+10 dBm, resolution @5 pm
81989A 1465 – 1575 nm, >+10 dBm, resolution @5 pm

Source Modules 0 dBm (Fabry-Perot)

81650A 1310 nm, single-mode
81651A 1550 nm, single-mode
81654A 1310/1550 nm, single-mode

Source Modules 17 dBm (Fabry Perot)

81655A 1310 nm, single-mode
81655A-E01 850 nm, multi-mode
81656A 1550 nm, single-mode
81657A 1310/1550 nm, single-mode

Optical Spectrum Analyzer

86142B High Performance Optical Spectrum Analyzer
86146B High Performance Optical Spectrum Analyzer with Filter Mode

Optical Attenuator Modules

81570A High Power Module, Straight Contact Connector
81571A High Power Module, Angled Contact Connector
81576A 2 Slot Wide High Power Module with Power Control, Straight Contact Connector
81577A 2 Slot Wide High Power Module with Power Control, Angled Contact Connector
81578A High Power Module, Multimode, Straight Contact Connector
Option 050 50/125 µm MMF
Option 062 62.5/125 µm MMF

Optical Switch Module

81591B 1 x 2 Optical Switch Module
81594B 2 x 2 Optical Switch Module
81595B 1 x 4 Optical Switch Module
Option 009 Single-mode
Option 062 Multimode

Power Sensor Modules

81634B InGaAs, +10 dBm to –110 dBm, 800 to 1700 nm
81635A (Dual Sensor) InGaAs, +10 dBm to –80 dBm, 800 to 1650 nm

Fast Power Sensor Modules
81636B InGaAs, +10 dBm to –80 dBm, 1250 to 1640 nm

High Power Sensor Module
81630B InGaAs, +28 dBm to –70 dBm, 970 to 1650 nm

Optical Heads

Optical heads require an interface module, Agilent 81618A (single) or 81619A (dual).
81623B Ge, +10 dBm to –80 dBm, 750 to 1800 nm
81624B InGaAs, +10 dBm to –90 dBm, 800 to 1700 nm

High Power Optical Heads
Optical heads require an interface module, Agilent 81618A (single) or 81619A (dual).
81626B InGaAs, +27 dBm to –70 dBm, 850 to 1650 nm
81628B InGaAs integrating sphere, +40 dBm to –60 dBm, 800 to 1700 nm

Return Loss Modules

81610A InGaAs, no internal source, dynamic range 70 dB
81613A InGaAs, internal sources 1310/1550 nm, dynamic range 75 dB

Accessories for Optical Heads 8162xB

81624CE Extension Cable, 4 m
81624DD Adapter (D-shape)
81624RM Rackmount for two heads
81625RM Rackmount for four heads

Accessories for Return Loss Modules 8161xA

81610CC Calibration Cable (requires connector interface 81000SI for connection to return loss module)

Ordering Information

For the most up-to-date information on the Agilent lightwave solution platform, please contact your Agilent Technologies sales representative or visit our web site at: **www.agilent.com/find/oct**

This overview shows all modules, controllers, and software packages for the Agilent lightwave solution platform.

All modules, except the full-size tunable laser sources (used with the 8164B mainframe), may be used with any of the mainframes.

The modules support a wide range of fiber connectors. Connector interfaces should be ordered for each input and output.

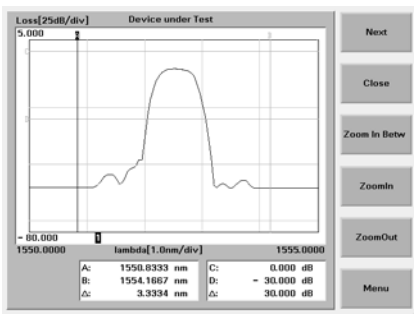
8163B Lightwave Multimeter

8163B

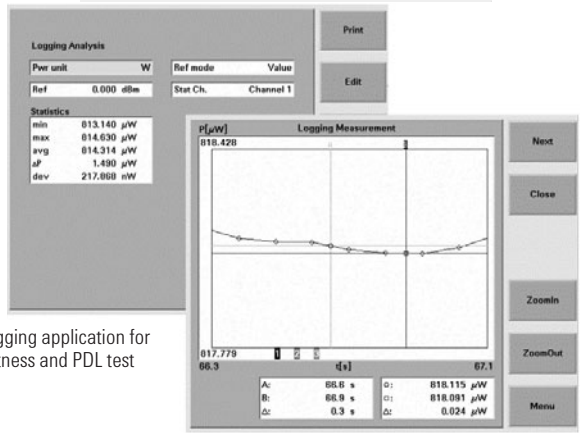
- **Benchtop and smart carry-along instrument**
- **Ready-to-use applications for ease of operation**
- **Cost effective solution for component test**
- **High-contrast color display**
- **Backward compatible with 815x and 816x-series modules**

The Agilent 8163B – Modular Stimulus-Response Solutions with Excellent Performance

The two slots Agilent 8163B lightwave multimeter is one of the basic measurement tools in the fiber optics industry. Its modularity and compact format makes it flexible enough to meet changing measurement needs, whether measuring optical power and loss with laser and power meter modules or using attenuator and switch as signal conditioning.



Insertion loss test result using laser source and power meter



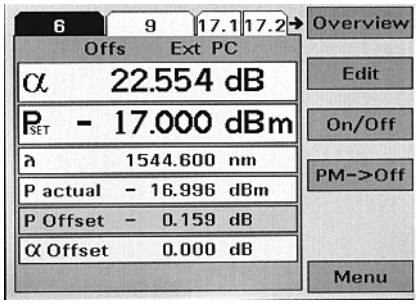
Logging application for flatness and PDL test

Built-In Applications

- Passive component test (PACT) – test pigtailed or connectorized-devices over all wavelengths with a compact tunable laser module and a power meter module
- Return loss/loss – measure the return loss and insertion loss of your devices with one of the 8161xA return loss modules and a power meter module
- Stability – check the long term power stability of the device under test with a source module and a power meter module or power head
- Logging – perform statistical analysis on the power readings of your device

Easy-hands-On and Remote Operation

A glance of instrument gives all information about instrument setting and measurement result with high-contrast color display. The wide viewing angle allows for clear readings, even when the instrument cannot be placed right in front of you. Its compactness and light weighted body is a smart and portable solution for manufacturing. When the need of system automation is considered for advanced manufacturability, GPIB and RS-232C ports together with Agilent's software library support easy system integration.



Signal conditioning operation for active component

- **High speed, high power, high dynamics measurement for passive component test**
- **Ready-to-use application for ease of operation**
- **Remote control for system automation**
- **Backward compatible with 815x and 816x series modules**

The Agilent 8164B – The Platform for Testing Fiber Optic Components

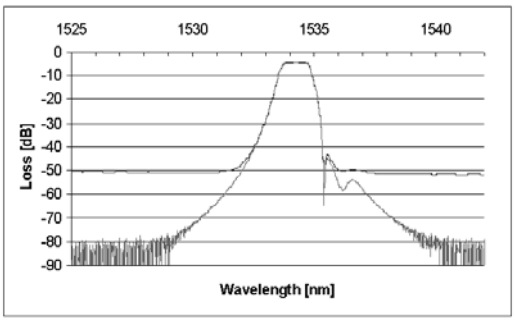
The Agilent 8164B lightwave measurement system supports a wide range of tunable laser modules together with measurement capability up to 8 channel power meter port in one-box, fit into today's requirement of AWG and CWDM applications. Its GPIB and RS-232C ports provide connectivity for remote controlling capability that can be utilized for system automation supported with Agilent's software library. For easy standalone operation of the 8164B, a 3.5 inch floppy disk drive, VGA port, PS/2 keyboard connector, and parallel printer port are provided.

Built-In Applications

- Passive component test (PACT) – test pigtailed or connectorized devices over all wavelengths with an Agilent tunable laser module and our power meter modules
- Stability – check the long term power stability of your device with a source module and a power meter module or power head
- Logging – Perform statistical analysis on the power readings of your device. Save the results to disk or print out a hardcopy

High Speed, High Power, High Dynamics

High standard performance is compressed within a small compact form factor of Agilent's lightwave mainframe that enables optical component research and development for new technology. Such challenge can only be solved with minimum measurement uncertainties by analyzing spectral characteristic of device under test with >70 dB dynamic range and pico-meter wavelength accuracy in loss properties such as IL, RL, and PDL. Same is true for dispersion property in component supporting higher data rate. All these capability is supported in one-box.



Agilent's spectrum analysis solution compared with conventional solution

Improve Cost of Manufacturing

Optical component markets are matured and competitive price is a key success factor to win market share. The Agilent 8164B is especially designed for component manufacturing with it flexibility of pluggable modules that provide the test environment for multiple applications. Today's test need of WDM component, for example, can be easily reconfigured to fit the need of production in amplifier test by just changing its modules, saving extra cost for additional mainframe. Ease of manufacturing automation with Agilent's *Plug&Play* software library supported with the mainframe also plays important role in return of instrument investment by improving yield and volume production.

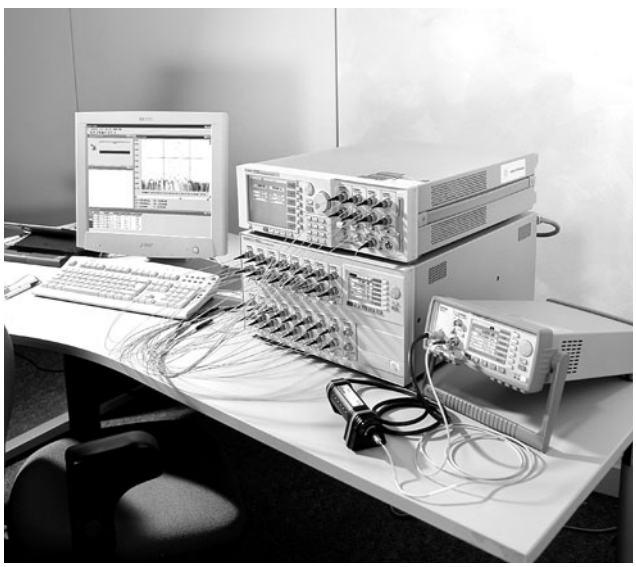
8166B Lightwave Multichannel System

8166B

- **Extender platform to flexibly adjust high channel-count applications**
- **Variety of plug-in modules for optimized setup**
- **Synchronize with laser module for simultaneous measurement**

The Agilent 8166B – Lightwave Multichannel System

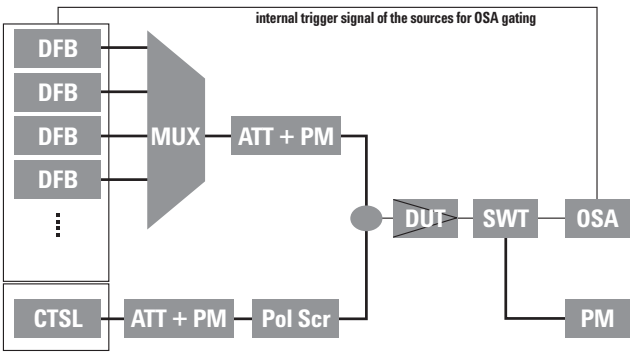
The Agilent 8166B lightwave multichannel system is the mainframe of choice for applications that involve testing high-channel count devices or devices with a need for a complete array of sources or sensors. For multi-port device such as WDM component, the ability to synchronize with tunable laser source even with other mainframe ensures simultaneous data logging at all plugged power meter. The platform offers 17 slots which can be equipped with any combination of modules to configure your own research and manufacturing test system.



40ch spectrum analysis synchronizing tunable laser source and power meter

Flexible Module Configuration for Complex Manufacturing Line

Simple configuration of instrument for one test parameter adds up and creates complex mechanism of manufacturing line when tests are moved from R&D to Production. Integrating all necessary test instruments into one box can minimize such complexity. General setup of EDFA can be build with a series of DFB bank together with switch, attenuator, and power meters. The Agilent's 8166B hosts 17 slots with customer specific module configuration.



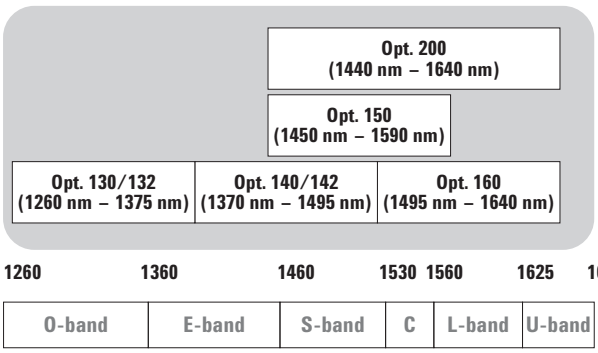
EDFA test system with configurable channel count

Further more, complexity of system configuration in manufacturing environment could induce operational mistake and a need of engineering skill for operation. One advantage of configuring all necessary test instrument into one box is to crease an environment for ease of integration. GPIB and RS-232C ports together with Agilent's software library lower integration and maintenance cost of system. Same process and procedures are repeated constantly without any human error by just clicking single button for setting, measurement, report.

- **Complete wavelength coverage from 1260 nm to 1640 nm**
- **Low SSE output for high dynamic range**
- **Built-in wavelength meter for high wavelength accuracy**
- **Sweep speeds up to 80 nm/s to reduce test times**
- **No compromise of measurement accuracy for sweep speed**

Tuning Range from 1260 nm to 1640 nm

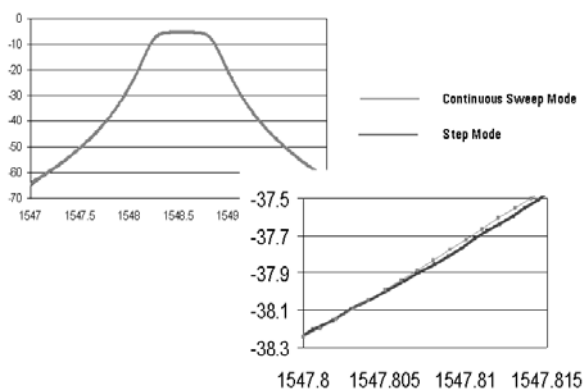
Agilent offers a family of tunable laser sources to cover the wavelength range of 1260 nm to 1640 nm. Whether you are measuring Dense Wavelength Division Multiplexing (DWDM) devices or a WDM device, such as, an LX4 component for 10 Gigabit Ethernet, Agilent has a laser to fit your testing needs.



Agilent TSL portfolio

It Sweeps as Precisely as It Steps

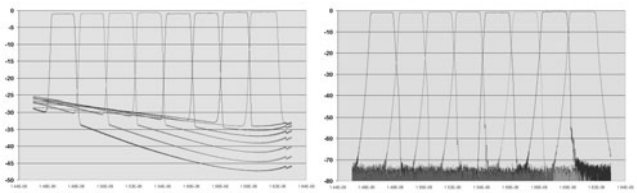
As manufacturing yields become more demanding it is critical for your test instruments to have optimal performance for any measurement condition. The 81600B offers several sweep speeds up to 80 nm/s without compromising measurement accuracy. In contrast to other lasers, the 81600B sweeps with the same precision as it steps; without the use of an external wavelength-tracking filter. No compromise on sweep speed.



No compromise on sweep speed

Advantage of Using Suppressed Laser Noise (SSE)

Source Spontaneous Emission (SSE), the sum of all spontaneous emissions inside the laser diode, of the tunable laser, is broadband light output in addition to the monochromatic laser line. This emission limits the noise floor of the tunable laser, which, in turn, limits the dynamic range of your measurements. The Agilent tunable laser source offers a low signal to source spontaneous emission ratio. For you, this means more dynamic range to enable your measurements to completely characterize DWDM devices with high channel isolation.



Low SSE and high power measurement result

Reduce Cost of Test

For DWDM components, high wavelength accuracy and dynamic range are most important. For CWDM components, a wide wavelength range, high power stability, dynamic range and low cost targets are key. Agilent's state-of-the-art tunable lasers meet the demanding requirements of high tech optical manufacturing facilities with fast sweep speed, high wavelength accuracy and power stability. This will reduce your test time while increasing your throughput, hence, reducing the cost of test in manufacturing to give you the competitive advantage.

Protect your Investment

Upgrade your earlier model Agilent tunable laser (8164xA/B, 8168xA/B) to the latest 81600B.

TLS Upgrade Option
Upgrade an Agilent tunable laser source to the latest 81600B Family product

	81600B#200
81640A/B	#UG1
81680A/B	
81480A/B	
81642A/B	
81682A/B	
81482B	

81600B-200 All-Band Tunable Laser Source, 1440 nm – 1640 nm, Low SSE

	Agilent 81600B-200			
Wavelength Range	1440 nm to 1640 nm			
Wavelength Resolution	0.1 pm, 12.5 MHz at 1550 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ±3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[4] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1475 nm – 1625 nm, at max. constant output power)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Maximum Output Power **(Continuous Power During Sweep)**	≥+3 dBm peak (typ.) ≥+2 dBm (1520 nm – 1610 nm) ≥–2 dBm (1475 nm – 1625 nm) ≥–7 dBm (1440 nm – 1640 nm)	≥+9 dBm peak (typ.) ≥+8 dBm (1520 nm –1610 nm) ≥+4 dBm (1475 nm –1625 nm) ≥–1 dBm (1440 nm – 1640 nm)		
Attenuation		max. 60 dB		
Power Repeatability (typ.)	±0.003 dB			
Power Stability[4]	±0.01 dB, 1 hour typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB	±0.1 dB (±0.3 dB in attenuation mode)		
Power Flatness Versus Wavelength	±0.25 dB[3], typ. ±0.1 dB	±0.3 dB[3], typ. ±0.15 dB		
		Continuous Sweep Mode		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.02 dB	±0.04 dB
Side-mode Suppression Ratio (typ.)	≥60 dB (1520 nm – 1610 nm)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Signal to Source **Spontaneous Emission Ratio**[2]	≥70 dB/nm (1520 nm –1610 nm) ≥80 dB/0.1 nm (typ., 1520 nm – 1610 nm) ≥66 dB/nm (typ., 1475 nm – 1625 nm) ≥60 dB/nm (typ., 1440 nm – 1640 nm)	≥48 dB/nm (1520 nm – 1610 nm) ≥58 dB/0.1 nm (typ., 1520 nm – 1610 nm) ≥43 dB/nm (1475 nm – 1625 nm) ≥37 dB/nm (1440 nm – 1640 nm)		
Signal to Total Source **Spontaneous Emission Ratio**[2]	≥65 dB (1520 nm – 1610 nm) ≥57 dB (typ., 1440 nm – 1640 nm)	≥30 dB (typ., 1520 nm – 1610 nm)		
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–145 dB/Hz (1520 nm – 1610 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] Wavelength range 1440 nm – 1630 nm.
[4] At constant temperature ±1 K.

