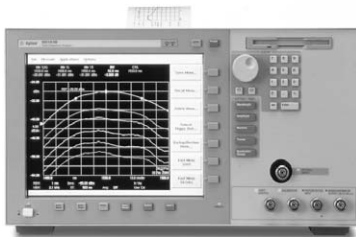
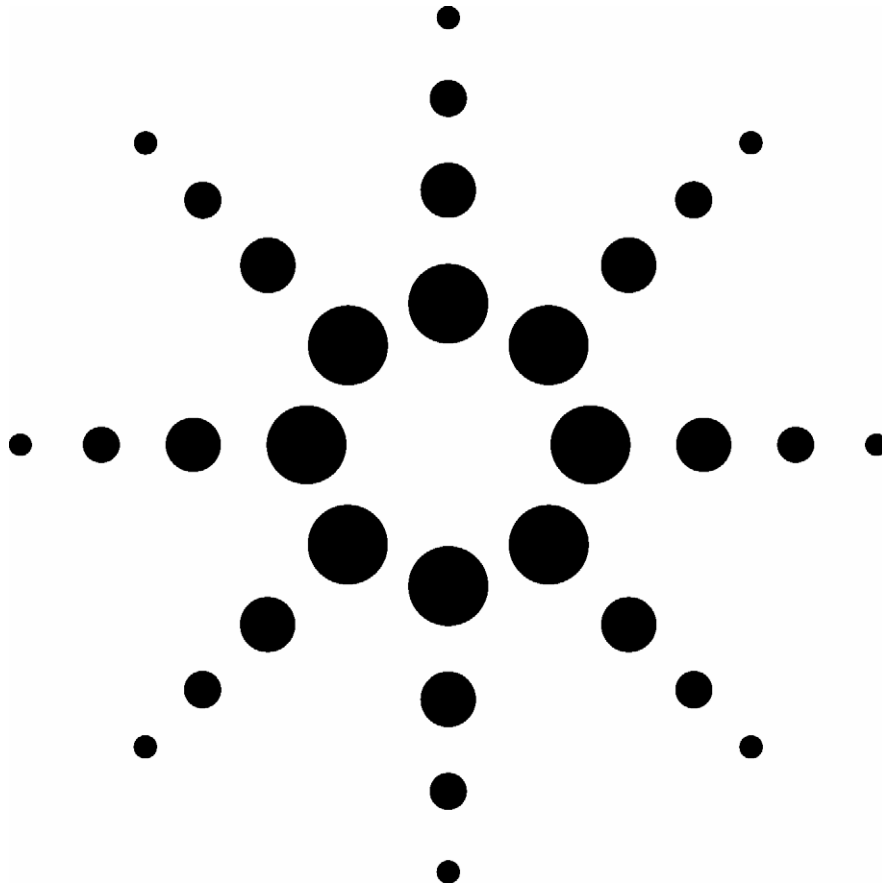


# Agilent 86146B Optical Spectrum Analyzer

## Technical Specifications

November 2005



- **Full-Feature Optical Spectrum Analyzer**  
Exhibits excellent speed and dynamic range with convenient and powerful user interface.
- **Filter Mode**  
Wavelength - filtered signal can be coupled to a single-mode fiber output for tunable-filter and channel-drop applications.
- **Dispersion penalty calculation**  
Dispersion Penalty calculation software combines 86146B and 86100C to measure time-resolved chirp and calculate dispersion penalty.



**Agilent Technologies**

# Specifications

## Characteristics and Specifications

The distinction between specifications and characteristics is described as follows:

- Specifications describe warranted performance.
- Characteristics provide useful, but non-warranted information about the functions and performance of the instrument.

The **specifications** apply to all functions, with video bandwidth autocoupled, 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 after 1 hour continuous operation and the auto-align routine has been run. Unless otherwise noted, specifications apply without USER CAL.

## Standard operation mode (not filter mode)

T(#) indicates temperature range and dependence.

