Agilent 8156xA and 8157xA Optical Attenuators

Technical Specifications

December 2002

Agilent's 8156xA and 8157xA Variable Optical Attenuators are instruments that attenuate and control the optical power level of light in single mode optical fibers. As plug-in modules for Agilent's Lightwave Multichannel platform (8163A/B, 8164A/B, 8166A/B) they allow you to set the attenuation factor and/or power level manually, or remotely via a common computer interface. Their high accuracy combined with their flexibility make them ideal as test and measurement equipment for the modern telecommunication industry.

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Modular Design for Multichannel Platform

Agilent's 8156xA and 8157xA variable optical attenuators are a family of plug-in modules for Agilent's Lightwave Multichannel Platform 8163A/B, 8164A/B and 8166A/B. The attenuator modules 81560A, 81561A, 81570A, 81571A and 81573A occupy one slot, while modules 81566A, 81567A, 81576A and 81577A occupy two slots. With 17 slots, the Agilent 8166A/B Lightwave Multichannel System can host up to 17 single slot modules or up to 8 dual slot modules.

Variable Optical Attenuators

The Agilent 81560A and 81561A are small, cost effective attenuator modules with high resolution for single wavelength applications. By entering the operating wavelength, the instrument automatically applies the appropriate corrections. Various calibration features allow the user to set a reference power. Both the attenuation and the power level, relative to the reference power, can then be set and displayed in the user interface. An integrated shutter, which can be used for protection purposes, or to simulate channel drops, is available.

Attenuator for High Optical Input Power

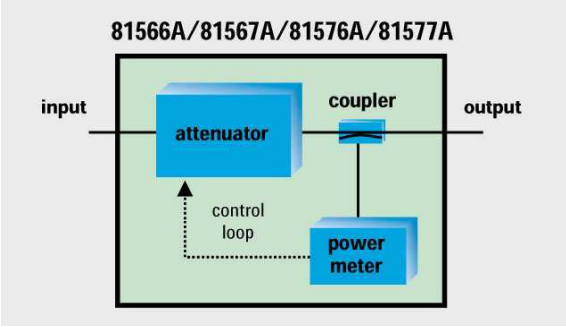
The Agilent 81570A and 81571A modules feature excellent wavelength flatness and can handle high input power levels. Combined with their low insertion loss, they are ideal for optical amplifer test, such as characterization of EDFAs and of Raman amplifiers, as well as for other multi-wavelength applications, such as DWDM transmission system test. Like the 81560A and 81561A, they feature the reference power functionality and an integrated shutter. A pigtail version can be used for optimization of insertion loss, polarization dependent loss and return loss when the fibers are spliced into the setup.

Attenuators with Power Control

Agilent's 81566A and 81567A attenuators feature power control functionality that allows you to set the output power level of the attenuator. The attenuator module firmware uses the feedback signal from a photo diode after a monitor tap, both integrated in the module, to set the desired power level at the output of the module. When the power control mode is enabled, the module automatically corrects power changes at the input to maintain the output level set by the user. After an initial calibration for the uncertainties at connector interfaces, absolute power levels can be set with high accuracy. The absolute accuracy of these power levels depends on the accuracy of the reference powermeter used for calibration.

Attenuators for High optical Input Power and with Power Control

The Agilent 81576A and 81577A also have the power control functionality of the Agilent 81566A and 81567A, but in addition, feature high power handling capability and excellent wavelength flatness for DWDM applications. To set a total power level of a multi-wavelength signal, it is necessary to determine the convolution of the singal's spectrum with the sensitivity of the photodiode over wavelength. An enhanced calibration feature supports this process and enables setting the integral power of a DWDM signal with a known spectrum.



Calibration Processes

Comprehensive offset functionality in the firmware enhances the calibration of the optical path in various test set-ups. There is an offset for the attenuation factor, and an independent offset for the output power level, to calibrate for losses due to the patch cords and connectors. Additionally, wavelength and offset value pairs can be stored in a table to compensate for wavelength dependent effects in the optical path of the set-up. This allows you to set the optical power level at your Device Under Test.