81600B

81600B-160 Tunable Laser Source, 1495 nm – 1640 nm, Low SSE

	Agilent 81600B-160			
Wavelength Range	1495 nm to 1640 nm			
Wavelength Resolution	0.1 pm, 12.5 MHz at 1550 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ± 3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[3] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1510 nm – 1620 nm, at max. constant output power)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Maximum Output Power **(Continuous Power During Sweep)**	≥–2 dBm peak (typ.) ≥–4 dBm (1520 nm – 1610 nm) ≥–6 dBm (1510 nm – 1620 nm) ≥–7 dBm (1495 nm – 1640 nm)	≥+7 dBm peak (typ.) ≥+5 dBm (1520 nm –1610 nm) ≥+3 dBm (1510 nm – 1620 nm) ≥–1 dBm (1495 nm – 1640 nm)		
Attenuation		max. 60 dB		
Power Repeatability (typ.)	±0.003 dB			
Power Stability[3]	±0.01 dB, 1 hour typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB	±0.1 dB (±0.3 dB in attenuation mode)		
Power Flatness Versus Wavelength	±0.2 dB, typ. ±0.1 dB (1495 nm – 1630 nm)	±0.3 dB, typ. ±0.15 dB		
		Continuous Sweep Mode		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.02 dB	±0.04 dB
Side-mode Suppression Ratio (typ.)[2]	≥40 dB (1520 nm – 1610 nm)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Signal to Source **Spontaneous Emission Ratio**[2]	≥64 dB/nm (1520 nm –1610 nm) ≥74 dB/0.1 nm (typ., 1520 nm – 1610 nm) ≥62 dB/nm (typ., 1510 nm – 1620 nm) ≥59 dB/nm (typ., 1495 nm – 1640 nm)	≥45 dB/nm (1520 nm – 1610 nm) ≥55 dB/0.1 nm (typ., 1520 nm – 1610 nm) ≥42 dB/nm (1510 nm – 1620 nm) ≥37 dB/nm (1495 nm – 1640 nm)		
Signal to Total Source **Spontaneous Emission Ratio**[2]	≥59 dB (1520 nm – 1610 nm) ≥56 dB (typ., 1495 nm – 1640 nm)	≥27 dB (typ., 1520 nm – 1610 nm)		
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–145 dB/Hz (1520 nm – 1610 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] At constant temperature ±1 K.

81600B-140 Tunable Laser Source, 1370 nm – 1495 nm, Low SSE

	Agilent 81600B-140			
Wavelength Range	1370 nm to 1495 nm			
Wavelength Resolution	0.1 pm, 15 MHz at 1450 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s (1372 nm to 1945 nm)			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ±3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[4] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1430 nm – 1480 nm, at max. constant output power)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Maximum Output Power **(Continuous Power During Sweep)**	≥–4.5 dBm peak (typ.) ≥–5 dBm (1430 nm – 1480 nm) ≥–7 dBm (1420 nm – 1480 nm) ≥–13 dBm (1370 nm – 1495 nm)	≥+5.5 dBm peak (typ.) ≥+5 dBm (1430 nm – 1480 nm) ≥+3 dBm (1420 nm – 1480 nm) ≥–3 dBm (1370 nm – 1945 nm)		
Attenuation		max. 60 dB		
Power Repeatability (typ.)	±0.003 dB			
Power Stability[4]	±0.01 dB, 1 hour (1420 nm – 1495 nm) typ. ±0.01 dB, 1 hour (1370 nm – 1420 nm) typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB (1420 nm – 1495 nm) typ. ±0.01 dB (1370 nm – 1420 nm)	±0.3 dB (1420 nm – 1495 nm) typ. ±0.03 dB (1370 nm – 1420 nm)		
Power Flatness Versus Wavelength	±0.2 dB, typ. ±0.1 dB (1420 nm – 1495 nm) typ. ±0.2 dB (1370 nm – 1420 nm)	±0.3 dB, typ. ±0.02 dB (1420 nm – 1495 nm) typ. ±0.03 dB (1370 nm – 1420 nm)		
		Continuous Sweep Mode[3]		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.015 dB	±0.03 dB
Side-mode Suppression Ratio (typ.)[2]	≥40 dB (1430 nm – 1480 nm)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Signal to Source **Spontaneous Emission Ratio**[2]	≥63 dB/nm (1430 nm –1480 nm) ≥73 dB/0.1 nm (typ., 1430 nm –1480 nm) ≥61 dB/nm (1420 nm – 1480 nm) ≥55 dB/nm (typ., 1370 nm – 1495 nm)	≥42 dB/nm (1430 nm –1480 nm) ≥52 dB/0.1 nm (typ., 1430 nm –1480 nm) ≥40 dB/nm (1420 nm – 1480 nm) ≥35 dB/nm (typ., 1370 nm – 1495 nm)		
Signal to Total Source **Spontaneous Emission Ratio**[2]	≥60 dB (1430 nm – 1480 nm) ≥58 dB (1420 nm – 1480 nm) ≥53 dB (typ., 1370 nm – 1495 nm)	≥28 dB (typ., 1430 nm – 1480 nm)		
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–145 dB/Hz (1430 nm – 1480 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] Valid for absolute humidity of 11.5 g/m³ (For example, equivalent of 50% relative humidity at 25°C).
[4] At constant temperature ±1 K.

81600B-150 Tunable Laser Source, 1450 nm – 1590 nm, Low SSE

	Agilent 81600B-150			
Wavelength Range	1450 nm to 1590 nm			
Wavelength Resolution	0.1 pm, 12.5 MHz at 1550 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ±3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[3] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1480 nm – 1580 nm, at max. constant output power)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Maximum Output Power **(Continuous Power During Sweep)**	≥–1 dBm peak (typ.) ≥–3 dBm (1520 nm – 1570 nm) ≥–6 dBm (1480 nm – 1580 nm) ≥–7 dBm (1450 nm – 1590 nm)	≥+7 dBm peak (typ.) ≥+5 dBm (1520 nm – 1570 nm) ≥+4 dBm (1480 nm – 1580 nm) ≥–1 dBm (1450 nm – 1590 nm)		
Attenuation		max. 60 dB		
Power Repeatability (typ.)	±0.003 dB			
Power Stability[3]	±0.01 dB, 1 hour typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB	±0.1 dB (±0.3 dB in attenuation mode)		
Power Flatness Versus Wavelength	±0.2 dB, typ. ±0.1 dB	±0.3 dB, typ. ±0.15 dB		
		Continuous Sweep Mode		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.02 dB	±0.04 dB
Side-mode Suppression Ratio (typ.)[2]	≥40 dB (1480 nm – 1580 nm)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Signal to Source **Spontaneous Emission Ratio**[2]	≥65 dB/nm (1520 nm –1570 nm) ≥75 dB/0.1 nm (typ., 1520 nm – 1570 nm) ≥61 dB/nm (typ., 1480 nm – 1580 nm) ≥59 dB/nm (typ., 1450 nm – 1590 nm)	≥45 dB/nm (1520 nm – 1570 nm) ≥55 dB/0.1 nm (typ., 1520 nm – 1570 nm) ≥42 dB/nm (1480 nm – 1580 nm) ≥37 dB/nm (1450 nm – 1590 nm)		
Signal to Total Source **Spontaneous Emission Ratio**[2]	≥60 dB (1520 nm – 1570 nm) ≥50 dB (typ., 1450 nm – 1590 nm)	≥30 dB (typ., 1520 nm – 1570 nm)		
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–145 dB/Hz (1480 nm – 1580 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] At constant temperature ±1 K.

81600B-130 Tunable Laser Source, 1260 nm – 1375 nm, Low SSE

	Agilent 81600B-130			
Wavelength Range	1260 nm to 1375 nm			
Wavelength Resolution	0.1 pm, 17.7 MHz at 1300 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ±3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[4] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1270 nm – 1350 nm, at max. constant output power)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Maximum Output Power **(Continuous Power During Sweep)**	≥–4 dBm peak (typ.) ≥–6 dBm (1290 nm – 1370 nm) ≥–9 dBm (1270 nm – 1375 nm) ≥–13 dBm (1260 nm – 1375 nm)	≥+5 dBm peak (typ.) ≥+4 dBm (1290 nm – 1370 nm) ≥+1 dBm (1270 nm – 1375 nm) ≥–3 dBm (1260 nm – 1375 nm)		
Attenuation		max. 60 dB		
Power Repeatability (typ.)	±0.003 dB			
Power Stability [4]	±0.01 dB, 1 hour (1260 nm – 1350 nm) typ. ±0.01 dB, 1 hour (1350 nm – 1375 nm) typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB (1260 nm – 1350 nm) typ. ±0.1 dB (1350 nm – 1375 nm)	±0.3 dB (1260 nm – 1350 nm) typ. ±0.3 dB (1350 nm – 1375 nm)		
Power Flatness Versus Wavelength	±0.2 dB, typ. ±0.1 dB (1260 nm – 1350 nm) typ. ±0.2 dB (1350 nm – 1375 nm)	±0.3 dB, typ. ±0.15 dB (1260 nm – 1350 nm) typ. ±0.3 dB (1350 nm – 1375 nm)		
		Continuous Sweep Mode[3]		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.02 dB	±0.04 dB
Side-mode Suppression Ratio (typ.)[2]	≥40 dB (1290 nm – 1370 nm)			
	Output 1 (Low SSE)	**Output 2 (High Power)**		
Signal to Source **Spontaneous Emission Ratio (typ.)**[2]	≥63 dB/nm (1290 nm – 1370 nm) ≥61 dB/nm (1270 nm – 1375 nm) ≥55 dB/nm (1260 nm – 1375 nm)	≥42 dB/nm (1290 nm – 1370 nm) ≥40 dB/nm (1270 nm – 1375 nm) ≥35 dB/nm (1260 nm – 1375 nm)		
Signal to Total Source **Spontaneous Emission Ratio (typ.)**[2]	≥58 dB (1290 nm – 1370 nm) ≥56 dB (1270 nm – 1375 nm) ≥51 dB (1260 nm – 1375 nm)	≥26 dB (1290 nm – 1370 nm)		
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–140 dB/Hz (1270 nm – 1375 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] Valid for absolute humidity of 11.5 g/m³ (For example, equivalent of 50% relative humidity at 25°C).
[4] At constant temperature ±1 K.

81600B-142 Tunable Laser Source, 1370 nm – 1495 nm, High Power

	Agilent 81600B-142			
Wavelength Range	1370 nm to 1495 nm			
Wavelength Resolution	0.1 pm, 15 MHz at 1450 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s (1372 nm – 1495 nm)			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ±3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[4] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1430 nm – 1480 nm, at max. constant output power)			
Maximum Output Power **(Continuous Power During Sweep)**	≥+8.5 dBm peak (typ.) ≥+7.5 dBm (1430 nm – 1480 nm) ≥+5 dBm (1420 nm – 1480 nm) ≥0 dBm (1370 nm – 1495 nm)			
With Option 003	reduced by 1.5 dB			
Power Repeatability (typ.)	±0.003 dB			
Power Stability[4]	±0.01 dB, 1 hour (1420 nm – 1495 nm) typ. ±0.01 dB, 1 hour (1370 nm – 1420 nm) typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB (1420 nm – 1495 nm) typ. ±0.1 dB (1370 nm – 1420 nm)			
With Option 003	Add ±0.2 dB			
Power Flatness Versus Wavelength	±0.2 dB, typ. ±0.1 dB (1420 nm – 1495 nm) typ. ±0.2 dB (1370 nm – 1420 nm)			
With Option 003	Add ±0.1 dB			
		Continuous Sweep Mode[4]		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.015 dB	±0.03 dB
Side-mode Suppression Ratio (typ.)[2]	≥ 40 dB (1430 nm – 1480 nm)			
Signal to Source **Spontaneous Emission Ratio**[2]	≥42 dB/nm (1430 nm – 1480 nm) ≥52 dB/0.1 nm (typ., 1430 nm – 1480 nm) ≥40 dB/nm (1420 nm – 1480 nm) ≥35 dB/nm (typ., 1370 nm – 1495 nm)			
Signal to Total Source **Spontaneous Emission Ratio (typ.)**[2]	≥28 dB (1430 nm – 1480 nm)			
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–145 dB/Hz (1430 nm – 1480 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] Valid for absolute humidity of 11.5 g/m³ (For example, equivalent of 50% relative humidity at 25°C).
[4] At constant temperature ±1 K.

81600B-132 Tunable Laser Source, 1260 nm – 1375 nm, High Power

	Agilent 81600B-132			
Wavelength Range	1260 nm to 1375 nm			
Wavelength Resolution	0.1 pm, 17.7 MHz at 1300 nm			
Mode-hop Free Tunability	Full wavelength range			
Maximum Sweep Speed	80 nm/s			
	Stepped Mode	**Continuous Sweep Mode (typ.)**		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Absolute Wavelength Accuracy[1]	±10 pm, typ. ±3.6 pm	±4.0 pm	±4.6 pm	±6.1 pm
Relative Wavelength Accuracy[1]	±5 pm, typ. ±2 pm	±2.4 pm	±2.8 pm	±4.0 pm
Wavelength Repeatability	±0.8 pm, typ. ±0.5 pm	±0.3 pm	±0.4 pm	±0.7 pm
Wavelength Stability[2] **(typ.)**	≤±1 pm, 24 hours			
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On**	100 kHz >50 MHz (1270 nm – 1350 nm, at max. constant output power)			
Maximum Output Power **(Continuous Power During Sweep)**	≥+9 dBm peak (typ.) ≥+7 dBm (1290 nm – 1370 nm) ≥+3 dBm (1270 nm – 1375 nm) ≥0 dBm (1260 nm – 1375 nm)			
Power Repeatability (typ.)	±0.003 dB			
Power Stability[4]	±0.01 dB, 1 hour (1260 nm – 1350 nm) typ. ±0.01 dB, 1 hour (1350 nm – 1375 nm) typ. ±0.03 dB, 24 hours			
Power Linearity	±0.1 dB (1260 nm – 1350 nm) typ. ±0.1 dB (1350 nm – 1375 nm)			
Power Flatness Versus Wavelength	±0.2 dB, typ. ±0.1 dB (1260 nm – 1350 nm) typ. ±0.2 dB (1350 nm – 1375 nm)			
		Continuous Sweep Mode[3]		
		at 5 nm/s	**at 40 nm/s**	**at 80 nm/s**
Dynamic Power Reproducibility (typ.)		±0.005 dB	±0.01 dB	±0.015 dB
Dynamic Relative Power Flatness (typ.)		±0.01 dB	±0.015 dB	±0.03 dB
Side-mode Suppression Ratio (typ.)[2]	≥40 dB (1270 nm – 1375 nm)			
Signal to Source **Spontaneous Emission Ratio**[2]	≥45 dB/nm (1290 nm – 1370 nm) ≥55 dB/0.1 nm (typ., 1290 nm – 1370 nm) ≥40 dB/nm (1270 nm – 1375 nm) ≥35 dB/nm (typ., 1260 nm – 1375 nm)			
Signal to Total Source **Spontaneous Emission Ratio (typ.)**[2]	≥28 dB (1290 nm – 1370 nm)			
Relative Intensity Noise (RIN) **(0.1 – 6 GHz) (typ.)**[2]	–145 dB/Hz (1270 nm – 1375 nm)			

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing.
[2] At maximum output power as specified per wavelength range.
[3] Valid for absolute humidity of 11.5 g/m³ (For example, equivalent of 50% relative humidity at 25°C).
[4] At constant temperature ±1 K.

Specifications

Wavelength and amplitude accuracy specifications require an angled connector from the source output to the receiver input ports. Wavelength specifications are defined with frequency terms. For convenience, the frequency delta ranges are provided with wavelength units (in parentheses) assuming a center wavelength of 1550 nm. Unless otherwise specified, amplitude specifications apply in peak detection mode, with unmodulated linewidths <2 MHz.

- **Compact form factor of tunable laser source**
- **Full wavelength range in S/C-band or C/L-band (110 nm coverage in one module)**
- **High power output up to +13 dBm**
- **SBS suppression feature enables high launch power**
- **Built-in wavemeter for active wavelength control**
- **Dynamic power control for excellent repeatability**

High Power Compact Tunable Lasers for S-, C- and L-band

The Agilent 819xxA compact tunable laser sources supply an output power of up to +13 dBm. Each module covers a total wavelength range of 110 nm, either in the S+C-band with the high power in C (81980A and 81989A), or in the C+L-band with the high power in the L-band (81940A, 81944A, 81949A).

Device Characterization at High Power Levels

The high output power of the 819xxA tunable lasers enhances test stations for optical amplifier, active components and broadband passive optical components. It helps overcome losses in test setups or in the device under test itself. Thus, engineers can test optical amplifiers such as EDFAs, Raman amplifiers, SOAs and EDWAs to their limits. These tunable lasers provide the high power required to speed the development of innovative devices by enabling the test and measurement of nonlinear effects.

SBS Suppression Feature Enables High Launch Power

The new SBS-suppression feature prevents the reflection of light induced by Stimulated Brillouin Scattering (SBS). It enables the launch of the high power into long fibers without intensity modulation, which is detrimental in time-domain measurements.

Compact tunable laser source with dual power meter in one box

Coherence Control Reduces Interference-Induced Power Fluctuations

A high-frequency modulation function is used to increase the effective linewidth to reduce power fluctuations caused by coherent interference effects. The modulation pattern is optimized for stable power measurements, even in the presence of reflections.

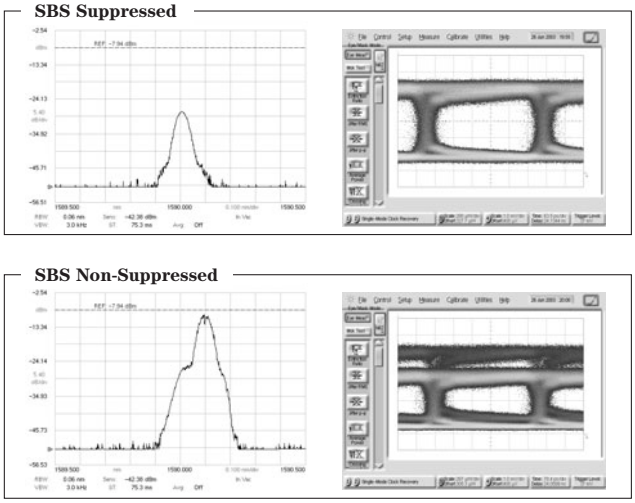
Internal Modulation

The internal modulation feature enables an efficient and simple time-domain extinction (TDE) method for Erbium-based optical amplifier test when used together with the external gating feature of the Agilent OSA.

It also supports the transient testing of optical amplifiers by simulating channel add/drop events.