Wavelength	Agilent 86146B	Notes
<b>Range</b>	600 nm to 1700 nm	
<b>Reproducibility</b>	±0.002 nm	With applied input fiber 9/125 µm; ≤ 1min
<b>Span Range</b>	0.2 nm to full range and zero span	
<b>Accuracy</b> After calibration with internal source and with enhanced wavelength calibration for specified range. 1480-1570 nm 1570-1620 nm	Typ ±0.01 nm Typ ±0.025 nm	At room temp; with applied input fiber 9/125 µm
After calibration with external reference source(s) ±10 nm of calibration reference point(s)	Typ ±0.01 nm	At room temp, with applied input fiber 9/125 µm
After user calibration over full wavelength range (600-1700 nm)	±0.2 nm	T(20-30°C), with applied input fiber 9/125 µm
Absolute Accuracy	±0.5 nm	Factory cal. 2 yr. cycle; T(20-30°C); with applied input fiber 9/125 µm
<b>Tuning Repeatability</b>	±0.002 nm	With applied input fiber 9/125 µm; ≤ 1min
<b>Span Linearity</b> 1525-1570 nm for spans <40 nm	Typ ±0.01 nm, Typ ±0.02 nm	T(20-30°C); with applied input fiber 9/125 µm
<b>Resolution Bandwidth (RBW)</b>		
<b>FWHM</b> (3 dB Bandwidth)	0.06, 0.07, 0.1, 0.14, 0.2, 0.33, 0.5, 1, 2, 5, 10 nm	Resolution of 10 nm is available for first order grating response only; with applied input fiber 9/125 µm
<b>Noise Marker Bandwidth Accuracy</b> using noise markers 1525-1610 nm ≥0.5 nm 0.2 nm 0.1 nm 0.06 nm	±2% ±3% ±7% ±12%	T(20-30°C)

<b>Amplitude</b>	<b>Agilent 86146B</b>	<b>Notes</b>
<b>Sensitivity</b>		Sensitivity is defined as signal value > 6 x RMS noise value.
600-750 nm	-60dBm	T(0-30°C), 2 <sup>nd</sup> order
750-900 nm	-75 dBm	
900-1250 nm	-75 dBm	T(0-30°C)
1250-1610 nm	-90 dBm	
1610-1700 nm	-80 dBm	T(20-30°C)
<b>Maximum Measurement Power</b>		Resolution bandwidth setting < channel spacing.
1525-1700 nm	Typ +15 dBm per channel, +30 dBm total	
600-1000 nm	Typ +15 dBm per channel, +30 dBm total	
1000-1525 nm	Typ +12 dBm per channel, +30 dBm total	
<b>Maximum Safe Power</b>		
Total safe power	+30 dBm	
Total power within any 10 nm portion of the spectrum	+23 dBm	
<b>Absolute Accuracy</b> at -20dBm, 1310 nm/1550 nm	± 0.5 dB	For resolution ≥ 0.1 nm, with applied input fiber 9/125 μm
<b>Scale Fidelity</b>		Excluding amplitude errors at low power levels due to noise, T(20-30°C), with applied input fiber 9/125 μm
Autorange off	± 0.05 dB	
Autorange on	± 0.07 dB	
<b>Display Scale</b> (log scale)	0.01-20 dB/DIV, -120 to +90 dBm	
<b>Amplitude Stability</b> (1310 nm, 1550 nm), 1 minute	±0.01 dB	For signals within 8 dB of top of screen, with applied input fiber 9/125 μm
15 minutes	±0.02 dB	Typ., with applied input fiber 9/125 μm
<b>Flatness</b>		With applied input fiber 9/125 μm
1290-1610 nm	±0.2 dB	Absorption of light by atmospheric moisture affects flatness at 1350-1420 nm
1250-1610 nm	±0.7 dB	
<b>Polarization Dependence</b>		For resolution ≥0.2 nm, at room temp, with applied input fiber 9/125 μm
1310 nm	±0.12 dB	
1530 nm, 1565 nm	±0.05 dB	
1600 nm	±0.08 dB	
1250-1650 nm	±0.25 dB	
<b>Dynamic Range</b>		
<b>In 0.1 nm Resolution Bandwidth</b>		Excluding multiple order grating response, With applied input fiber 9/125 μm
<b>1550 nm</b> at ±0.8 nm (±100 GHz at 1550 nm) at ±0.5 nm (±62.5 GHz at 1550 nm) at ±0.4 nm (±50 GHz at 1550 nm) at ±0.2 nm (±25 GHz at 1550 nm)	-60 dB -58 dB -55 dB Typ -40 dB	Average of all states of polarization
<b>Monochromator Input</b>	<b>Agilent 86146B</b>	<b>Notes</b>
<b>Input Return Loss</b> Straight connector (9/125 μm)	>35 dB	Depends on the quality of the attached connector; With applied 9/125 μm straight connector