Calibration is even easier and more convenient if the reference powermeter and the attenuator are hosted by the same mainframe: All power related offsets can be determined by a firmware function that reads a value from the reference powermeter. The difference between the power value read by the reference powermeter and the actual value of the attenuator is automatically stored as the offset.

Key Features

- Wide wavelength range: 1200 - 1700 nm
- High resolution: 0.001 dB
- Modular design allows up to 17 attenuators in one mainframe
- Active power control options to set power levels directly
- Comprehensive offsets allow easy calibration of the set-up
- Integrated shutter
- Agilent's versatile optical connector interfaces for all common types of connectors

High Power Modules

- High input powers up to 2 Watt
- Excellent wavelength flatness: typical ±0.05 dB
- Low insertion loss: typical 0.7 dB
- Pigtail option

8156xA Applications

- Bit Error Rate test
- Characterization of receivers, transmitters and line cards
- Test of single channel transmission systems
- DWDM channel equalization
- Loss simulation in fiber optic links
- Testing and calibrating the linearity of power meters

8157xA Applications

Optical Amplifier Test
- Characterization of EDFAs
- Test of Raman amplifiers

Multichannel transmission system test
Loss simulation of DWDM signals in fiber optic links

The Agilent 8156xA and 8157xA modules are produced to the ISO 9001 international quality system standard as part of Agilent's commitment to continually increasing customer satisfaction through improved quality control.

Variable Optical Attenuator Modules

	Agilent 81560A	Agilent 81561A
Connectivity [1]	straight connector	angled connector
Fiber type	9/125 µm SMF28	9/125 µm SMF28
Wavelength range	1200-1700 nm	1200-1700 nm
Attenuation range	0-60 dB	0-60 dB
Resolution	0.001 dB	0.001 dB
Repeatability [2]	+/- 0.01 dB	+/- 0.01 dB
Accuracy (uncertainty) [3]	+/- 0.1 dB 4	+/- 0.1 dB 4
Settling time [5]	typ. 100 ms	typ. 100 ms
Insertion loss [6]	typ. 1.7 dB	typ. 1.7 dB
Polarization dependent loss 6 [7]	<0.05 dBpp	<0.05 dBpp
Return loss 6	typ. 45 dB	typ.60 dB
Maximum input power [8]	+22 dBm	+22 dBm
Shutter isolation	typ. 100 dB	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 min.	

(6.0)

[1] For Agilent's versatile optical connector interfaces

[2] At constant wavelength, temperature

[3] Unpolarized; temperature constant and within 23 °C ± 5 °C;
for input power • +10 dBm attenuation $_{nominal}$ = attenuation $_{display}$
for input power > 10 mW and 1500 nm < λ < 1600 nm apply correction:
attenuation $_{nominal}$ = attenuation $_{display}$ (1+0.0002 · (P[mW] - 10) · (λ[µm] - 1.5))

[4] For λ = 1550 nm ± 15 nm and for input power • +10 dBm; typically ± 0.1 dB for 1250 nm < λ < 1650 nm