Cost Effective Passive Component Test

Agilent's compact tunable laser sources provide excellent wavelength and power accuracies to enable reliable swept wavelength measurement for passive component test in a cost effective way. The built-in wavelength meter with a closed feedback loop for enhanced wavelength accuracy allows dynamic wavelength logging in continuous sweep mode. The integrated dynamic power control loop guarantees highly repeatable measurements.



Laser characteristics in long fiber with and without SBS suppression

8198xA and 8194xA Compact Tunable Laser Source (cont.)

81980A and 81989A Compact Tunable Laser Source, 1465 nm – 1575 nm
81940A and 81949A Compact Tunable Laser Source, 1520 nm – 1630 nm

	Agilent 81980A, 81940A	Agilent 81989A, 81949A
Wavelength Range	1465 nm to 1575 nm (81980A and 81989A) 1520 nm to 1630 nm (81940A and 81949A)	
Wavelength Resolution	1 pm, 125 MHz at 1550 nm	5 pm, 625 MHz at 1550 nm
Mode-hop Free Tuning Range	Full wavelength range	
Maximum Tuning Speed	50 nm/s	
Absolute Wavelength Accuracy	±20 pm	±100 pm
Relative Wavelength Accuracy	±10 pm, typ. ±5 pm	±50 pm
Wavelength Repeatability	±2.5 pm, typ. ±1 pm	±5 pm
Wavelength Stability (typ., over 24 h)[3]	±2.5 pm	±5 pm
Linewidth (typ.), Coherence Control Off **Effective Linewidth (typ.),** **Coherence Control On[1]**	100 kHz >50 MHz for 1525 nm – 1575 nm (81980A and 81989A) >50 MHz for 1570 nm – 1620 nm (81940A and 81949A)	
Maximum Output Power **(Continuous Power During Tuning)**	≥+10 dBm ≥+13 dBm for 1525 nm – 1575 nm (81980A and 81989A) ≥+13 dBm for 1570 nm – 1620 nm (81940A and 81949A)	
Minimum Output Power	+6 dBm	
Power Linearity (typ.)	±0.1 dB	
Power Stability[3]	±0.01 dB over 1 hour typ. ±0.0075 dB over 1 hour typ. ±0.03 dB over 24 hours	
Power Flatness Versus Wavelength	±0.3 dB, typ. ±0.15 dB	
Power Repeatability (typ.)	±10 mdB	
Side-mode Suppression Ratio (typ.)[1]	≥45 dB	
Signal to Source Spontaneous **Emission Ratio[2]**	≥45 dB 48 dB/nm for 1525 nm – 1575 nm (81980A and 81989A) 48 dB/nm for 1570 nm – 1620 nm (81940A and 81949A)	
Signal to Total Source **Spontaneous Emission Ratio (typ.)[1]**	≥25 dB ≥30 dB for 1525 nm – 1575 nm (81980A and 81989A) ≥30 dB for 1570 nm – 1620 nm (81940A and 81949A)	
Relative Intensity Noise (RIN) (typ.)[1]	–145 dB/Hz	
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm	

[1] At maximum output power as specified per wavelength range.
[2] Value for 1 nm resolution bandwidth.
[3] At constant temperature ±0.5 K.

- **SMF with 1310 nm, 1550 nm, or 1310/1550 nm, and MMF with 850 nm**
- **Selectable 1 mW or 20 mW output power**
- **Excellent CW power stability of <±0.005 dB (15 min.)**
- **Return loss test in combination with Agilent Return Loss module**

Flexible Application Fit

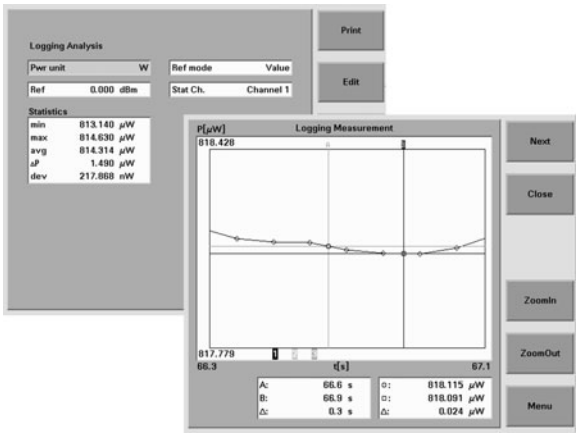
Agilent 8165xA Fabry-Perot laser source are a family of plug-in modules for Agilent's Lightwave Solution Platform. Laser module offers ideal power and loss characterization solution for optical component and fiber with wavelength at 850 nm, 1310 nm, and 1550 nm, mainly used in optical telecommunication including today's fiber to the home (FTTH) and short reach applications such as Fibre Channel and Gigabit Ethernet.

Ideal Solution for IL, RL, and PDL Tests

Combination of Agilent's Fabry-Perot laser source and wide variety of power meter (or optical head) provides basic setup for insertion loss (IL) characterization. Operations of single click to reference and single connection of test device immediately show result of IL. Such measurement can be continuously repeated over time with ensured laser stability of <±0.005 dB to test in different environmental condition for durability which is normally required by fiber and sub-component manufactures. Agilent's 8161xA return loss module can utilize external laser source such as Fabry-Perot laser to setup Return loss (RL) test. Adding Agilent 8169A Polarization Controller enables testing of polarization property of optical components.

Ease of Manual Operation

Test environment is simple and small footprint. Manual manufacturing operation on work-bench requires friendly operating environment which allows user to operate without instrument training. Mainframe's build-in applications including stability, logging, PACT provides application-fit environment for instrument operation.



Logging application for flatness and PDL test using Fabry-Perot laser module

PnP Software Drivers for Fast Process Automation

The powerful and easy to use *Plug&Play* drivers allow fast implementation of complex measurement control programs.

8165xA Fabry-Perot Laser Modules (cont.)

Standard Modules, 0 dBm

	Agilent 81650A	Agilent 81651A	Agilent 81654A	Agilent 81655A E01[5]
Type	Fabry-Perot Laser			
Center Wavelength[1]	1310 nm ±15 nm	1550 nm ±15 nm	1310/1550 nm ±15 nm	850 nm ±10 nm
Fiber Type	Single-mode 9/125 µm	Single-mode 9/125 µm	Single-mode 9/125 µm	Standard multi-mode 50/125 µm
Spectral Bandwidth (rms)[1,2]	<3.5 nm	<4.5 nm	<3.5 nm/ 4.5 nm	<5.0 nm
Output Power	>0 dBm (1 mW)			>3 dBm (2 mW)
CW Power Stability[3,4] – short term (15 min.) – long term (24 h) – to back reflection (RL ≥14dB)	<± 0.005 dB typ. <± 0.003 dB with coherence control active typ. ±0.03 dB typ. ±0.003 dB			typ. <±0.005 dB typ.<±0.05 dB
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8″ x 1.3″ x 13.2″)			
Weight	0.5 kg			
Recalibration Period	2 years			
Operating Temperature	0°C to 45°C			
Humidity	Non condensing			
Warm-up Time	60 minutes[3]			

High Power Modules, 13 dBm

	Agilent 81655A	Agilent 81656A	Agilent 81657A
Type	Fabry-Perot Laser		
Center Wavelength[1]	1310 nm ± 15 nm	1550 nm ± 15 nm	1310/1550 nm ± 15 nm
Fiber Type	Standard single-mode 9/125 µm	Standard single-mode 9/125 µm	Standard single-mode 9/125 µm
Spectral Bandwidth (rms)[1,2]	<5.5 nm	<7.5 nm	<5.5 nm/7.5 nm
Output Power	>+13 dBm (20 mW)		
CW Power Stability[3,4] – short term (15 min.) – long term (24 h) – to back reflection (RL ≥14 dB)	<±0.005 dB typ <±0.003 dB with coherence control active typ. ±0.03 dB typ. ±0.003 dB		
Dimensions (H x W x D)	75 mm H x 32 mm W x 335 mm (2.8″ x 1.3″ x 13.2″)		
Weight	0.5 kg		
Recalibration Period	2 years		
Operating Temperature	0°C to 45°C		
Humidity	Noncondensing		
Warm-up Time	60 min[3]		

[1] Central wavelength is shown on display.
[2] rms: root mean square.
[3] Warm-up time 20 min, if previously stored at the same temperature.
[4] Controlled environment ($_{\Delta}$T = ±1°C).
[5] Special Option.

Supplementary Performance Characteristics

Internal Digital Modulation Mode

270 Hz, 330 Hz, 1 kHz, 2 kHz and free selection 200 Hz to 10 kHz.
All output signals are pulse shaped, duty cycle 50 %.
Internal coherence control for linewidth broadening.

Output Attenuation

The output power of all source modules can be attenuated from 0 dB to 6 dB in steps of 0.1 dB.

81635A
81634B
81630B
81636B
81623B
81624B
81626B
81628B

- **Complete wavelength range, 750 nm – 1800 nm**
- **Low uncertainty of ≤±0.8% at reference conditions**
- **Low PDL of ≤±0.005 dB, for polarization sensitive tests**
- **High dynamic range of 55 dB**
- **High power measurements of up to +40 dBm**
- **Support of high channel count testing with dual power sensor**
- **Support of bare-fiber and open-beam applications with a 5 mm detector**
- **Synchronous measurements with a laser source or external modulation**

Wide Variety of Optical Power Sensors and Optical Heads

Superiority of Agilent's stimulus-response test solutions have guaranteed performance. Agilent has been an industry leader in optical instrumentation since the early 1980s – excellence in laser sources, reliable power sensor modules and large detector optical heads.

Passive Component Test

For multi-channel devices, such as, CWDM and AWG, for R&D or the manufacturing environment, accurate measurements at a minimum cost are in demand. The modular design provides the user with the flexibility to add power meters or mainframes for high channel count or high dynamic range applications. Testing of free space optics, such as, thin film filter (TFF) and waveguide alignment, are easily supported with the optical head. Its 5 mm detector and long, moveable reach provides the user with easy handling.

Active Component Test

High power amplifiers and sources are developed today in order to transmit signals over longer distances and to support a high loss environment for complex systems. High power measurements of +40 dBm, can be accomplished without an attenuator, of which could add to the measurement uncertainty.

Research and Calibration

Low measurement uncertainty of <±0.8% and low PDL of <±0.005 dB are a couple of the key features found in the Agilent power sensors. All of Agilent's power meter products are NIST and PTB traceable to guarantee precise optical power measurements. All metrology labs are ISO 17025 certified to meet general requirements for the competence of testing and calibration laboratories.


Physikalisch-Technische Bundesanstalt
Braunschweig und Berlin
PTB
copy
Kalibrierschein
Calibration Certificate
Optical Power Meter
Agilent Technologies
Agilent 81624B
Agilent Technologies Manufacturing GmbH & Co KG
Photonic Measurement Division
Herrenberger Str. 130
71034 Böblingen, Germany
4
17.01.2005 - 03.02.2005
Braunschweig, 2005-02-07

Certificate of Calibration

Specifications

	Agilent 81635A	Agilent 81634B	Agilent 81630B
Sensor Element	InGaAs (dual)	InGaAs	InGaAs
Wavelength Range	800 nm to 1650 nm	800 nm to 1700 nm	970 nm to 1650 nm
Power Range	–80 dBm to +10 dBm	–110 dBm to +10 dBm	–70 dBm to +28 dBm
Applicable Fiber Type	Standard SM and MM up to 62.5 µm core size, NA ≤0.24	Standard SM and MM up to 100 µm core size, NA ≤0.3	Standard SM and MM up to 100 µm core size, NA ≤0.3
Uncertainty (accuracy) at Reference Conditions	typ. <±3.5 % (800 nm to 1200 nm) ±3 % (1200 nm to 1630 nm)	±2.5 % (1000 nm to 1630 nm)	±3.0 % for 1255 nm to 1630 nm at 980 nm ±3.5 % (add ±0.5% per nm if 980 nm is not the center wavelength) at 1060 nm ±4.0 % (add ±0.6% per nm if 1060 nm is not the center wavelength)
Total Uncertainty	typ. ±5.5% ± 200 pW (800 nm to 1200 nm) ±5% ± 20 pW (1200 nm to 1630 nm)	±4.5% ± 0.5 pW (1000 nm to 1630 nm)	±5 % ± 1.2 nW (1255 nm to 1630 nm) at 980 nm ±5.5 % ± 1.2 nW (add ±0.5% per nm if 980 nm is not the center wavelength) at 1060 nm ±6.0 % ± 1.2 nW (add ±0.6 % per nm if 1060 nm is not the center wavelength)
Relative Uncertainty – due to polarization – spectral ripple (due to interference)	 typ. <±0.015 dB typ. <±0.015 dB	 <±0.005 dB <±0.005 dB	 <±0.01 dB <±0.005 dB
Linearity (power) – at 23°C ± 5°C – at operating temp. range	CW –60 dBm to +10 dBm typ. <±0.02 dB (800 nm to 1200 nm) <±0.02 dB (1200 nm to 1630 nm) typ. <±0.06 dB (800 nm to 1200 nm) <±0.06 dB (1200 nm to 1630 nm)	CW –90 dBm to +10 dBm <±0.015 dB (1000 nm to 1630 nm) <±0.05 dB (1000 nm to 1630 nm)	CW –50 dBm to +28 dBm (970 nm – 1630 nm) ≤±0.05 dB ≤±0.15 dB
Return Loss	>40 dB	>55 dB	>55 dB
Noise (peak to peak)	typ. <200 pW (800 nm to 1200 nm) <20 pW (1200 nm to 1630 nm)	<0.2 pW (1200 nm to 1630 nm)	<1.2 nW (1255 nm – 1630 nm)
Averaging Time (minimal)	100 µs	100 µs	100 µs
Analog Output	None	included	included
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8″ x 1.3″ x 13.2″)	75 mm x 32 mm x 335 mm (2.8″x 1.3″x 13.2″)	75 mm x 32 mm x 335 mm (2.8″x 1.3″x 13.2″)
Weight	0.5 kg	0.5 kg	0.6 kg
Recommended Recalibration Period	2 years	2 years	2 years
Operating Temperature	+10°C to +40°C	0°C to +45°C	0°C to +35°C
Humidity	Non-condensing	Non-condensing	Non-condensing
Warm-up Time	20 min	20 min	20 min

	Agilent 81636B
Sensor Element	InGaAs
Wavelength Range	1250 nm to 1640 nm
Power Range	–80 dBm to +10 dBm
Applicable Fiber Type	Standard SM and MM up to 62.5 µm core size, NA ≤0.24
Uncertainty (accuracy) at Reference Conditions	±3 % (1260 nm to 1630 nm)
Total Uncertainty	±5% ± 20 pW (1260 nm to 1630 nm)
Relative Uncertainty – due to polarization – spectral ripple (due to interference)	 typ. ±0.015 dB typ. ±0.015 dB
Linearity (power) – at 23°C ± 5°C – at operating temperature range	CW –60 to +10 dBm, (1260 nm to 1630 nm) <±0.02 dB <±0.06 dB
Return Loss	>40 dB
Noise (peak to peak)	<20 pW (1260 nm – 1630 nm)
Averaging Time (minimal)	25 µs
Dynamic Range at Manual Range Mode – at +10 dBm-range – at ±0 dBm-range – at –10 dBm-range – at –20 dBm-range	 typ. >55 dB typ. >55 dB typ. >52 dB typ. >45 dB
Noise at Manual Range Mode (peak to peak) – at +10 dBm-range – at ±0 dBm-range – at –10 dBm-range – at –20 dBm-range	CW –60 to +10 dBm, 1260 nm to 1630 nm <50 nW <5 nW <1 nW <500 pW
Analog Output	Included
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")
Weight	0.5 kg
Recommended Recalibration Period	2 years
Operating Temperature	+10°C to +40°C
Humidity	Non-condensing
Warm-up Time	0 min

	Agilent 81623B	Agilent 81623B Calibration Option C85/C86	Agilent 81623B Calibration Option C01/C02
Sensor Element	Ge, ø 5 mm		
Wavelength Range	750 nm to 1800 nm		
Power Range	–80 dBm to +10 dBm		
Applicable Fiber Type **Open Beam**	Standard SM and MM max 100 µm core size, NA ≤0.3 Parallel beam max ø 4 mm		
Uncertainty at Reference Conditions	±2.2 % (1000 nm to 1650 nm) ±3.0 % (800 nm to 1000 nm)	±2.2 % (1000 nm to 1650 nm) ±2.5 % (800 nm to 1000 nm)	±1.7 % (1000 nm to 1650 nm) ±3.0 % (800 nm to 1000 nm)
Total Uncertainty	±3.5% ± 100 pW (1000 nm to 1650 nm) ±4.0% ± 250 pW (800 nm to 1000 nm)	±3.5% ± 100 pW (1000 nm to 1650 nm) ±3.5% ± 250 pW (800 nm to 1000 nm)	±3.0% ± 100 pW (1000 nm to 1650 nm) ±4.0% ± 250 pW (800 nm to 1000 nm)
Relative Uncertainty – due to polarization – spectral ripple (due to interference)	<±0.01 dB (typ. <±0.005 dB) <±0.006 dB (typ. <±0.003 dB)		
Linearity (power) – at 23°C ±5°C – at operating temp. range	(CW –60 dBm to +10 dBm) <±0.025 dB <±0.05 dB		
Return Loss	>50 dB, typ. >55 dB		>56 dB
Noise (peak to peak)	<100 pW (1200 nm to 1630 nm) <400 pW (800 nm to 1200 nm)		
Averaging Time (minimal)	100 µs		
Analog Output	included		
Dimensions	57 mm x 66 mm x 156 mm		
Weight	0.5 kg		
Recommended Recalibration Period	2 years		
Operating Temperature	0°C to 40°C		
Humidity	Non-condensing		
Warm-up Time	40 min		

Optical Power Meter (cont.)