<b>Sweep</b>		
<b>Max. Sweep Rate</b>	Typ 40 nm/56.3 ms	
<b>Max. Sampling Rate in Zero Span</b>	Typ 50 $\mu$ s/trace point	
<b>Sweep Cycle Time</b> 50 nm span, auto zero off 50 nm span, auto zero on 100 nm span 500 nm span	Typ < 180 ms Typ < 340 ms Typ < 400 ms Typ < 650 ms	
<b>ADC Trigger Accuracy</b> Jitter (distributed uniformly) Trigger delay range	Typ < $\pm$ 0.5 $\mu$ s Typ 2 $\mu$ s-6.5 ms	
<b>Pulse Mode Accuracy</b>		
<b>Turn On</b> ( $\geq$ 2 $\mu$ s after rising edge)	Typ. < $\pm$ 0.2 dB	(starting from dark)
<b>Turn Off</b> ( $\geq$ 10 $\mu$ s after falling edge)	Typ. < $\pm$ 0.2 dB (30 dB extinction)	

## Operation using Filter Mode

### Insertion Loss Stability

1550 nm, 15 minutes	0.5 dB	Immediately following enhanced single point auto align, at constant temperature
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### Insertion Loss

1550 nm	Typ. 10 dB	At room temperature
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### Filter Bandwidth: (From 1530 nm to 1610 nm)

	0.5 dB	1.0 dB	3.0 dB
<b>RBW Nominal Setting</b>	<b>Actual Bandwidth (nm)</b>		
0.04 nm	Typ 0.016	Typ 0.023	Typ 0.039
0.05 nm	Typ 0.019	Typ 0.026	Typ 0.045
0.07 nm	Typ 0.033	Typ 0.044	Typ 0.063
0.1 nm	Typ 0.076	Typ 0.089	Typ 0.115
0.2 nm	Typ 0.134	Typ 0.147	Typ 0.173
0.3 nm	Typ 0.257	Typ 0.270	Typ 0.297
0.5 nm	Typ 0.421	Typ 0.434	Typ 0.460
	$\pm$ 20%		

### Filter Bandwidth: Adjacent Channel Rejection (at 1550 nm)\*

	12.5 GHz	25 GHz	50 GHz	100 GHz
	$\pm$ 0.1 nm	$\pm$ 0.2 nm	$\pm$ 0.4 nm	$\pm$ 0.8 nm
0.04 nm	Typ 40 dB	Typ 50 dB	Typ 55 dB	Typ 55 dB
0.05 nm	Typ 40 dB	Typ 50 dB	Typ 55 dB	Typ 55 dB
0.07 nm	N/A	Typ 50 dB	Typ 55 dB	Typ 55 dB
0.1 nm	N/A	Typ 40 dB	Typ 50 dB	Typ 55 dB
0.2 nm	N/A	Typ 40 dB	Typ 45 dB	Typ 55 dB
0.3 nm	N/A	N/A	Typ 45 dB	Typ 55 dB
0.5 nm	N/A	N/A	Typ 45 dB	Typ 50 dB

\*Adjacent Channel Rejection limited to 60 dB below total integrated power

### Filter Bandwidth: Polarization Dependence

1550 nm	Typ $\pm$ 0.2 dB	for 0.2 nm filter bandwidth and greater, at room temperature
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<b>Computer Interfacing</b>	<b>Agilent 86146B</b>	<b>Notes</b>
<b>Remote Control</b>	Web enabled controls	
Compatibility	IEEE-488.1, IEEE-488-2 (100%)	
Interfaces	LAN, GPIB, Parallel Printer Port, External VGA Monitor, Keyboard and Mouse (PS/2)	
<b>Floppy Disk</b>	3,5" 1.44 MB, MS-DOS	MS-DOS is a U.S. registered trademark of Microsoft Corporation
Data export	Spreadsheet and Word Processor Compatible (CSV ASCII)	
Graphics export	CGM, PCL, GIF	
<b>Instrument Drivers</b>	Universal Instrument Drivers (PNP), Compatible with VEE, Labview, Visual Basic and C++	Labview is a U.S. registered trademark of National Instruments.