[5] Stepsize < 1 dB; for full range typically 6 s

[6] For λ = 1550 nm ± 15 nm with Agilent reference connectors

[7] Temperature constant and within 23 °C ± 5 °C

[8] Exposure time <2h

Variable Optical Attenuator Modules with Power Control

	Agilent 81566A		Agilent 81567A	
Connectivity [1]	straight connector		angled connector	
Fiber type	9/125 µm SMF28		9/125 µm SMF28	
Wavelength range	1250-1650 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 [2]	+/- 0.01 dB	+/- 0.015 dB [3]	+/- 0.01 dB	+/- 0.015 dB [3]
Accuracy (uncertainty) [4]	+/- 0.1 dB 5		+/- 0.1 dB 5	
Settling time [6]	typ. 100 ms	typ. 300 ms	typ. 100 ms	typ. 300 ms
Relative power meter uncertainty [7]	+/- 0.03 dB +/- 20 pW		+/- 0.03 dB +/- 20 pW	
Insertion loss [8]	typ. 2.2 dB		typ. 2.2 dB	
Polarization dependent loss [8, 9]	<0.08 dBpp		<0.08 dBpp	
Return loss [8]	typ. 45 dB		typ. 60 dB	
Maximum input power [10]	+22 dBm		+22 dBm	
Shutter isolation	typ. 100 dB		typ. 100 dB	
Weight	1.3 kg			
Dimensions (H x W x D)	75 mm x 64 mm x 335 mm (2.8″ x 2.6″ x 13.2″)			
Recommended recalibration period	2 years			
Operating temperature	10 °C – 45 °C			
Humidity	Non-condensing			
Warm-up time	30 min.			

(6.0)

[1] For Agilent's versatile optical connector interfaces
[2] At constant wavelength, temperature
[3] Output power > -50 dBm, input power •+17 dBm, for input power >+17 dBm add typically ± 0.01 dB
[4] Unpolarized; temperature constant and within 23 °C ± 5 °C;
for input power • +10 dBm attenuation nominal = attenuation display
for input power > 10 mW and 1500 nm < λ < 1600 nm apply correction:
attenuation nominal = attenuation display (1+0.0002 · (P[mW] - 10) · (λ[µm] - 1.5))
[5] For λ = 1550 nm ± 15 nm and for input power < +10 dBm; typically ± 0.1 dB for 1250 nm < λ < 1650 nm
[6] Stepsize < 1 dB; for full range typically 6 s
[7] For λ < 1630 nm and constant wavelength; SOP constant; temperature constant and within 23°C ± 5°C,
input power <+17dBm, for input power > +17 dBm add ± 0.02 dB
[8] For λ = 1550 nm ± 15 nm with Agilent reference connectors
[9] Temperature constant and within 23 °C ± 5 °C
[10] Exposure time < 2h

Variable Optical Attenuator Modules for high-power applications

	81570A	81571A	81573A	81575A
Connectivity	straight connector versatile interface	angled connector versatile interface	SMF pigtail FC/APC termination	PMF pigtail SC/APC termination
Fiber type	9/125 µm SMF28	9/125 µm SMF28	9/125 µm SMF28	Fujikura PANDA 8/125 cutoff < 1400nm
Wavelength range	1200 – 1700 nm			
Attenuation range	0-60 dB			
Resolution	0.001 dB			
Repeatability [1]	+/- 0.01 dB			
Accuracy (uncertainty) [1, 2, 3, 4]	+/-0.1 dB			+/-0.2 dB
Settling time [5]	typ. 100 ms			
Transition speed	typ. 0.1 ... 12 dB/s			
Attenuation flatness [1, 4, 6]	< +/- 0.07 dB (typ. +/- 0.05 dB) for 1520 nm < λ < 1620 nm [8] typ. +/- 0.10 dB for 1420 nm < λ < 1640 nm [8]			
Spectral ripple [7]	typ. +/- 0.003 dB			
Insertion loss [2, 4, 9, 10]	typ. 0.7 dB excluding connectors < 1.6 dB (typ. 1.0 dB) including connectors 11			typ. 0.7 dB excl. connectors typ. 1.2 dB incl. connectors [11]
Insertion loss flatness [1, 11]	typ. +/- 0.1 dB for 1420 nm <λ <1615 nm [4]			
Polarization dependent loss [2, 9, 11]	<0.08 dBpp (typ. 0.03 dBpp)			N/A
Polarization extinction ratio	N/A			typ 20 dB [1, 2, 12]
Return loss [9, 11]	typ. 45 dB	typ. 57 dB	typ. 57 dB	typ. 57 dB
Maximum input power [13]	+33 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 min.			