	Agilent 81624B	Agilent 81624B Calibration Option C01/C02	Agilent 81626B	Agilent 81626B Calibration Option C01/C02
Sensor Element	InGaAs, ø 5 mm		InGaAs, ø 5 mm	
Wavelength Range	800 nm to 1700 nm		850 nm to 1650 nm	
Power Range	–90 dBm to +10 dBm		–70 to +27 dBm (1250 nm to 1650 nm) –70 to +23 dBm (850 nm to 1650 nm)	
Applicable Fiber Type Open Beam	Standard SM and MM max 100 µm core size, NA ≤0.3 Parallel beam max ø 4 mm		Standard SM and MM max 100 µm core size, NA ≤0.3 Parallel beam max ø 4 mm	
Uncertainty at Reference Conditions	±2.2 % (1000 nm to 1630 nm)	±1.5 % (970 nm to 1630 nm)	±3.0 % (950 nm to 1630 nm)	±2.5 % (950 nm to 1630 nm)
Total Uncertainty	±3.5% ± 5 pW (1000 nm to 1630 nm)	±2.8% ± 5 pW (970 nm to 1630 nm)	±5.0% ± 500 pW (950 nm to 1630 nm)	±4.5% ± 500 pW (950 to 1630 nm max 23 dBm) (1250 to 1630 nm max 27 dBm)
Relative Uncertainty – due to polarization – spectral ripple (due to interference)	≤±0.005 dB (typ. ±0.002 dB) ≤±0.005 dB (typ. <±0.002 dB)		≤±0.005 dB (typ. ±0.002 dB) ≤±0.005 dB (typ. <±0.002 dB)	
Linearity (power) – at 23°C ±5°C – at operat. temp. range	CW –70 dBm to +10 dBm, 1000 nm to 1630 nm <±0.02 dB <±0.05 dB		CW –50 dBm to +27dBm, 950 nm to 1630 nm <±0.04 dB <±0.15 dB	
Return Loss	typ. 60 dB		>45 dB	>47 dB
Noise (peak to peak)	<5 pW		<500 pW	
Averaging Time (min.)	100 µs		100 µs	
Analog Output	included		Included	
Dimensions	57 mm x 66 mm x 156 mm		57 mm x 66 mm x 156 mm	
Weight	0.5 kg		0.5 kg	
Recommended Recalibration Period	2 years		2 years	
Operating Temperature	0°C to 40°C		0°C to +35°C	
Humidity	Non-condensing		Non-condensing	
Warm-up Time	40 min		40 min	

	Agilent 81628B with Integrating Sphere
Sensor Element	InGaAs
Wavelength Range	800 nm to 1700 nm
Power Range	–60 dBm to +40 dBm (800 nm to 1700 nm) For operation higher than 34 dBm[1]
Damage Power	40.5 dBm
Applicable Fiber Type Open Beam	Single mode NA ≤0.2, Multimode NA ≤0.4 ø ≤3 mm center of sphere
Uncertainty at Reference Conditions	±3.0 % (970 nm to 1630 nm)
Total Uncertainty ≤10 dBm >10 dBm to ≤20 dBm >20 dBm to ≤38 dBm	(970 nm to 1630 nm) ±4.0% ± 5 nW ±4.5% ±5%
Relative Uncertainty – due to polarization – due to speckle noise at source linewidth: 0.1 pm to 100 pm >100 pm	 typ. ≤±0.006 dB typ. ≤±0.02 dB typ. ≤±0.002 dB
Linearity (power) ≤10 dBm >10 dBm to ≤20 dBm >20 dBm to ≤37 dBm >37 dBm to ≤38 dBm	(CW –40 dBm to +38 dBm), (970 nm to 1630 nm) ≤±0.03 dB ≤±0.06 dB ≤±0.09 dB ≤±0.10 dB at 23°C ± 5°C, for operating temperature range add ±0.03 dB
Return Loss	typ. >75 dB
Noise (peak to peak)	<5 nW
Averaging Time (minimal)	100 µs
Analog Output	Included
Dimensions	55 mm x 80 mm x 250 mm
Weight	0.9 kg (without heat sink)
Recommended Recalibration Period	2 years
Operating Temperature	0°C to +40°C
Humidity	Non-condensing
Warm-up Time	40 min

[1] For optical power higher than 34 dBm the attached heat sink MUST be used! For continuous optical power or average optical power higher than 38 dBm the connector adapters will get warmer than permitted according to the safety standard IEC 61010-1. The 81628B Optical Head can handle optical power up to 40 dBm, however, operation above 38 dBm is at the operators own risk. Agilent Technologies Deutschland GmbH will not be liable for any damages caused by an operation above 38 dBm.

81610A
81613A

- **Single module for return loss (RL) test**
- **High dynamic range of 75 dB**
- **Build-in Fabry-Perot laser source for 1310 nm and 1550 nm**
- **Use any external laser source, including tunable laser for swept RL applications**
- **Three easy calibration steps for enhanced accuracy**

Plug&Play for RL measurement

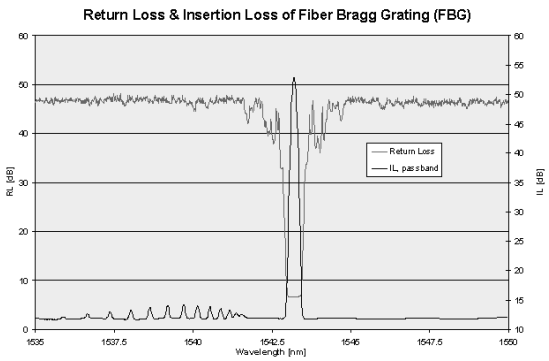
Portability and cost effective; a single mainframe, single module and single connection to the device under test are all you need to make a return loss (RL) measurement. Agilent's RL test solution solves the complex operation of calibration and is able to exclude measurement uncertainties due to coupler/filter usage in your design. In addition, a built-in FP laser at 1310 nm and 1550 nm enables basic component tests.

Meeting Manufacturing Needs

The need for IL and RL for optical component test is fulfilled with the RL module when used with an optical power meter – preferably an optical head due to its flexibility. On-board application software supports step-by-step operation with instructions.

Swept RL Measurement with a Tunable Laser Source

Today's passive component devices are not only characterized at a single wavelength, but over a wide wavelength range using a tunable laser source. The swept wavelength measurement concept is applicable for RL measurements using an Agilent tunable laser source (TLS) in synchronous operation of the two modules.



Swept RL Measurement, FBG with open and terminated output

Specifications

	81610A		81613A	
Source	external input only		Fabry-Perot Laser (internal)	
Output Power	—		typ. –4 dBm	
Center Wavelength	—		1310 nm/1550 nm ±20 nm typ.	
Sensor Element	InGaAs		InGaAs	
Fiber Type	Standard single-mode 9/125 µm		Standard single-mode 9/125 µm	
External Input	max input power: 10 dBm min input power: 0 dBm damage input power: 16 dBm		— — —	
Wavelength Range for External Input	1250 nm to 1640 nm		—	
Dynamic Range	70 dB		75 dB	
Relative Uncertainty of Return Loss (RL)	with broadband source	with Agilent FP sources	User calibration	*Plug&play*
RL ≤55 dB	<±0.25 dB	typ. <±0.5 dB	<±0.5 dB (typ. <±0.3 dB)	typ. <±0.6 dB
RL ≤60 dB	<±0.3 dB	typ. <±1.0 dB	<±0.6 dB (typ. <±0.4 dB)	typ. <±1.5 dB
RL ≤65 dB	<±0.65 dB	typ. <±2.0 dB	<±0.8 dB (typ. <±0.5 dB)	—
RL ≤70 dB	<±1.7 dB	—	<±1.9 dB (typ. <±0.8 dB)	—
RL ≤75 dB	—	—	typ. <±2.0 dB	—
Total Uncertainty	add ±0.2 dB	add typ. ±0.2 dB	add ±0.2 dB	add typ. ±0.2 dB
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8″ x 1.3″ x 13.2″)		75 mm x 32 mm x 335 mm (2.8″ x 1.3″ x 13.2″)	
Weight	0.6 kg		0.6 kg	
Recommended Recalibration Period	2 years		2 years	
Operating Temperature	10 to 40°C		10 to 40°C	
Humidity	Non-condensing		Non-condensing	
Warm-up Time	20 minutes		20 minutes	

- **Low insertion loss of 0.7 dB**
- **Flatness over Wavelength**
- **Wide wavelength coverage in both singlemode and multimode fiber**
- **High attenuation resolution of 0.001 dB**
- **Active power control option**

Modular Design, Fit for Various Components or Networks

Agilent's 8157xA variable optical attenuators are a family of plug-in modules for the Lightwave Solution Platform, 8163A/B, 8164A/B and 8166A/B. The attenuator modules 81570A, 81571A and 81578A occupy one slot, while modules 81576A and 81577A occupy two slots.

Variable Optical Attenuators

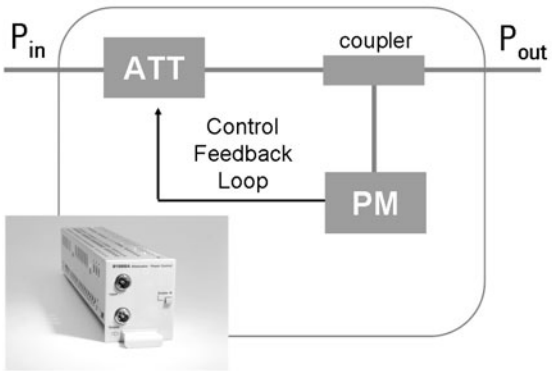
The Agilent 81570A, 81571A and 81578A are small, high resolution and are cost effective. Attributes of the attenuators are excellent wavelength flatness, ability to handle high input power levels and various calibration features to allow the user to set the reference power level. The attenuation and the power level, relative to the reference power, can be set and displayed on the mainframe user interface. The integrated shutter, can be used for protection from high power signals or to simulate channel drops.

Attenuators for High Optical Input Power

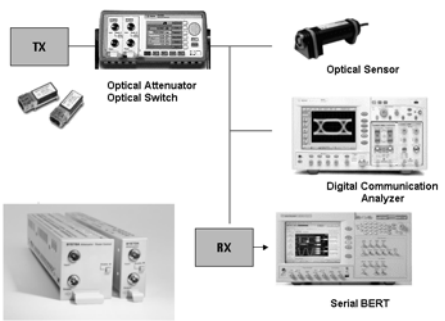
The Agilent attenuator modules feature excellent wavelength flatness and can handle input power levels of 2 mW. This attribute combined with the low insertion loss make them ideal for optical amplifier tests, such as, characterization of EDFAs and Raman amplifiers; as well as, for other multi-wavelength applications, for instance, DWDM transmission system test.

Attenuators with Power Control

Agilent's 81576A and 81577A attenuators have an added feature of dynamic power control. This function allows the user to control the attenuation more precisely by setting the output power level of attenuator, as opposed to only setting the attenuation. The module firmware uses a feedback signal from a photodiode after a monitor tap, both integrated in the module, to set and monitor the desired power level. When the power control mode is enabled, the module automatically corrects for power changes in the input signal to maintain the output level set by the user. After an initial calibration for connector interface uncertainties, absolute power levels can be set with high accuracy. The absolute accuracy of these power levels depends on the accuracy of the reference power meter used for calibration.



Block diagram of attenuator with power control



Transceiver and Receiver Test

Calibration Processes

A unique feature of the attenuator is the wavelength-offset table, which enhances the calibration capacity by setting the integral power of a DWDM signal with a known spectrum.

Specifications for 8157xA

Agilent's modular optical attenuators are a family of plug-in modules for Agilent's 8163A/B, 8164A/B and 8166A/B mainframes. Their high power handling capability together with excellent wavelength flatness and low insertion loss make them ideal for testing optical amplifiers and other DWDM test applications.

Modular Optical Attenuator Modules for High-Power Applications

	81570A	81571A	81576A		81577A	
Connectivity	Straight connector versatile interface	Angled connector versatile interface	Straight connector versatile interface		Angled connector versatile interface	
Fiber Type	9/125 µm SMF28		9/125 µm SMF			
Wavelength Range	1200 – 1700 nm		1250 – 1650 nm			
Attenuation Range	0 – 60 dB		0 – 60 dB			
Resolution	0.001 dB		0.001 dB			
			Attenuation Setting	**Power Setting**	**Attenuation Setting**	**Power Setting**
Repeatability[1]	±0.01 dB		±0.010 dB	±0.015 dB[14]	±0.010 dB	±0.015 dB[14]
Accuracy (uncertainty)[1, 2, 3, 4]	±0.1 dB		±0.1 dB	—	±0.1 dB	—
Settling Time (typical)[5]	typ. 100 ms		100 ms	300 ms	100 ms	300 ms
Transition Speed (typical)	0.1 – 12 dB/s		0.1 – 12 dB/s			
Relative Power Meter Uncertainty[15]	—		±0.03 dB ± 200 pW[16]			
Attenuation Flatness[1, 4, 6]	<±0.07 dB (typically ±0.05 dB) for 1520 nm <λ <1620 nm[8] typically ±0.10 dB for 1420 nm <λ <1640 nm[8]					
Spectral Ripple (typical)[7]	±0.003 dB		±0.003 dB			
Insertion Loss[2, 4, 9, 10]	Typically 0.7 dB excluding connectors <1.6 dB (typically 1.0 dB) including connectors[11]		Typically 0.9 dB (excluding connectors) <1.8 dB (typically 1.2 dB) Connectors Including[11]			
Insertion-Loss Flatness (typical)[1, 11]	±0.1 dB for 1420 nm <λ <1615 nm[4]		±0.1 dB for 1420 nm <λ <1615 nm[4]			
Polarization-Dependent Loss[2, 9, 11]	<0.08 dBpp (typically 0.03 dBpp)		<0.10 dBpp (typically 0.05 dBpp)			
Polarization Extinction Ratio	—		—			
Return Loss (typical)[9, 11]	45 dB (at 1550 nm ±15 nm)	57 dB (at 1550 nm ±15 nm)	45 dB		57 dB	
Maximum Input Power[13]	+33 dBm	+33 dBm	+33 dBm		+33 dBm	
Shutter Isolation (typical)	100 dB	100 dB	100 dB		100 dB	

[1] At constant temperature.
[2] Output power >–40 dBm, input power <+27 dBm. For input power >+27 dBm add typically ±0.01 dB.
[3] Temperature within 23°C ± 5°C.
[4] Input power <+30 dBm; λ = 1550 nm ± 15 nm; typical for 1250 nm <λ <1650 nm.
[5] For unpolarized light (SMF versions), or polarized light with TE mode injected in the slow axis (PMF version).
[6] Step size <1 dB; for full range: typically 6 s.
[7] Relative to reference at 0 dB attenuation.
[8] Linewidth of source ≥100 MHz.
[9] λ_{disp} set to 1550 nm; attenuation ≤20 dB.
For attenuation >20 dB:
add typically 0.01 dB (α [db] – 20) for 1520 nm < λ <1620 nm.
and typically 0.02 dB (α [db] – 20) for 1420 nm <λ <1640 nm.
[10] For λ = 1550 nm ± 15 nm.
[11] Add typically 0.1 dB for λ = 1310 nm ± 15 nm.
[12] Measured with Agilent reference connectors.
[13] Excluding connectors, measured using a broadband source.
[14] Agilent Technologies assumes no responsibility for damages caused by scratched or poorly cleaned connectors.
[15] Output power >–40 dBm, input power <+27 dBm; for input power >+27 dBm add typically ±0.01 dB.
[16] Wavelength and SOP constant; temperature constant and between 23°C ±°C; λ <1630 nm.
[17] Input power ≤+27 dBm; for input power >+27 dBm add ±0.02 dB.

Variable Optical Attenuator Modules (Multimode Fibers)

The specifications below are valid for constant operating and signal launch conditions.

	81578A-050	81578A-062
Connectivity	Straight connector versatile interface	
Fiber Type	50/125 µm MMF	62.5/125 µm MMF
Wavelength Range	700 nm – 1400 nm	
Attenuation Range	0 – 60 dB	
Resolution	0.001 dB	
Repeatability[1, 2, 5]	±0.015 dB	
Accuracy (uncertainty)[1, 2, 3, 4, 5]	typ. ±0.15 dB (800 nm – 1350 nm) ±0.2 dB (at 850 nm ±15 nm, 1310 nm ±15 nm)	
Settling Time[6]	typ. 100 ms	
Transition Speed	typ. 0.1 – 12 dB/s	
Insertion Loss[1, 2, 4, 5]	typ. 1.0 dB (NA = 0.1) typ. 1.3 dB (NA = 0.2) 2.0 dB (NA = 0.2)	typ. 1.0 dB (NA = 0.1) typ. 1.3 dB (NA = 0.2) 2.0 dB (NA = 0.2) typ. 3.0 dB (NA = 0.27)
Return Loss[2, 5, 7]	typ. 27 dB	
Maximum Input Power[8]	+27 dBm	
Shutter Isolation	typ. 100 dB	
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.8" x 1.3" x 13.2")	
Weight	0.9 kg	
Recommended Recalibration Period	2 years	
Operating Temperature	10°C – 45°C	
Humidity	Non-condensing	
Warm-up Time	30 minutes	

[1] At constant operating conditions.
[2] Effective spectral bandwidth of source >5 nm.
[3] For mode launch conditions with NA = 0.2; for every ΔNA = 0.01 add typ. ±0.01 dB.
[4] Temperature within 23°C ±5°C and unpolarized light.
[5] At 850nm ±15 nm, 1310 nm ±15 nm.
[6] Step size <1 dB, for full range: typ. 6 seconds.
[7] The return loss is mainly limited by the return loss of the front panel connectors.
[8] Agilent Technologies Deutschland GmbH assumes no responsibility for damages caused by scratched or poorly cleaned connectors.

Ordering Information

For the most up-to-date information on Agilent 8157xA optical attenuators, please contact your Agilent Technologies sales representative or visit our web site at: **www.agilent.com/comms/lightwave**

Please contact your Agilent Technologies sales representative for a polarization maintaining fiber pigtail version.

Connector Interface
All modules require two connector interfaces, 81000xI series (physical contact).

81591B
81594B
81595B

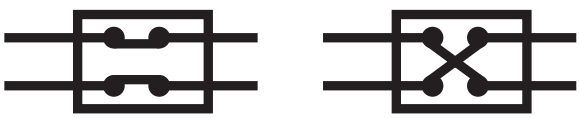
- **Wide wavelength range for singlemode and multimode applications**
- **Excellent repeatability specified over 10,000 random cycles**
- **Low insertion loss of <1.0 dB**
- **Single-slot modular design, allows up to 17 switches in one mainframe**

Modular Design for Solution Platform

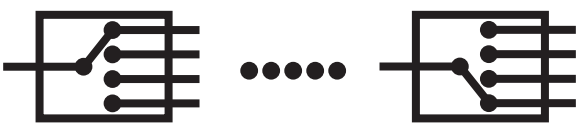
The Agilent modular optical switches are a family of plug-in modules to be used with the Lightwave Solution Platform. The switches enable manufacturers' of optical networks and components to automate their processes by routing optical signals to various test instrumentation. Adding modular optical switches to this instrument platform allows for a flexible and cost effective all-in-one solution to be developed for optical component tests in automated test environments.