<b>General Specifications</b>	
<b>Dimensions</b>	222mm high x 425mm wide x 427 mm long
<b>Weight</b>	16.5 kg
<b>Environmental</b> Temperature* Humidity EMI	Operating 0°C to 55°C, Storage -40°C to 70°C Operating <95% RH, Storage: Noncondensing Conducted and radiated interference is in compliance with CISPR pub 11, IEC 801-3, IEC 801-4 and IEC 555-2
<b>Power Requirements</b> Voltage and frequency Maximum power consumption	90 Vac to 260 Vac, 44 to 444 Hz 230W

\*Floppy disk and printer operating temperature range 0°C to 45°C



## Options and Accessories

Options (available on new instruments only)	Agilent 86146B
Current Source	86146B-001
White Light Source *	86146B-002
Built-in 1310 & 1550 nm EELED Source *	86146B-004
Wavelength Calibrator	86146B-006
DWDM Spectral Analysis Application	Included
Passive Component Test Application	Included
Amplifier Test Application	Included
Source Test Application	Included
Connector Interface	FC/PC: 81000FI SC/PC: 81000KI DIN: 81000SI ST: 81000VI E2000: 81000PI LC: 81002LI MU: 81002MI
Certificate of Calibration	Included

\* 86146B-002 and 004 are exclusive.

### OSA Fiber Sizes

Model Number	Optical Input	86146B-002* (White Light Source)	86146B-004* (1310/1550 EELED)	86146B-006 (Calibrator)	Photodiode Input	Mono Output 1
86146B	9 $\mu\text{m}$	62.5 $\mu\text{m}$	9 $\mu\text{m}$	9 $\mu\text{m}$	50 $\mu\text{m}$	9 $\mu\text{m}$

\* 86146B-002 and 004 are exclusive.

## Options and Accessories: Specifications

<b>86146B-001 Current Source</b>	<b>Agilent 86146B</b>
<b>Range</b>	0 to $\pm 200$ mA (source or sink)
<b>Resolution</b>	Typ 50 $\mu$ A steps
<b>Accuracy</b>	2% $\pm 50$ $\mu$ A
<b>Clamp Voltage</b> (nominal)	$\pm 2.7$ V
<b>Noise Density at 1 kHz</b>	Typ $< 4$ nA/ $\sqrt{\text{Hz}}$
<b>Stability Within 30 Minutes</b>	Typ $< 100$ ppm $\pm 500$ nA
<b>Temperature Drift</b>	Typ $< (100 \text{ ppm } \pm 500 \text{ nA})/K$
<b>Pulse Mode</b>	
Pulse Range	10 $\mu$ s to 6.5 ms
Pulse Resolution	100 ns
Duty Cycle Range	Pulse width/1 s to 100%

<b>86146B-002 White Light Source</b>	
<b>Wavelength*</b>	900 nm to 1700 nm
<b>Minimum Output Power Spectral Density**</b> (9/125 $\mu$ m fiber) 900 to 1600 nm 900 to 1600 nm 1600 to 1700 nm	-67 dBm/nm (0.2 nW/nm) Typ -64 dBm/nm (0.4 nW/nm) -70 dBm/nm (0.1 nW/nm)
<b>Minimum Output Power Spectral Density***</b> 50/125 $\mu$ m fiber 62.5/125 $\mu$ m fiber	Typ -50 dBm/nm (10 nW/nm) Typ -46 dBm/nm (25 nW/nm)
<b>Output Stability**</b>	Typ $\pm 0.02$ dB over 10 minutes
<b>Lamp Lifetime, Mean Time Between Failures**</b> (MTBF)	Typ $> 5000$ hours

\* filtered below 850 nm

\*\* with applied input fiber 9/125 $\mu$ m

\*\*\* typ; includes power in full numerical aperture of fiber

<b>86146B-004 EELED Sources</b>	
<b>Minimum Spectral Power Density</b> 1300 to 1320 nm, 1540 to 1560 nm 1250 to 1620 nm	$> -40$ dBm/nm (10nW/nm) Typ $> -60$ dBm/nm (1nW/nm)
<b>Return Loss</b> With straight connector	Typ $> 25$ dB
<b>Stability</b> (ambient temp. $< \pm 1^\circ\text{C}$ ) Over 15 minutes Over 6 hours	Typ $< \pm 0.02$ dB Typ $< \pm 0.05$ dB