(5.6)

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

Variable Optical Attenuator Modules with Power Control for high-power applications

	81576A		81577A	
Connectivity	straight connector, versatile interface		angled connector, versatile interface	
Fiber type	9/125 µm SMF			
Wavelength range	1250 – 1650 nm			
Attenuation range	0-60 dB			
Resolution	0.001 dB			
	Attenuation Setting	Power Setting	Attenuation Setting	Power Setting
Repeatability [1]	+/- 0.010 dB	+/- 0.015 dB [2]	+/- 0.010 dB	+/- 0.015 dB [2]
Accuracy (uncertainty) [1, 3, 4, 5]	+/-0.1 dB		+/-0.1 dB	
Settling time [6]	typ. 100 ms	typ. 300 ms	typ. 100 ms	typ. 300 ms
Transition speed	typ. 0.1 ... 12 dB/s			
Relative power meter uncertainty [7]	+/- 0.03 dB +/- 200 pW [8]			
Attenuation flatness [1, 5, 9]	< +/- 0.07 dB (typ. +/- 0.05 dB) for 1520 nm < λ < 1620 nm [10] typ. +/- 0.10 dB for 1420 nm < λ < 1640 nm [10]			
Spectral ripple [11]	typ. +/- 0.003 dB			
Insertion loss [3, 5, 12, 13]	typ. 0.9 dB excluding connectors < 1.8 dB (typ. 1.2 dB) including connectors [14]			
Insertion loss flatness [1, 14]	typ. +/- 0.1 dB for 1420 nm < λ < 1615 nm [5]			
Polarization dependent loss [3, 12, 14]	<0.10 dBpp (typ. 0.05 dBpp)			
Return loss [12, 14]	typ. 45 dB		typ. 57 dB	
Maximum input power [15]	+33 dBm			
Shutter isolation	typ. 100 dB			
Dimensions (H x W x D)	75 mm x 64 mm x 335 mm (2.8" x 2.6" x 13.2")			
Weight	1.3 kg			
Recommended recalibration period	2 years			
Operating temperature	10 °C – 45 °C			
Humidity	Non-condensing			
Warm-up time	30 min.			

(5.6)

[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
[6] Stepsize < 1 dB; for full range: typ. 6 s
[7] Wavelength and SOP constant;
temperature constant and between 23°C +/- 5°C; λ< 1630 nm
[8] Input power ≤ +27 dBm,
for input power > +27 dBm add +/- 0.02 dB
[9] Relative to reference at 0 dB attenuation
[10] λ_{disp} set to 1550 nm; attenuation ≤ 20 dB;
for attenuation > 20 dB:
add typ. 0.01 dB (α [db] – 20) for 1520 nm < λ < 1620 nm
add typ. 0.02 dB (α [db] – 20) for 1420 nm < λ < 1640 nm
[11] Linewidth of source ≥ 100 MHz
[12] For λ = 1550 nm +/- 15 nm
[13] Add typ. 0.1 dB for λ = 1310 nm +/- 15 nm
[14] Measured with Agilent reference connectors
[15] Agilent Technologies Deutschland GmbH assumes no responsibility for damages caused by scratched or poorly cleaned connectors.

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

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Related Agilent Literature

Agilent 8163B Lightwave Multimeter
Agilent 8164B Lightwave Measurement System
Agilent 8166B Lightwave Multichannel System
Technical Specifications
p/n 5988-3924EN

Agilent 8159xA/S Modular Optical Switches
Technical Specifications
p/n 59885071EN

Optical variable Attenuator in BER Test Applications
Application Note
p/n 5988-3159EN

Measuring the Dependence of Optical Amplifers on Input Power Using an Attenuator
Application Note
p/n 5988-5260EN

Agilent Optical Attenuators
Product Overview
p/n 5988-3988EN

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