The 1 x 2 optical switch has two positions:

The 2 x 2 non-blocking (crossover) optical switch also has two positions:

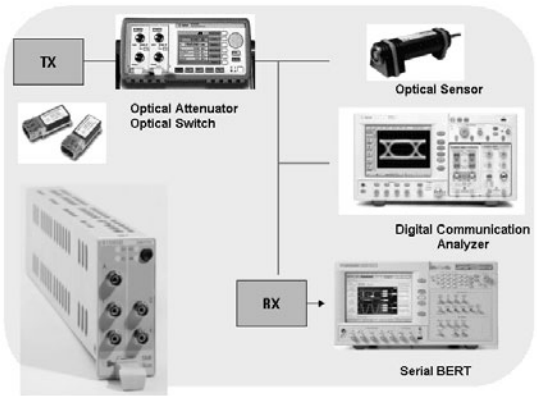


The 1 x 4 optical switch also has four positions:



Application Fit for Passive and Active Component Tests

Agilent's 8159xB modular optical switch family offers 1 x 2, 2 x 2 and 1 x 4 input/output port switching as plug-in modules for Agilent's 8163A/B, 8164A/B and 8166A/B mainframes. High repeatability makes the switches ideal for signal routing in automated test environments. Each switch type is available with angled FC connectors for singlemode and straight FC connectors for multimode applications.



Solution for system integration using optical switch

Integrating Switches Without Increasing System Uncertainty

Agilent's switching modules are designed for the best optical performance. Therefore you gain the flexibility you need in your automated test stations without compromising your measurement accuracy.

Modular Optical Switch Specifications

	81591B		81594B		81595B	
Switch Type	1 x 2		2 x 2		1 x 4	
Fiber Interface	# 009 single mode	# 062 multimode	# 009 single mode	# 062 multimode	# 009 single mode	# 062 multimode
Fiber Type	9/125 µm SMF	62.5/125 µm MMF	9/125 µm SMF	62.5/125 µm MMF	9/125 µm SMF	62.5/125 µm MMF
Connectivity	FC/APC – R angled	FC/PC straight	FC/APC – R angled	FC/PC straight	FC/APC – R angled	FC/PC straight
Wavelength Range	1270 – 1670 nm	700 – 1400 nm	1270 – 1670 nm	700 – 1400 nm	1270 – 1670 nm	700 – 1400 nm
Insertion Loss	<1.0 dB[3]	<1.0 dB[1]	<1.5 dB[3]	<1.0 dB[1]	<2.0 dB[4]	<2.0 dB[1]
Polarization Dependent Loss	typ. 0.05 dBpp	N/A	typ. 0.05 dBpp	N/A	typ. 0.07 dBpp	N/A
Repeatability[2]	±0.02 dB	±0.02 dB[1]	±0.02 dB	±0.02 dB[1]	±0.03 dB	±0.03 dB[1]
Return Loss	typ. 55 dB	typ. 20 dB	typ. 50 dB	typ. 20 dB	typ. 55 dB	typ. 20 dB
Crosstalk	typ. –70 dB	typ. –70 dB	typ. –70 dB	typ. –70 dB	typ. –70 dB	typ. –70 dB
Switching Time	<10 ms					
Lifetime	>10 million cycles					
Maximum Input Power	+20 dBm					
Dimensions (H x W x D)	75 mm x 32 mm x 335 mm (2.9″ x 1.3″ x 13.2″)					
Weight	0.5 kg					
Operating Temperature	10°C to 45°C					
Storage Temperature[5]	–40°C to 70°C					
Humidity	Non-condensing					
Warm-up Time	30 min.					

[1] Specification is typical with 50/125 µm multimode fiber.
[2] Worst case measurement deviation over 10,000 random switching cycles.
[3] For λ = 1550 nm; for 1270 nm < λ < 1670 nm add 0.3 dB.
[4] For λ = 1550 nm; for 1270 nm < λ < 1670 nm add 0.6 dB.
[5] Allow minimum acclimatization of 2 hours if previously stored outside operating temperature range before turning on the module.

Ordering Information

Modules for single mode fiber interface: #009
Modules for multimode fiber interface: #062

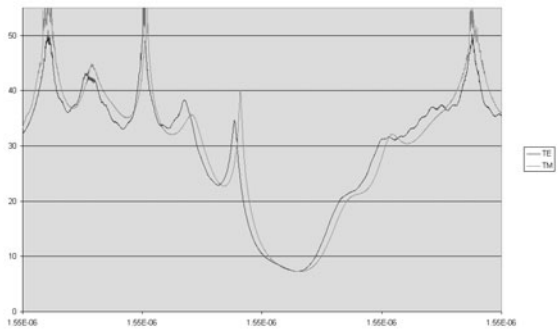
- **Precise manual and remote adjustments of polarization state**
- **Nine Save/Recall registers of SOP**
- **Continuous autoscanning mode, tuning the SOP across the entire Poincaré sphere**

Developing and manufacturing competitive, high-value components and systems for today's optical industries requires precise attention to polarization dependence. The Agilent 8169A Polarization Controllers can help by saving time, money and effort when measuring with controlled polarization.

Polarization dependence can occur in many components, including filters, multiplexers, EDFAs, polarization maintaining fiber, isolators, switches, lasers, detectors, couplers, modulators, interferometers, retardation plates and polarizers. Device performance will be determined by polarization-dependent sensitivity, loss, gain, degree of polarization and polarization mode dispersion. These polarization phenomena enhance or degrade performance depending on the application area, be it communications, sensors, optical computing or material analysis.

An Important Part of a Measurement System

A polarization controller is an important building block of an optical test system because it enables the creation of all possible states of polarization. For passive device test, the polarized signal stimulates the test device while the measurement system receiver monitors the response to changing polarization. Sometimes polarization must be adjusted without changing the optical power. At other times, polarization must be precisely synthesized to one state of polarization (SOP) and then adjusted to another SOP according to a predetermined path.



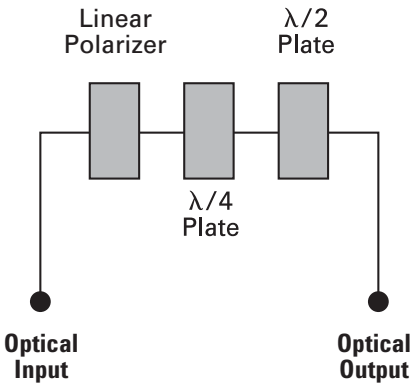
Characterizing polarization dependence of a passive optical filter component. Orthogonal great circles on the Poincaré sphere show how the Agilent 8169A synthesizes relative state-of-polarization points according to a specified path.

The Agilent 8169A Polarization Controller

The Agilent 8169A provides polarization synthesis relative to a built-in linear polarizer. The quarter-wave plate and half-wave plate are individually adjusted to create all possible states of polarization. The input light can be either polarized or unpolarized due to the input polarizer. Built-in algorithms within the Agilent 8169A enable the transition path from one state of polarization on the Poincare sphere to another to be specified along orthogonal great circles. These features are important because device response data can be correlated to specific states of polarization input to the test device. PDL measurement of DWDM components using the Mueller Matrix method is one of the main applications. The Mueller method stimulates the test path with four precisely known states. Precise measurement of the corresponding output intensities allows calculation of the upper row of the Mueller matrix, from which PDL is calculated. This method is fast, and ideal for swept-wavelength testing of PDL with high wavelength resolution.

Application Matrix for Agilent 8169A Polarization Controllers

Application Description	Agilent 8169A Application
1. Polarization synthesis	Yes
2. Complete, automatically stepped, adjustments of polarization over the entire Poincare sphere	Yes (deterministic)
3. Single-wavelength polarization – dependent loss measurement	Yes
4. Swept-wavelength polarization – dependent loss measurement	Yes
5. Polarization – dependent gain measurements of EDFA	Yes
6. Polarization nulling for EDFA characterization	Yes
7. Polarization sensitivity measurements of optical coupling factor	Yes (power delta vs SOP)
8. Optical waveguide TE/TM mode testing	Yes
9. Polarized beam alignment relative to principal polarization states of the test device	Yes
10. Polarization adjustment of optical launch conditions for polarization mode dispersion measurements	Yes
11. Simulate depolarized signals using rapid polarization scanning	Yes



Agilent 8169A Block Diagram

Specifications

Specifications describe the instruments' warranted performance over the 0° C to +55° C temperature range after a one-hour warm-up period. Characteristics provide information about non-warranted instrument performance. Specifications are given in normal type. Characteristics are stated in *italicized* type.Spliced fiber pigtail interfaces are assumed for all cases except where stated otherwise.

Description	Agilent 8169A
Operating Wavelength Range	1400 to 1640 nm
Insertion Loss Variation over 1 full rotation Variation over complete wavelength range	<1.5 dB ±<0.03 dB ±<0.1 dB
Polarization Extinction Ratio *Characteristic*	>45 dB (1530 to 1560 nm) >40 dB (1470 to 1570 nm) *>30 dB (1400 to 1640 nm)*
Polarization Adjustment Resolution Fast axis alignment accuracy at home position Angular adjustment accuracy: minimum step size greater than minimum step size *Settling time (characteristic)* Memory Save/Recall registers Angular repeatability after Save/Recall Number of scan rate settings Maximum rotation rate	 0.18° (360°/2048 encoder positions) ±0.2° ±0.09° ±<0.5° *<200 ms* 9 ±0.09° 2 360°/sec
Maximum Operating Input Power Limitation	+23 dBm
Operating Port Return Loss (characteristic) *Individual reflections*	 *>60 dB*
Power Requirements	48 to 60 Hz 100/120/220/240 V_{rms} 45 VA max
Weight	9 kg (20 lb)
Dimensions (H x W x D)	10 x 42.6 x 44.5 cm 3.9 x 16.8 x 17.5 in

81490A

Key Benefits

- Repeatable and reproducible measurements permit narrower production test margins and improved specifications of the characterized devices
- Reliable measurements ensure comparability of the test results
- Support for full compliance to IEEE 802.3ae stressed eye test in combination with the N4917A Optical Receiver Stress Test solution
- Wide extinction range offers highest test range coverage to ensure best quality of the tested devices under all target operating conditions
- Rapid test reconfiguration with dual-wavelength to switch between 1310 nm and 1550 nm by remote control or manually without exchanging a module
- Scalability with integration into industry-standard Agilent LMS platform extends your optical workbench capabilities

Specifications

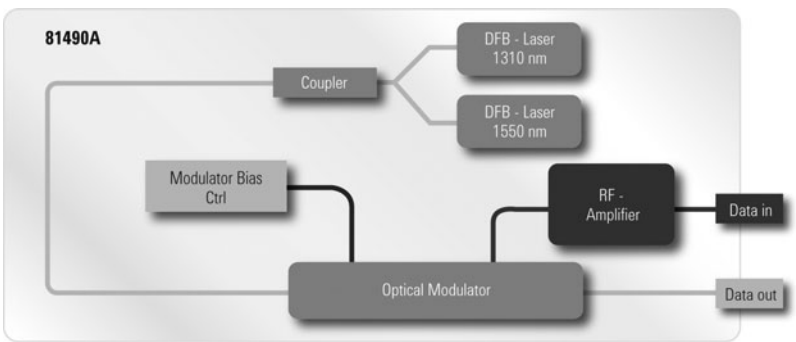
Extinction Ratio
ER 1 ... 10 dB
Rise and Fall Times
t_r, t_f (80/20) <30 ps
Vertical Eye Closure Penalty
VECP <0.5 dB
Jitter
<0.2 UI
Relative Intensity Noise (RIN)
RIN <–136 dB/Hz
Transmitter Wavelength
1310 ± 10 nm, 1550 nm ± 10 nm
Unmodulated Optical Output Power
P_{out} >4 mW

81490A Reference Transmitter

Agilent's 81490A Reference Transmitter is designed to offer excellent eye quality as a reference for testing 10_GbE-L and 10_Gb-E according to IEEE 802.3ae and according to 10 GFC Fibre Channel specifications. The module is fully integrated into the industry standard LMS 816xB platform.

Offering both 1310 and 1550 nm gives the fastest reconfiguration between these two transmission bands without reconnecting.

The separation of the signal source and the modulator is the only way to offer a zero-chirp modulation. This is essential for a clean and repeatable eye diagram when modulating with an appropriate clean external source to fulfill the requirements of the IEEE standard. Another advantage of this design compared to directly modulated transmitters is the wide extinction ratio range that can only be achieved with this design.



Reference Optical Receiver Module

81495A Reference Receiver

81495A

Key Benefits

- Clean eye for best loop back performance in transceiver test
- Low noise and low jitter to support reliable O/E conversion for stressed eye test
- Compliance to IEEE 802.3/10 GFC stressed eye test in combination with the N4917A Optical Receiver Stress Test solution
- Quick signal level verification and diagnosis with average optical power meter
- Scalability with integration in the industry standard Agilent LMS platform extends your optical workbench capabilities

Specifications

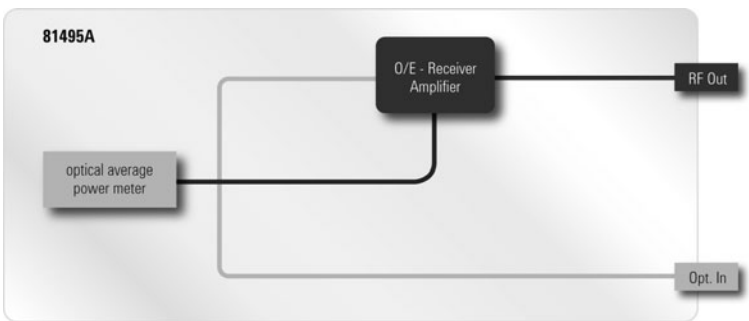
Conversion Gain
>400 V/W
Conversion Bandwidth
$f_{-3\ dB\ el}$ >9 GHz
Wavelength Range
1290 – 1560 nm
Measurement Range of Optical Power Meter
+3 ... –30 dBm
RF Output Coupling
DC
Fiber Output
SMF 9/125

81495A Reference Receiver

Agilent's 81495A single mode reference receiver is designed for testing transceiver loopback according to IEEE 802.3/10 GFC. The module is fully integrated into the industry standard LMS 816xB platform.

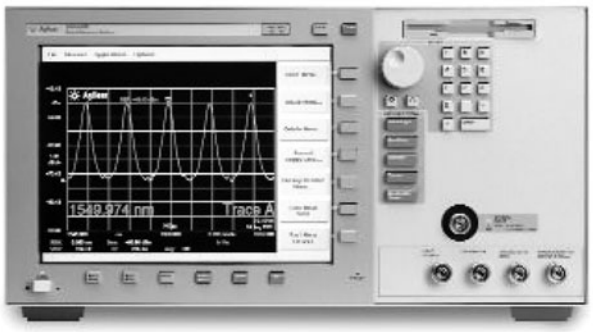
For the transceiver loop back test the return signal of the transceiver is feed back to the BERT (Bit Error Ratio Tester). As the transceiver output is optical, the signal must first be converted to the electrical domain with the 81495A Reference Receiver. The performance of this conversion has significant influence on the results of the loopback test. The 81495A reference receiver works perfectly with the N4917A Optical Transceiver Stress Test solution.

The 81495A reference receiver provides an integrated optical average power meter. The capability of verifying the average optical power of the connected signal at any time is a fast and simple way to avoid problems with the test setup and the test results.



86142B
86146B

- **Filter mode**
- **Excellent wavelength accuracy and low polarization dependence**
- **90 dBm sensitivity and 90 dB dynamic range**
- **Flexible monochromator output model**
- **Applications with automatic pass/fail checking**



Agilent 86164B

86142B and 86146B Optical Spectrum Analyzers

The Agilent 8164xB family of grating-based optical spectrum analyzers display the amplitude of light versus wavelength over a 600 to 1700 nm wavelength range. The OSA uses a patented double-pass monochromator design to simultaneously achieve high sensitivity and dynamic range with a fast sweep time. This is key for characterizing DWDM components and multiple channel systems, especially in a manufacturing environment where speed, accuracy and throughput are critical. The OSAs also have a two year calibration cycle keeping production on-line longer.

Built-in Applications

Agilent Technologies has developed a unique concept for built-in applications. The complete suite of applications enables the user to develop tests that can be customized to their particular measurement. The current package of applications contains the following:

- Passive component test application
- WDM application
- Amplifier test application
- Source test application

Additional Features

The Agilent 8614xB family of optical spectrum analyzers feature up to six traces and four independent markers. The built-in trace math function of the OSA allows for multiple traces to be used for normalization measurements. The markers allow for easy measurement of wavelength separation (GHz or nm), power density and optical signal-to-noise ratio.

Filter Mode

In Filter Mode, available with the 86146B, the light from the grating monochromator is directed to a single-mode fiber optical output from the instrument. The monochromator can be swept or set to a fixed wavelength. At the front panel, the user has the option of routing the light back to a photodetector in the OSA, especially for alignment, or to another instrument for analysis. As with standard operation, the resolution bandwidth of this tunable wavelength filter can be set by the user.

Channel Drop

One of the features of Filter Mode is to allow a single channel to be isolated from a tightly spaced DWDM signal. The WDM firmware application can sequentially or selectively drop WDM channels that require additional analysis. It is possible to select a certain wavelength or a certain channel to be dropped out. It can then be quantitatively analyzed in the time domain. It is now possible to switch between parametric measurements in the physical domain to functional measurements in the time domain.

Time Resolved Chirp

Agilent's filter mode channel-drop feature enables lower cost of test and higher flexibility of use than other solutions. However, the benefits don't end there. A second feature of Agilent's filter mode is the ability to measure time-resolved chirp (TRC). Chirp is the small frequency shift that occurs during optical signal modulation. It is caused by the slight changes in refractive index of the optical modulator. TRC is the instantaneous optical frequency deviation versus time. Measuring TRC enables lower cost lasers to be used in DWDM components.

The TRC measurement is made using the 86146B OSA and the 86100C Digital Component Analyzer. The 86100C requires an optical module like the 86105B, 86105C or 86116A. The software, provided with the 86146B performs the TRC measurement and Dispersion Penalty Calculation (DPC). The DPC routine can be used to qualify transmitters for the distance over which they can be used and is an alternative to measuring dispersion penalty using a bit error ratio setup.

Core Specification*	86142B	86146B
Wavelength		
Range	600 – 1700 nm	600 – 1700 nm
Accuracy		
1480 – 1570 nm	±0.01 nm	±0.01 nm
1570 – 1620 nm	±0.025 nm	±0.025 nm
Resolution Bandwidth		
FWHM	0.06, 0.1, 0.2, 0.4, 1.2, 5, 10 nm	0.06, 0.07, 0.1, 0.14 0.2, 0.33, 0.4, 1.2, 5, 10 nm
Polarization Dependence		
1530 nm, 1565 nm	±0.05 dB	±0.05 dB
1250 nm – 1650 nm	±0.25 dB	±0.25 dB
Dynamic Range (0.1 nm RBW)		
1250 – 1610nm		
±0.5, 1, 5 nm	–70 dB	
At ±0.8 nm	–60 dB	–60 dB
At ±0.4 nm	–55 dB	–55 dB

* For detailed spec conditions please refer to technical specification.

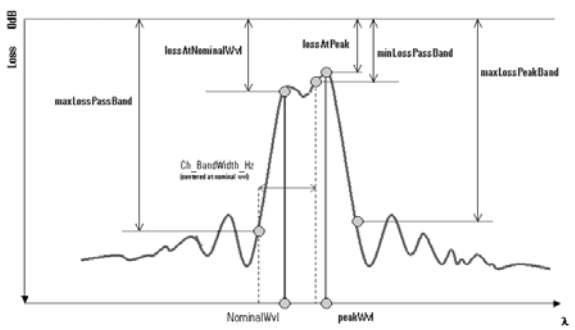
N4150A Photonic Foundation Library

N4150A

- **Software library to enable automation of stimulus-response system**
- **Predetermined solution specification**
- **Easy-to-use Application-Programmable Interface (API) with *Plug&Play* drivers**
- **Ready-to-go user interface with the Photonic Analysis Toolbox**

Comprehensive Analysis Tool for Component Research

Measuring just the IL or PDL is often not sufficient to characterize component and fibers. To obtain a more complete picture of the component's characteristics, especially for WDM components, further parameters such as bandwidth, channel spacing, center wavelength are desired. The PFL offers a set of functions to analyze spectral insertion loss measurement.

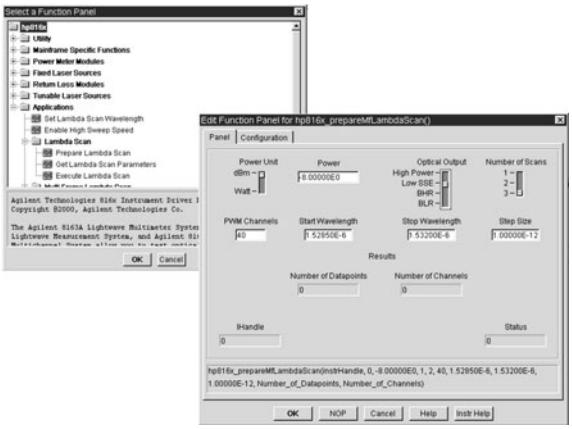


Analysis Tool for Component Characterization

Test Software Solution for High-Volume Manufacturing

A novel class of test software, especially designed to suit the speed, automation and reliability requirements of the manufacturing floor, can now be combined with the well-regarded reliability of Agilent's optical component test equipments.

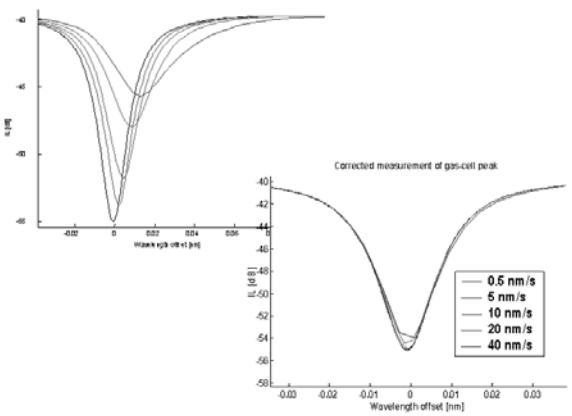
Reduce implementation time for system automation with easy Plug&Play driver or using user-friendly graphical programming environment of Agilent Photonic Foundation Library. Or simply copy & past from variety of sample programs provided in various programming environment.



Plug&Play driver

Remove Measurement Uncertainties

Adaption of appropriate power meter average time in conjunction with sweep speed of tunable laser source, correction of waveplate retardation error by polarization controller, correction of wavelength accuracy are some measurement uncertainty needed to be considered when tunable laser source and power meter are used for component test in a swept condition. Agilent Photonic Foundation Library is the industry's only tool to improve the measurement accuracy by proprietary methods, ensuring swept measurement performance close to the static performance at full speed.



Correction algorithm for spectrum characterization

Specifications

	Technical Specifications
Required Instruments and Options	8164B Lightwave Measurement System (mainframe); 81600B Tunable Laser module, #072 angled connector interface; One or more 81634A or 81634B Power Sensor(s); 8166A Lightwave Multichannel System(s) (mainframe), as many as required; Launch cable (81113PC or comparable), standard single-mode fiber, max. length 2 m, connects directly to power meter (straight cleave or connector) for reference measurement, and to device under test for device measurement (splice or connector); 8169A Polarization Controller, #022 angled connector interface; N4160A Jumper Cable Kit, length 0.4 m, protected standard single-mode fiber, E-2108.6 angled connectors, required to connect tunable laser with polarization controller; Matching connector interfaces and adapters.
Required Test Station Controller and Software	PC as test station controller, according to minimum system requirements; N4150A or N4151A Photonic Foundation Library, release 1.0 or later; Mainframe software release 2.57 or later; Module firmware release 2.62 or later (81600B: release 2.63 or later); 816x VISA VXI*plug&play* driver, release 2.91 or later; 8169A VISA VXI*plug&play* driver, release 1.31 or later.
Wavelength Range	1520 nm to 1620 nm
Wavelength Resolution	0.5 pm, 62.5 MHz at 1550 nm
Absolute Wavelength Uncertainty (typ.)[1]	±3 pm
Relative Wavelength Uncertainty (typ.)[1]	±2 pm
Wavelength Repeatability (typ.)[1]	±1 pm
Insertion Loss Measurement Range (typ.)[2]	≥75 dB (3 sweeps) ≥60 dB (2 sweeps) ≥35 dB (1 sweep)
Operating Conditions	ambient temperature 20°C to 30°C, constant ±1 K relative humidity <80%, non-condensing
Warm-up Time	1 hour

	Insertion loss ≤10 dB PDL ≤0.25 dB_{pp}	**Insertion loss ≤35 dB PDL ≤0.25 dB_{pp}**	**Insertion loss ≤55 dB PDL ≤0.25 dB_{pp}**
Number of Sweeps	1	2	3
Relative Insertion Loss Uncertainty (typ.)[3, 4, 5]	±0.022 dB	±0.022 dB	±0.032 dB
Polarization Dependent Loss (PDL) Uncertainty (typ.) Device Under Test Connected with Fusion Splices[3, 5]	±0.020 dB	±0.030 dB	±0.080 dB
Polarization Dependent Loss (PDL) Uncertainty (typ.) Device Under Test Connected with Physical Connectors[3, 5]	±0.035 dB	±0.040 dB	±0.085 dB
Total Measurement Time (typ)[3, 6]	60 s (1 channel)	110 s (1 channel) 10 min (40 channels)	155 s (1 channel)

[1] Wavelength range 1520 – 1540 nm; sweep speed ≤10 nm/s, step size = sweep speed x 0.1 ms or integer multiples; power meter range ≥–40 dBm.
[2] Source power set to –8.5 dBm; power meter zeroing prior to measurement.
[3] Measurement settings as follows: 20 nm span; 2 pm step size; 5 or 10 nm/s sweep speed; coherence control off; individual reference measurement for each power meter channel prior to measurement. Source power set to –8.5 dBm. Valid where spectral response is flat within a range of ±50 pm.
[4] For polarization dependent devices, the measurement result corresponds to the insertion loss for unpolarized light.
[5] All optical patchcords and fibers fixed and settled for 3 minutes; launch cable connected directly to power meter.
[6] With recommended system configuration, no other application running in parallel. Includes instrument initialization, measurement of device under test at four states of polarization, data acquisition and transmission. Reference measurements excluded.

N7781A
N7782A
N7783A
N7784A
N7785A
N7786A
N7788A

N7781A Polarization Analyzer

The Agilent N7781A is a compact high-speed Polarization Analyzer which provides comprehensive capabilities for analyzing polarization properties of optical signals. This includes representation of the State of Polarization (SOP) on the Poincaré Sphere (Stokes Parameter). The on-board algorithms together with the on-board calibration data ensure highly accurate operation across a broad wavelength range.

Due to its real time measurement capability (1 MSamples/s) the instrument is well suited for analyzing disturbed and fluctuating signals as well as for control applications requiring real time feedback of polarization information.

Analogue data output ports are provided, for example for support of control loops in automated manufacturing test systems.

Key Features

- Measurement of Stokes Parameter (SOP)
- Measurement of degree of polarization (DOP)
- High-speed operation (>1 MSamples/s)
- Analog output port for DOP/SOP data
- Robust, no moving parts

N7782A PER Analyzer/N7783A Thermal Cycling Unit

Agilent's N7782A series of PER Analyzers has been designed for high speed and highly accurate testing of the polarization extinction ratio (PER) in PM fibers. The polarimetric measurement principle guarantees reliable measurements of PER values of up to 50 dB.

The real time measurement capability in combination with automation interfaces makes this unit ideally suited for integration in manufacturing systems, for example pig-tailing stations for laser diodes and planar waveguide components. Analog interfaces are provided for integration of the system in control loop applications.

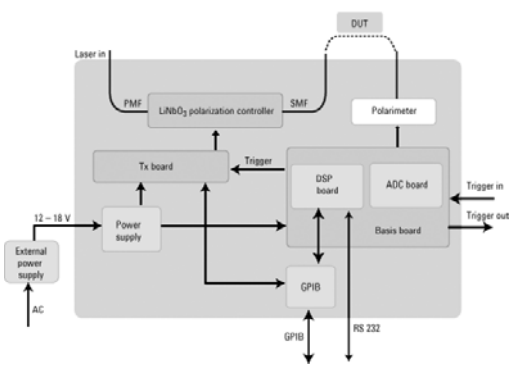
Key Benefits

- Accurate PER-measurement up to 50 dB
- Real-time display of PER
- Easy-to-use: Reliable results independent of operator skill set
- Swept-wavelength and heating/stretching method available
- Measurement of the PER versus wavelength
- Fast/slow axis detection
- Instruments available for 850 nm up to 1640 nm
- Internal fixed wavelength sources at 850 nm/1310 nm/1550 nm available

10

Agilent's Thermal Cycling Unit N7783A is fully controlled by the Agilent N7782A PER-Analyzer and allows accurate and repeatable cycling of the temperature of the fiber under test. The PER measurement system consisting of the Agilent N7782A and the Agilent N7783A shows excellent accuracy and repeatability. Ease of use and automation interfaces, such as analog output ports for active alignment, make it particularly useful for production environments.

N7788A PMD / PDL component analyzer setup



N7784A, N7785A, N7786A Polarization Conditioning Solutions

As Polarization Stabilizer the Agilent N7784A provides a stable output State of Polarization (SOP) even with fluctuations and drifts of the input SOP as occurring for example through temperature drift and mechanical settling processes. The stabilized output signal is guided in a Polarization Maintaining Fiber (PMF). Alternatively an external electrical feedback signal can be provided for stabilizing the SOP.

As Synchronous Scrambler the Agilent N7785A switches the SOP of the output signal in a (pseudo) random way. Switching of the SOP occurs within few microseconds. The SOP is stable for a predefined time until it again switches to a new SOP. An electrical trigger input can be used to synchronize the scrambler with external events.

As Polarization Stabilizer the Agilent N7786A provides a stable output State of Polarization (SOP) even with fluctuations and drifts of the input SOP. The stabilized output signal is guided in a Standard Single-Mode Fiber (SMF). The output SOP can be defined in following ways:

- **Set-and-forget:** When the front button is pushed, the current SOP is stored and maintained, even if polarization changes occur on the instrument input
- **Defined Stokes:** The target output SOP can be defined by the user using the Stokes parameters

With a built-in polarimeter the Agilent N7786A provides truly high-speed polarization analysis capabilities: More than 500,000 samples can be taken with a sample rate of up to 1 Megasamples per second.

The units do not contain any moving parts and therefore are robust and withstand even rough environmental conditions. All above mentioned are supported by a PC software package.

N7788A Optical Component Analyzer

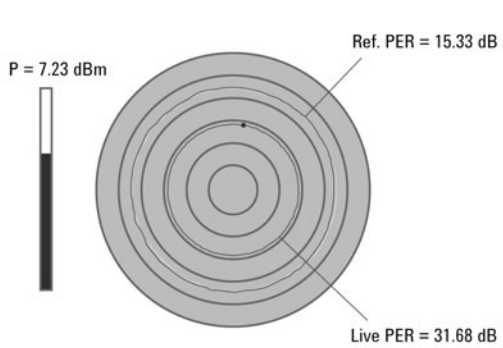
Agilent Technologies pushes the limits of component measurements with the N7788A Component Analyzer. Its proprietary technology is comparable with the well-known **Jones-Matrix-Eigenanalysis (JME)** which is the standard method for measuring Polarization Mode Dispersion (PMD) or differential group delay (DGD) of optical devices. Compared to the JME, Agilent's new **single scan technology** offers a range of advantages:

A complete set of parameters:

- DGD/PMD/PDL/2nd order PMD
- Power/Loss
- TE/TM-Loss
- Principal States of Polarization (PSPs)
- Jones and Mueller Matrices

Key Benefits

Highest accuracy in a single sweep: no averaging over multiple sweeps required
High measurement speed
Complete measurement across C/L-band in less than 10 seconds (no need to wait for many averages)
Robustness against fiber movement/vibration and drift: Fixing fibers with sticky tape on the table or even operation on isolated optical table is not required
No limitation on optical path length of component
The internal referencing scheme guarantees reliable and accurate measurements



N7781A Polarization Analyzer Characteristics

	Benchtop		
Option	-100	-200	-500
Operating Wavelength Range	850 nm – 1000 nm	950 nm – 1100 nm	1260 nm – 1640 nm
Factory Calibrated Range[1]	850 nm	980 nm	1460 nm to 1620 nm
SOP Accuracy	<±1° on Poincaré Sphere		
DOP Accuracy	<±2% <±0.5 % (typ.) after calibration[2]		
Sampling Rate	up to 1 MHz		
Maximum SOP Movement	Rate >50 K SOP-revolutions/s[3,4]		
Input Power Range	–50 dBm ... +7 dBm		
Operating Temperature	+10°C ... 40°C		
Interfaces	GPIB, USB		
Optical Connector Interfaces (other on request) N7781-021 N7781-022	 FC/PC Optical Connector (straight) FC/APC Optical Connector (angled)		
Dimensions (H x W x D)	70 mm x 330 mm x 270 mm (2.75" x 12.0" x 10.6")		
Analogue Output	0...5 V		
Power	100 V – 240 V, <36 W		

[1] Other factory calibration ranges on request.
[2] Valid at calibration wavelength and calibration temperature.
[3] SOP-revolutions in Stokes representation (Poincaré sphere).
[4] For input power >–20 dBm.

N7782A PER Analyzer Characteristics

	Benchtop						
Option	-100	-101	-200	-400	-401	-500	-501
Internal Fixed Wavelength Source	—	850 nm	—	—	1310 nm 1550 nm	—	1550 nm
Wavelength Operating Range	850 – 1000 nm		950 – 1100 nm	1260 – 1640 nm			
Factory Calibrated Range	850 nm		980 nm	1270 – 1375 nm 1460 – 1620 nm		1460 – 1620nm	
PER Range	0 – 50 dB						
Input Power Range	–35 ...10 dBm		–40 ...10 dBm	–50 dBm ... +7 dBm			
Measurement Update Rate	>10 Hz						
Displayed Parameters	PER, Power, Angle						
Operating Temperature	+5°C ... +40°C						
Interfaces	USB, GPIB, Analog ports for measurement output (0 to 5 V)						
Power	100 – 240 VAC, <36 W						
Dimensions (H x W x D)	70 mm x 330 mm x 270 mm (2.75" x 12.0" x 10.6")						

N7783A Thermal Cycling Unit Characteristics

Fiber Jacket Diameter	up to 3 mm
Thermal Cycling Time	1 to 10 seconds (adjustable)
Thermal Cycling Range	0°C to 60°C
Power	100 – 240 VAC, <36 W
Dimensions (H x W x D)	64 mm x 160 mm x 61 mm A state of the art PC with GPIB/USB Interface is required; it is not included

N7784A High Speed Polarization Controller Characteristics

Wavelength Operating Range	SOP scrambling and switching operation SOP stabilization[1]	1260 – 1640 nm 1550 ± 30 nm[2]
Speed	SOP Switching time Scrambler	<10 µs Up to 100 K SOPs/s
Reset Free, Endless Operation		Yes
DOP		<5% (when working as scrambler)
Polarization Extinction Ratio (when working as stabilizer)		>25 dB
Insertion Loss	SOP scrambling and switching operation SOP stabilization	<3 dB <5 dB
Max Input Power	Port I, II Port III	20 dBm 0 dBm[3]
Optical Connector Interface		FC/APC (others on request)

[1] Using the optical feedback signal through ports III and IV.
[2] Other wavelength ranges on request.
[3] Other Max Input Power levels for port III available upon request.

N7785A Synchronous Scrambler Characteristics

Wavelength Operating Range		1260 – 1640 nm
Speed	SOP Switching time Scrambler	<10 µs Up to 100 K SOPs/s
DOP		<5% (when working as scrambler)
Insertion Loss		<3 dB
Max. Input Power		20 dBm
Optical Connector Interface		FC/APC (others on request)

N7786A Polarization Synthesizer Characteristics

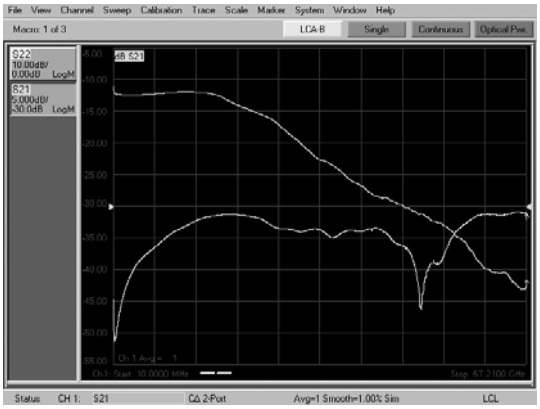
Polarization Control & Stabilization			
Wavelength Operating Range		1260 – 1640 nm[1]	
Speed	SOP Switching time SOP Cycle time Scrambler	<10 µs (non-deterministic) <25 µs (deterministic SOPs) Up to 100 K SOPs/s	
DOP		<5% (when working as scrambler)	
Reset-free, Endless Operation		Yes	
Remaining SOP Error (when stabilizing)		<2°	
Polarization Analysis			
Option		-400	-500
Wavelength Operating Range		1260 – 1640 nm	1260 – 1640 nm
Factory Calibrated Range		1270 – 1375 nm 1460 – 1620 nm	1460 – 1620 nm
SOP Accuracy		<±1° on Poincaré Sphere[2]	
DOP Accuracy		<±2% <±0.5% (typ.) after calibration	
Sampling Rate		Up to 1 MHz	
Internal Buffer		>500 000 samples	
Input Power Range		–26 dBm ... +19 dBm	
General			
Optical Connector Interface		FC/APC (others on request)	
Trigger Input/Output		TTL	
Insertion Loss		<4 dB	

[1] In "Defined Stokes" application: full accuracy is achieved only in factory calibration range of Polarization Analyzer.
[2] With respect to the signal at the Output connector of the instrument.

N7788A Optical Component Analyzer Characteristics

Option		-400	-500
Wavelength Operating Range[1]		1260 – 1640 nm	1260 – 1640 nm
Factory Calibrated Range[2]		1270 – 1375 nm 1460 – 1620 nm	1460 – 1620 nm
Wavelength Resolution		1 pm[3]	
Wavelength Accuracy		15 pm[3]	
PMD[4] **Range**		0 – 1000 ps	
PMD Accuracy		±(0.03 ps + 2% of PMD value)	
PDL Range		0 – 10 dB	
PDL Accuracy		±(0.01 dB + 4% of PDL value)[5]	
Dynamic Range		>57 dB	
Input Power Range		–50 dBm ... +7 dBm	
Optical Connector Laser Input		FC/APC (others on request)	
Optical Connector DUT	N7788A-031 N7788A-032	Straight DUT Port Angled DUT Port	

[1] The wavelength range for passive component test applications is determined by the overlap between the wavelength range of the tunable laser source and the wavelength range of the instrument.
[2] Other factory calibration wavelength ranges on request.
[3] Valid for operation with Agilent family of tunable laser sources. Because wavelength accuracy is determined by the tunable laser, operation with other laser sources may result in different wavelength accuracy.
[4] Average DGD value across 100 nm wavelength range.
[5] Valid for 1500 nm to 1620 nm.



N4373B Lightwave Component Analyzer

Agilent's N4373B Lightwave Component Analyzer (LCA) is the instrument of choice to test the most advanced 40 Gb/s electro-optical components, with up to 67 GHz modulation bandwidth.

Modern optical transmission systems require fast, accurate and repeatable characterization of the core electro-optical components, the transmitter, receiver, and their subcomponents (lasers, modulators and detectors), to guarantee performance with respect to modulation bandwidth, jitter, gain, and distortion.

The N4373B achieves fast measurements by including the E8361A Performance Network Analyzer. A unique new calibration concept significantly reduces setup time to a maximum of several minutes, depending on the selected measurement parameters. This results in increased productivity in R&D or on the manufacturing floor.

The fully integrated "turn-key" N4373B helps reduce time to market, compared to the time-consuming development of a self-made setup.

By optimizing the electrical and the optical design of the N4373B for lowest noise and ripple, the accuracy has been improved by better than a factor of 2, compared to its predecessor, the 86030A 50 GHz LCA. This increased accuracy improves the yield from tests performed with the N4373B by narrowing margins needed to pass the tested devices.

Using the advanced measurement capabilities of the network analyzer, all S-parameter related characteristics of the device under test, like responsivity and 3 dB-cutoff frequency, can be qualified with the new N4373B Lightwave Component Analyzer from 10 MHz to 67 GHz.

Key Benefits

- High absolute and relative accuracy measurements improve the yield of development and production processes. With the excellent accuracy and reproducibility, measurement results can be compared among test locations world wide
- High confidence and fast time-to-market with a NIST-traceable turn-key solution
- Significantly increased productivity using the fast and easy measurement setup with a unique new calibration process leads to lower cost of ownership

Relative Frequency Response Uncertainty
±0.5 dB @50 GHz (typ)
±1.0 dB @67 GHz (typ)
Absolute Frequency Response Uncertainty
±0.9 dB @50 GHz (typ)
±1.3 dB @67 GHz (typ)
Typical Noise Floor
–60 (55) $dB_{A/W}$ for O/E measurements @50 (67) GHz
–64 (59) $dB_{W/A}$ for E/O measurements @50 (67) GHz
Typical Phase Uncertainty: ±2.7°
Time Domain Option -010 Included
Transmitter Wavelength: 1550 nm ± 20 nm
Selectable Output Power at the Transmitter
Polarization Maintaining Fiber Output
Optimizes repeatability, especially for modulator characterization
Build-in Performance Test
Optical Input Power up to +15 dBm
Powerful Remote Control
State of the art COM programming interface based on Microsoft .NET® makes remote control fast and easy
USB Connector on Front Panel
Allows easy data transfer to other computers, even if no LAN is used

Applications

In digital photonic transmission systems, the performance is ultimately determined by Bit Error Ratio Test (BERT). As this parameter describes the performance of the whole system, it is necessary to design and qualify subcomponents like modulators and PIN detectors, which are analog by nature, with different parameters that reflect their individual performance.

These components significantly influence the overall performance of the transmission system with the following parameters:

- 3 dB bandwidth of the electro- optical transmission
- Relative frequency response, quantifying how the signal is transformed between optical and electrical or input and output vs. modulation frequency
- Absolute frequency response, relating the conversion efficiency of signals from the input to the output
- Electrical reflection at the RF port
- Group delay of the opto-electronic component

Only a careful design of these electro-optical components over a wide modulation signal bandwidth guarantees successful operation in the transmission system.

Features

Turn-key Solution

In today's highly competitive environment, short time-to-market with high quality is essential for new products. Instead of developing a time consuming home-grown measurement solution that might be limited in transferability and support, a fully specified and supported solution, helps to focus resources on faster development and on optimizing the manufacturing process.

In the N4373B, all optical and electrical components are carefully selected and matched to each other, to minimize noise and ripple in the measurement traces. Together with the temperature stabilization of the core components, this improves the repeatability and the accuracy of the overall system. Extensive factory calibration data ensures accurate and reliable measurements that can only be achieved with an integrated solution like the N4373B.

Easy Calibration

An LCA measures the modulation relation between optical and electrical signals. This is why user calibration of such systems can evolve into a time consuming task. With the new calibration process implemented in the N4373B the tasks that have to be done by the user are reduced to one electrical calibration. Even this can be automated with an ECAL kit, taking only several minutes depending on the LCA settings, without manual interaction.

State-of-the-art Remote Control

Testing the frequency response of electro-optical components under a wide range of parameters, which is often necessary in qualification cycles, is very time consuming and repetitive.

Therefore all functions of the LCA could be controlled remotely via LAN over a state-of-the-art Microsoft .NET or COM interface. Based on example programs it is very easy for every user to build applications for their requirements.

These examples are covering applications like integration of complete LCA measurement sequences into a Microsoft Excel® document.

Integrated Optical Average Power Meter

In cases where an unexpectedly low responsivity is measured from the device under test, it is very helpful to get a fast indication of the CW optical power that is launched into the LCA receiver. The reason might be caused by a bad connection or a bent fiber in the setup. For this reason a measurement of the average optical power at the LCA receiver is very helpful for fast debugging of the test setup.

This average power meter can be also used to set the exact average output power of the LCA transmitter by shorting the connection between the LCA optical transmitter output and the LCA optical receiver input. By adjusting the transmitter output power in the LCA user interface, the desired transmitter optical average power can be set.

PMF Output and Power Setting of the Transmitter

In applications like $LiNbO_3$ modulator characterization, it is necessary to launch stably polarized CW light into the optical modulator input. The N4373B LCA offers just this, as an additional feature for the E/O measurement. This saves the need for an additional DFB laser source, decreasing test cost and simplifying the setup.

Specification (for detailed specifications see technical data sheet)

Frequency Range	10 MHz to 67 GHz
LCA Optical Input	
Operating input wavelength range	1280 nm to 1625 nm
Maximum linear average input power	Optical input 1: +5 dBm Optical input 2: +15 dBm
Optical return loss (typ.)	>27 dBo
Average power measurement range	Optical input 1: –20 dBm to +5 dBm on optical input 1 Optical input 2: –10 dBm to +15 dBm on optical input 2
Average power measurement uncertainty (typ.)	±0.5 dBo
LCA Optical Output	
Optical modulation index (OMI)	>5 % typ. at 1 GHz modulation frequency and –8 dBm RF power
Output wavelength	(1550 ± 20) nm
Average output power range	–1 dBm to +5 dBm
Average output power uncertainty (typ.)	±0.5 dBo

N4373B Lightwave Component Analyzer (cont.)

System Performance O/E Measurements	0.05 GHz to 0.2 GHz	0.2 GHz to 0.7 GHz	0.7 GHz to 20 GHz	20 GHz to 50 GHz	50 GHz to 67 GHz
DUT Response ≥–26 dB (W/A)[1] Relative Frequency Response Uncertainty	±2.0 dBe typ.	±0.8 dBe (±0.5 dBe typ.)	±0.8 dBe (±0.5 dBe typ.)	±0.8 dBe (±0.5 dBe typ.)	±2.3 dBe (±1.3 dBe typ.)
DUT Response ≥–26 dB (W/A)[1] Absolute Frequency Response Uncertainty	±2.5 dBe typ.	±1.8 dBe (±0.9 dBe typ.)	±1.8 dBe (±0.9 dBe typ.)	±1.8 dBe (±0.9 dBe typ.)	±2.8 dBe (±1.3 dBe typ.)
DUT Response ≥–26 dB (W/A)[1] Frequency Response Repeatability (typ.)	±0.02 dBe	±0.02 dBe	±0.02 dBe	±0.1 dBe	±0.2 dBe
Minimum Measurable Frequency response (noise floor)[2]	–64 dB (W/A) typ.	–64 dB (W/A)	–64 dB (W/A)	–64 dB (W/A)	–59 dB (W/A)
DUT Response ≥–15 dB (A/W)[1] Relative Frequency Response Uncertainty[2]	±2.0 dBe typ.	±0.8 dBe (±0.5 dBe typ.)	±0.8 dBe (±0.5 dBe typ.)	±0.8 dBe (±0.5 dBe typ.)	±2.3 dBe (±1.3 dBe typ.)
DUT Response ≥–25 dB (A/W)[1] Absolute Frequency Response Uncertainty[2]	±2.5 dBe typ.	±1.8 dBe (±0.9 dBe typ.)	±1.8 dBe (±0.9 dBe typ.)	±1.8 dBe (±0.9 dBe typ.)	±2.8 dBe (±1.3 dBe typ.)
DUT Response ≥–15 dB (A/W)[1] Frequency Response Repeatability (typ.)[2]	±0.02 dBe	±0.02 dBe	±0.02 dBe	±0.2 dBe	±0.5 dBe
Minimum Measurable Frequency Response (noise floor)[2, 3]	–60 dB (A/W) typ.	–60 dB (A/W)	–60 dB (A/W)	–60 dB (A/W)	–55 dB (A/W)

Ordering Information

The N4373B consists of an N4373B-014, -010 67 GHz PNA and an optical test set which is mechanically connected to the PNA.
To protect your network analyzer investment, Agilent offers the integration of an already owned E8361A PNA with the optical test set.

N4373B Ordering Options

LCA Options
N4373B-301 67 GHz LCA Based on E8361A-014, -010 (time domain) PNA and 1550 nm Optical Test Set
Warranty: 1 year warranty
N4373B-399[1] 67 GHz, 1550 nm Optical Test Set with Integration of
- E8361A-014 Customer Supplied PNA,
- E8361A-UNL Customer Supplied PNA[2]

Includes:
- Recalibration and Performance Verification of PNA[3]
- 1 Year Warranty for Complete System Including PNA

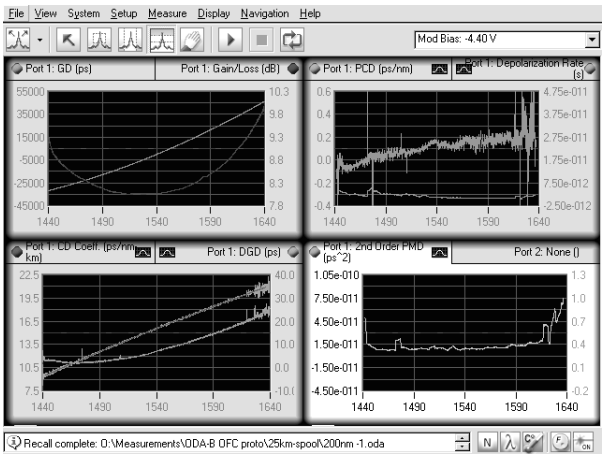
N4373B-021 Straight Connector
N4373B-022 Angled Connector (recommended)

Recommended Accessory
N4694A-00F 2 Port Microwave Electronic Calibration Kit f-f (required for specified performance)

Accessories[4]
N4373-87906 FC/APC to FC/APC Optical Patch Cord (0.5 m)
N4373-87907 FC/APC to FC/PC Optical Patch Cord (0.5 m)
81000NI FC/APC Optical Adapter
N5520B Adapter, 1.85 mm (f) to 1.85 (f), DC to 67 GHz
85058-60121 1.85 mm Test Port Adapter f-m
N4697-60200 f-m 1.85 mm Flexible Test Port Cable

[1] Customer supplied PNA other than the mentioned models will need additional technical effort. In this case call your local Agilent sales representative.
[2] Option -UNL decreases receiver sensitivity of PNA with impact to overall system specifications.
[3] Possible repair effort needed due to failure in recalibration and verification is not included.
[4] These accessories are included in the LCA shipment, and can be ordered separately for replacement.

- **Fastest measurement speed for high throughput in manufacturing test**
- **Highest CD and PMD accuracy and resolution for manufacturing and R&D**
- **Specified operation over 1260 to 1640 nm (O-L band)**
- **2nd-order PMD, GD-ripple and other analysis functions**
- **Expandable for enhanced PDL accuracy and multiport use**
- **Industry-standard measurements with the modulation phase shift method**



Agilent 86038B User Interface Display

An Innovative Solution for Loss and Dispersion Measurements

High transmission data rates in optical communication networks are achieved with components and fibers ensured to have appropriate loss and dispersion properties. The challenge is to deliver this assurance in an accurate and cost-effective way. The new Agilent 86038B can simultaneously measure chromatic dispersion (CD), polarization mode dispersion (PMD), insertion loss (IL), and polarization dependent loss (PDL), with the industry standard modulation phase shift method, allowing full characterization of optical components and fibers with a single connection. By integrating Agilent's premier tunable laser source (TLS) and performance network analyzer (PNA), the Agilent 86038B is optimized for high accuracy and resolution with fast swept-wavelength measurements.

Reduce Time to Market for 10 and 40 Gb/s

The new Agilent 86038B provides reliable accuracy and extensive analysis tools, giving deeper insight into device characteristics, faster, to reduce time to market. The time-consuming task of polarization-resolved spectral measurement is solved by implementing swept-wavelength measurements, characterizing group delay (GD) and attenuation spectra at a pre-determined set of polarization states, and using matrix analysis to calculate differential group delay (DGD), PMD and PDL. Higher-level analysis for 2nd-order PMD is also provided. For example, the measurement time for a 200 nm wavelength range is 20 seconds, enabling high throughput for lower costs.

Increase Throughput and Reduce Cost of Test

The modularity of the system design, using the modular TLS and 4-slot Lightwave Measurement System allows exchanging laser options and adding functional modules for flexible adaption to specific test needs, allowing more projects to be accepted and completed.

Specification

Group Delay and Differential Group Delay Measurement

Relative Group Delay Repeatability	
<0 dB to –10 dB level	±20 fs
<–10 dB to –20 dB level (characteristic)	±150 fs
<–20 dB to –30 dB level (characteristic)	±500 fs
<–30 dB to –40 dB level (characteristic)	±5 ps
Relative Group Delay Uncertainty (<0 dB to –10 dB level)	±50 fs
Differential Group Delay Repeatability	±50 fs
Differential Group Delay Uncertainty (<0 dB to –10 dB level)	±90 fs
PMD Uncertainty	±0.03 ps + 7%
2nd-order uncertainty (typ)	PCD based on DGD uncertainty
Group Delay Time Resolution	1 fs
Modulation Frequency Range	5 MHz to 2.5 GHz
Group Delay Loss Range	50 dB

Measurements performed at the same temperature as the normalization temperature ±0.5°C
Performance measured using a 2.2 meter thermally isolated SMF patch cord.
Modulation frequency = 2 GHz. IFBW = 70 Hz, 1 nm wavelength step size
Repeatability is defined as the worst (plus or minus) standard deviation over the TLS wavelength range from 10 sweeps.

Length Measurement

Length Uncertainty (typ)	±0.2 mm +5x10^{-6} L for L<56 km

Amplitude Measurement

Polarization Dependent Loss Accuracy	±0.15 typ (0.03 dB with Option #400)
System Dynamic Range (characteristic)	50 dB
Gain Loss Uncertainty	±0.1 dB typ. (0.02 dB with Option #400)

Wavelength Measurement

Wavelength Range	
with Agilent 81600B-200 Tunable Laser Source	1440 nm to 1640 nm
with Agilent 81600B-160 or 81640B	1495 nm to 1640 nm
with Agilent 81600B-150	1450 nm to 1590 nm
with Agilent 81600B-140	1370 nm to 1495 nm
with Agilent 81600B-130	1260 nm to 1375 nm
with Agilent 81640A	1510 nm to 1640 nm
Minimum Wavelength Step Size	0.1 pm
Absolute Wavelength Accuracy[1,2]	
Stepped mode with Agilent 86122A (typ.)	±1 pm
Swept mode without Agilent 86122A and with 81600B or 81640B	<5 pm
Stepped mode without Agilent 86122A and with 81640A	±15 pm
Relative Wavelength Accuracy[1,3]	
Stepped mode without Agilent 86122A and with 81600B or 81640B	±5 pm
Stepped mode without Agilent 86122A and with 81600B or 81640B (characteristic)	±2 pm
Stepped mode without Agilent 86122A and with 81640A	±7 pm
Stepped mode with Agilent 86122A and with 81640A (characteristic)	±3 pm

Optical Fiber Chromatic Dispersion Measurement

CD Accuracy	0.1ps/nm +0.3%CD
Zero Dispersion Wavelength Accuracy (characteristic)[4]	±150 pm
Zero Dispersion Wavelength Repeatability (characteristic)[4]	±9 pm
Accuracy of dispersion slope at the zero dispersion wavelength (characteristic)[4]	±25 fs/nm^2
Repeatability of dispersion slope at the zero dispersion wavelength (characteristic)[4]	±3 fs/nm^2

General Information

Assembled Dimensions: (H x W x D)	55.5 cm x 43.5 cm x 55.5 cm
Net Weight	Standard system: 54 kg

[1] Valid for one month and within a ±4.4 K temperature range after automatic wavelength zeroing. Measured with wavelength meter based on wavelength in vacuum.
[2] For details, refer to tunable laser's absolute wavelength accuracy specification.
[3] For details, refer to tunable laser's relative wavelength accuracy specification.
[4] Derived from GD specification.

- **Characterize WDM spectra during R&D, manufacturing, and commissioning**
- **Wavelength accuracy up to ±0.2 ppm**
- **Simultaneously measure wavelengths and powers of up to 1000 channels**
- **Automatic optical signal-to-noise ratio measurements**
- **Automated measurement routines and data logging**

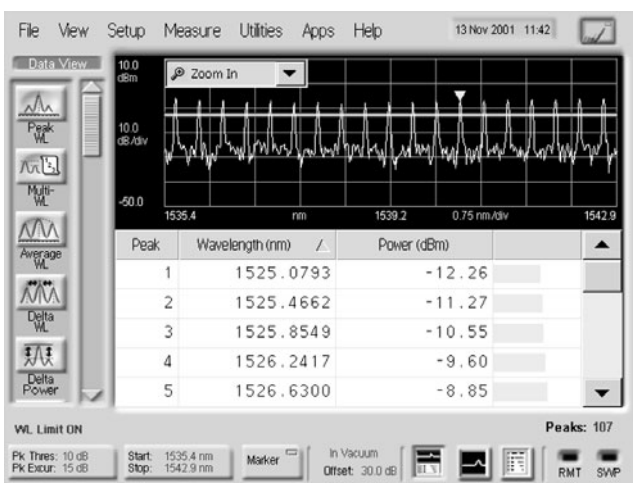
As the demand for access to more information increases, the need for greater capacity on transmission systems drives component manufacturers and network equipment manufacturers to push their capabilities to new limits. The successful design and deploy dense wavelength division multiplexing (DWDM) systems stringent performance criteria must be met in order to guarantee quality, uninterrupted communication. With Agilent multi-wavelength meters, you will be able to address these demands with confidence.

The Performance You Need – When You Need It

The Agilent family of multi-wavelength meters is just that – a family. Each model uses compatible SCPI remote commands. You pay for only the performance you need, when you need it. If your requirements become more demanding in the future, you can substitute another Agilent multi-wavelength meter, avoiding unnecessary cost and time developing new code for your test system. With the new 86122A, you can upgrade to a unit with the best performance available. Agilent multi-wavelength meters allow you to optimize test costs while protecting your investments.

Simultaneously Measure up to 1000 Wavelengths and Powers

The Agilent 86120B, 86120C, and 86122A multi-wavelength meters, like other Michelson interferometer-based wavelength meters, allow you to measure the average wavelength of the input signal. In addition, the Agilent multi-wavelength meters – with advanced digital processing – accurately and easily differentiate and measure up to 1000 (200 and 100 for the 86120C and 86120B, respectively) discrete wavelengths.



The new 86122A offers an easy-to-use graphical interface to optimize efficiency

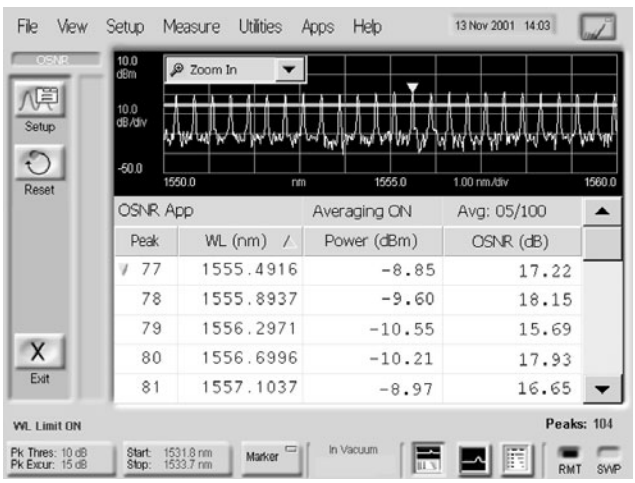
Agilent multi-wavelength meters simultaneously measure the individual powers of discrete wavelengths, offering the following measurement capabilities:

- 1 to 1000 wavelengths and powers
- Average wavelength and total power
- Up to ±0.2 ppm wavelength accuracy
- Up to 5 GHz wavelength resolution
- Calibrated for evaluation in air or vacuum
- Wavelength units in nm, THz, or wave number (cm^{-1})
- Amplitude units in dBm, mW, or µW
- OSNR and averaged OSNR for WDM SONET/SDH systems
- Rugged design to withstand strong shocks and vibrations

WDM Transmission Systems

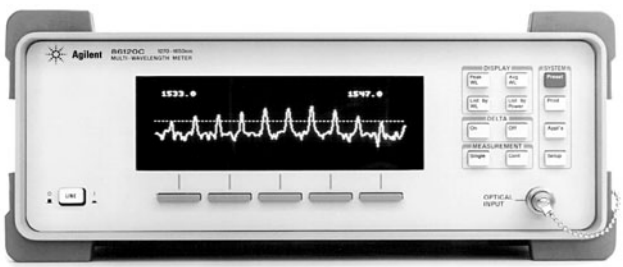
Combining measurement performance with reliability, the Agilent multi-wavelength meters allow easy and accurate verification of optical carrier performance in transmission systems by measuring wavelength, power, and optical signal-to-noise ratios during design and manufacturing test.

The 86122A multi-wavelength meter is optimized for measuring ultra-dense channel spacing with an absolute wavelength accuracy of up to ±0.2 ppm (±0.3 pm referenced to 1550 nm). With a resolution of <5 GHz, it is an ideal solution for the design and manufacturing of next-generation optical networks.



The Agilent 86122A displaying signal-to-noise ratios

With a rugged and portable package, the 86120B and 86120C multi-wavelength meters are ideal for optical network commissioning and monitoring applications. With the 86120C resolution of <10 GHz (<20 GHz for the 86120B) and absolute wavelength accuracy of ±2 ppm or ±3 pm at 1550 nm (±3 ppm, ±5 pm at 1550 nm for the 86120B), you can confidently verify system performance of DWDM systems with channels spaced at <50 GHz.



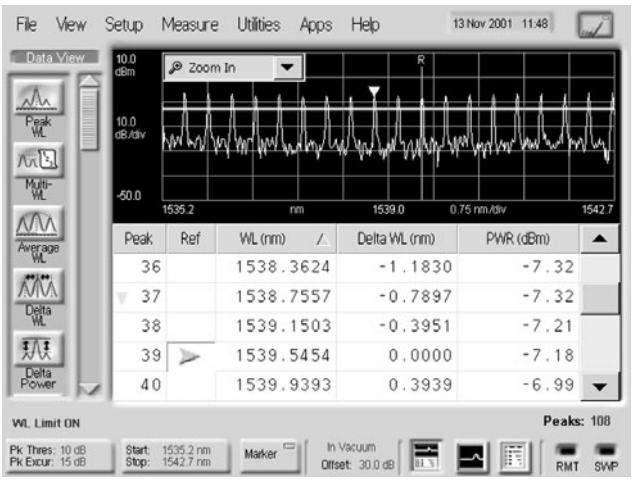
The Agilent 86120B/C and 86122A can simultaneously resolve and measure the individual optical carrier wavelengths and powers to confirm channel spacing, drift, crosstalk, and optical signal-to-noise ratios.

Sources

The superior wavelength and amplitude measurement capabilities of the Agilent 86120B, 86120C and 86122A multi-wavelength meters enable maximum performance of your components. You can measure DFB, FP or multiple DFB laser wavelengths and amplitudes during burn-in, environmental evaluation, final test, and incoming inspection. Calculate center wavelengths of broader linewidth sources, such as LED's or Bragg-grating filtered ASE responses, using the user-selectable broadband algorithm.

Relative Wavelength and Amplitude Measurements

The Agilent 86120B, 86120C, and 86122A allow you to optimize systems or components for wavelength stability and channel spacing. You can compare individual optical carrier wavelengths and powers to those of a user-selected reference, and monitor dynamic changes.



In Delta Mode, the Agilent 86122A displays relative wavelengths and powers

Built-in Data Logging

Designed with the R&D engineer in mind, the 86122A multi-wavelength meter allows you to capture changes in all system parameters over time, without having to develop external remote programs. Using the data-logging mode, the 86122A records measured data at user-specified intervals with a time stamp and stores the data on the built-in hard drive of the instrument. This data can then be easily downloaded via floppy drive, GPIB, or the LAN as a comma-separated variable (.csv) file to your spreadsheet program for graphing and analysis.

Advanced Measurement Applications Allow System Verification and Monitoring

The Agilent 86120B/C and 86122A multi-wavelength meters augment your productivity by processing the measurement data to automatically and directly give you system performance results, such as:

Drift

The Drift routine allows you to monitor, as a function of time or other dynamic conditions, changes in wavelength and amplitude of your optical signal or signals while simultaneously logging wavelength and amplitude:

- Current values – to give you the real-time status of your laser sources
- Maximum and minimum values – so you can record the limits reached during the measurement
- Total drift – so that you can measure the total variation of your signals during testing

Optical Signal-To-Noise Ratio

Verify transmission system performance with the Optical Signal- to-Noise Ratio routine, which easily allows you to determine all the signal-to-noise ratios in your system with:

- Noise measured halfway between channels – for quick verification
- Noise measured at user-defined wavelengths – for maximum flexibility
- Noise normalized to a 0.1 nm bandwidth – for easy comparison

Fabry-Perot Laser Characterization (available on 86120C and 86122A)

This measurement routine allows you to characterize your Fabry-Perot laser source quickly, easily, and accurately. You can obtain immediate results of:

- Total power
- Full-width at half maximum
- Mean wavelength
- Mode spacing

Coherence Length (available on 86120B only)

The Agilent 86120B automatically allows accurate measurements of the coherence length of Fabry-Perot laser sources typically used in CD-ROM drives or datacom transmission systems:

- Measurement range from 1 to 200 mm
- Accuracy within 5%
- Display laser coherence length and cavity optical length

Instrument Drivers

Instrument drivers compatible with LabView, Visual Basic, C++, and LabWindows are available for the Agilent 86120B, 86120C, and 86122A multi-wavelength meters. These drivers enable remote program development by offering building blocks that allow you to customize your measurements.

Specifications

The technical specifications apply to all functions over the temperature range 0 to 55°C and relative humidity <95%, unless otherwise noted. All specifications apply after the instrument's temperature has been stabilized for 15 minutes in Normal Update mode, unless otherwise noted.
Specifications describe the instrument's warranted performance. Supplementary performance characteristics provide information about non-warranted instrument performance in the form of nominal values, and are printed in *italic* typeface.

		86120B	86120C	86122A
Maximum Number of Laser Lines Input		100	200	1000
Wavelength	Range	700 – 1650 nm (182 to 428 THz)	1270 – 1650 nm (182 to 236 THz)	1270 – 1650 nm (182 to 236 THz)
	Absolute Accuracy	±3 ppm (±0.005 nm at 1550 nm, ±0.004 nm at 1310 nm) for laser lines separated by ≥30 GHz	±2 ppm (±0.003 nm at 1550 nm and 1310 nm) for laser lines separated by ≥15 GHz	±0.5 ppm (±0.75 pm at 1550 nm and ±0.65 pm at 1310 nm); ±0.2 ppm[1] (±0.3 pm at 1550 nm and 1310 nm) for laser lines separated by ≥10 GHz
	Minimum Resolvable Separation (equal power lines input)	*20 GHz (0.16 nm at 1550 nm, 0.11 nm at 1300 nm)*[2]	*10 GHz (0.08 nm at 1550 nm, 0.06 nm at 1300 nm)*[3]	*5 GHz (0.04 nm at 1550 nm; 0.03 nm at 1310 nm)*[4]
	Display Resolution	0.001 nm, normal update mode; 0.01 nm, fast update mode	0.001 nm	0.0001 nm
	Units	nm (vacuum or standard air), cm^{-1}, THz	nm (vacuum or standard air), cm^{-1}, THz	nm (vacuum or standard air), cm^{-1}, THz
Power	Absolute Accuracy	±0.5 dB (at ±30 nm from 780, 1310, and 1550 nm)	±0.5 dB (at ±30 nm from 1310 and 1550 nm)	±0.5 dB (at ±30 nm from 1310 and 1550 nm)
	Flatness, 30 nm from any wavelength	*±0.2 dB, 1200 – 1600 nm* *±0.5 dB, 700 – 1650 nm*	*±0.2 dB, 1270 – 1600 nm* *±0.5 dB, 1270 – 1650 nm*	*±0.2 dB, 1270 – 1600 nm* *±0.5 dB, 1270 – 1650 nm*
	Linearity	±0.3 dB, 1200 – 1600 nm	±0.3 dB, 1270 – 1600 nm	±0.3 dB, 1270 – 1600 nm
	Polarization Dependence	±0.5 dB, 1200 – 1600 nm *±1.0 dB, 700 – 1650 nm*	±0.5 dB, 1270 – 1600 nm *±1.0 dB, 1600 – 1650 nm*	±0.5 dB, 1270 – 1600 nm *±1.0 dB, 1600 – 1650 nm*
	Units	dBm, mW, µW	dBm, mW, µW	dBm, mW, µW
Sensitivity[5]	Single Line Input	–40 dBm, 1200 – 1600 nm	–40 dBm, 1270 – 1600 nm –30 dBm, 1600 – 1650 nm	–40 dBm, 1270 – 1600 nm –30 dBm, 1600 – 1650 nm
	Multiple Lines Input	*30 dB below total input power, but not less than single line input sensitivity, 700 – 1650 nm*	*30 dB below total input power, but not less than single line input sensitivity, 1270 – 1650 nm*	*30 dB below total input power, but not less than single line input sensitivity, 1270 – 1650 nm*
Input Power	Maximum Displayed Level (sum of all lines input)	+10 dBm	+10 dBm	+10 dBm
	Maximum Safe Input Level (sum of all lines input)	+18 dBm	+18 dBm	+18 dBm
Built-in Automatic Measurement Applications				
	Signal-to-Noise Ratio (0.1 nm noise bandwidth), lines above –25 dBm	*>35 dB, channel spacing ≥200 GHz* *>27 dB, channel spacing ≥100 GHz*	*>35 dB, channel spacing ≥100 GHz* *>27 dB, channel spacing ≥50 GHz*	*>35 dB, channel spacing ≥100 GHz* *>27 dB, channel spacing ≥50 GHz*
	Signal-to-Noise Ratio of Modulated Lasers (with averaging) (0.1 nm noise bandwidth), lines above –25 dBm, 100 averages	*>35 dB, channel spacing ≥200 GHz* *>27 dB, channel spacing ≥100 GHz*	*>35 dB, channel spacing ≥100 GHz* *>27 dB, channel spacing ≥50 GHz*	*>35 dB, channel spacing ≥100 GHz* *>27 dB, channel spacing ≥50 GHz*
	Drift	Max, Min, Max-Min wavelengths and powers over time		
Laser Classification		FDA Laser Class I according to 21 CFR 1040.10; IEC Laser Class 1 according to IEC 60825		
Dimensions		140 mm H x 340 mm W x 465 mm D (5.5 in x 13.4 in x 18.3 in)		133 mm H x 425 mm W x 520 mm D (5.2 in x 16.7 in x 20.5 in)
Weight		9 kg (19 lb)		14.5 kg (32 lb)

[1] Specify 86122A-002 option.
[2] For lines separated by less than 30 GHz, wavelength accuracy is reduced.
[3] For lines separated by less than 15 GHz, wavelength accuracy is reduced.
[4] For lines separated by less than 10 GHz, wavelength accuracy is reduced.
[5] Contact Agilent Technologies for availability of special instruments with higher sensitivity.

Accessories

Optical Head Adapters

These adapters are to be used with Agilent optical heads only.
The connector adapters are needed to attach connectorized fibers.
Optical Head Adapters with integral D-shape for 8162xx optical head (except 81628B – see threaded version):

81001FA FC/PC, FC/APC
81001KA SC
81001LA LC/F3000
81001PA E2000
81001MA MU
81000ZA Blank Adapter

Optical Head Adapters with threaded version for 81628B optical heads:

81000FA FC/PC, FC/APC
81000KA SC
81003LA LC/F3000
81000PA E2000
81000VA ST
81003TD MTP (for female connectors only)

Connector Adapter for Optical Heads

81624DD D-shaped adapter to be used with the Agilent 8162xx optical heads except 81628B. For use with threaded adapters.

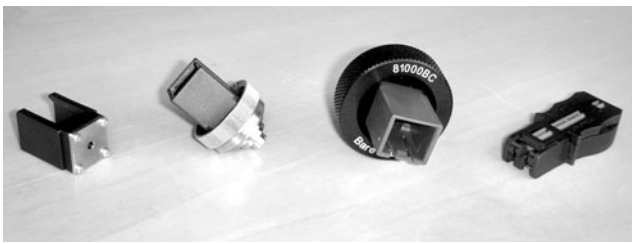
Optical Connector Interface

Used with Agilent Lightwave instruments and modules. Not to be used with optical heads. These flexible connector interfaces can be exchanged by the user and allow easy cleaning of instrument front-end interfaces.

Optical Connector Interface for straight and angled, physical and non-physical contact. All connectors are available for straight and angled connection, unless otherwise noted.

81000FI FC/PC (wide key)
81000NI FC/APC (narrow key)
81000KI SC
81000LI LC/F3000 physical contact
81002LI LC/F3000 sensor modules only
81000HI E2000 physical contact
81000PI E2000 sensor modules only
81000MI MU physical contact
81002MI MU sensor modules only
81000VI ST

Bare Fiber Adapters and Interfaces



81000BC Bare Fiber Connectivity Set for 81623B, 81624B and 81626B (1x head Adapter, 1x 0-400 µm fiber holder, 1x 400-900 µm fiber holder, 1x gauge)
81000BI Bare Fiber Connectivity Set for 81630B and 81634B (1x sensor adapter, 1x 0-400 µm fiber holder, 1x 400-900 µm fiber holder, 1x gauge)
81004BH Bare Fiber Holder Set (10x 0-400 µm fiber holder)
81009BH Bare Fiber Holder Set (10x 400-900 µm fiber holder)

Lenses

Used with the Agilent optical heads in combination with an optical head adapter.

81050BL Lens, effective focal length of lens = 6.2 mm, NA_{max} = 0.37, wavelength range 900 to 1700 nm, for multi-mode fibers with NA ≤0.3
81010BL Lens, effective focal length of lens = 2.9 mm, NA_{max} = 0.19, wavelength range 900 to 1700 nm, for single-mode fibers with NA ≤0.13

Universal Through Adapter

In combination with an Agilent 81000xI connector interface, this adapter allows you to mate an HMS-10 connector to another HMS-10, FC/PC/SPC, APC, DIN, ST, E-2000, or SC connector. It can also be used to mate an Agilent 81000BR reference reflector to a patchcord. The Agilent 81000UM is a through-adapter only. It can not be used at the fiber interfaces of the modules.

81000UM Universal Through Adapter

Reference Reflector

81000BR Reference Reflector
A gold-plated HMS-10 connector for use in calibrating return loss. Return loss is 0.18dB ± 0.1dB (96% ± 2%)
81610CC Calibrated Reflection Patchcord for use in calibrating return loss and front-panel offset in return loss measurements.