## 86146B-006 Wavelength Calibrator

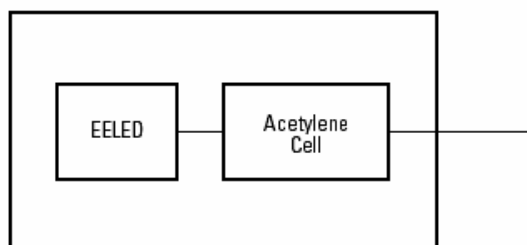


Figure 1: Wavelength calibrator block

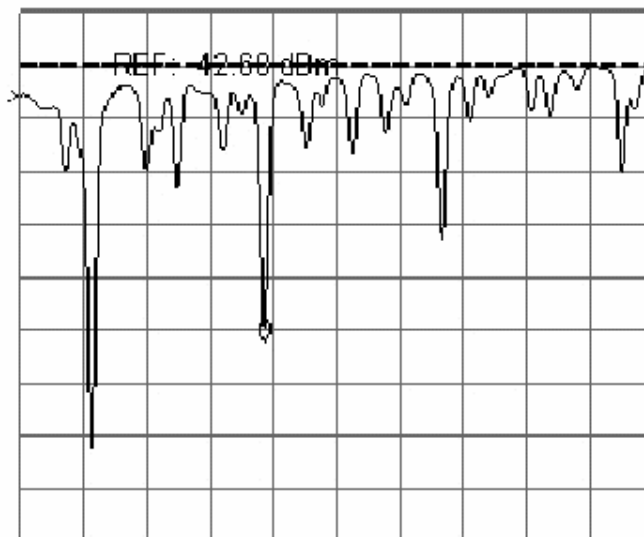


Figure 2: Wavelength calibrator absorption spectrum

The wavelength calibrator option provides an onboard wavelength reference that can be used to automatically calibrate the optical spectrum analyzer. The calibrator is based on an EELED and an Acetylene gas absorption cell, Figure 1. The Acetylene absorbs light at very specific wavelengths based on the molecular properties of gas. The cell is illuminated by an EELED and the OSA uses the absorption pits to perform a wavelength calibration, Figure 2. Since the absorption of the Acetylene gas is a physical constant it never needs calibrating.

The wavelength calibrator enhances the OSA to achieve better than  $\pm 10$  pm wavelength accuracy and removes the need to use a tunable laser source and multi-wavelength meter as an external reference.

<b>Additional Parts and Accessories</b>	<b>Agilent 86146B</b>
<b>Printer Paper</b> (5 rolls / box)	9270-1370
<b>Additional Connector Interfaces</b>	See Agilent 81000 series
<b>9 <math>\mu</math>m Single Mode Connector Saver</b>	Standard
<b>Rack-mount Flange Kit</b>	86146B-AX4
<b>Transit Case</b>	9211-2657
<b>BenchLink Lightwave Software*</b>	Standard

\* Agilent N1031A BenchLink Lightwave allows transfer of measurement results over a GPIB Interface to a PC for the purposes of archiving, printing and further analysis. Not usable with Windows XP.



# Definition of Terms

## Wavelength

- Absolute Accuracy (after user cal) refers to the wavelength accuracy after the user has performed the internal wavelength calibration using a source of known wavelength.
- Reproducibility refers to the amount of wavelength drift, which can occur over the specified time while the OSA is swept across a source of known wavelength.
- Tuning Repeatability refers to the wavelength accuracy of returning to a wavelength after having tuned to a different wavelength.

## Resolution

- FWHM refers to the Full-Width-Half-Maximum resolutions that are available. This indicates the width at half power level of the signal after passing through the resolution slits.

## Amplitude

- Scale Fidelity refers to the potential errors in amplitude readout at amplitudes other than at the calibration point. This specification is sometimes called linearity.
- Flatness defines a floating band, which describes the error in signal amplitude over the indicated wavelength range. (This error may be removed at a given wavelength by performing the user amplitude calibration).
- Polarization Dependence refers to the amplitude change that can be seen by varying the polarization of the light entering the OSA. This is not to be confused with amplitude variations caused by the varying distribution of energy between the different modes in fiber that are multimode at the wavelength of interest.

## Sensitivity

- Sensitivity is defined as the signal level that is equal to six times the RMS value of the noise. Displayed sensitivity values are nominal. Slightly lower values may have to be entered to achieve specified sensitivity.

## Dynamic Range

- Dynamic Range is a measure of the ability to see low-level signals that are located very close (in wavelength) to a stronger signal. In electrical spectrum analyzers, this characteristic is generally called shape factor.

## Sweep Time

- Maximum Sweep Rate refers to the maximum rate that the instrument is able to acquire data and display it. This rate may be limited by multiple internal processes when using default number of trace points.
- Sweep Cycle Time refers to the time required to make a complete sweep and prepare for the next sweep. It can be measured as the time from the start of one sweep to the start of the next sweep.

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[www.agilent.com/comms/lightwave](http://www.agilent.com/comms/lightwave)

#### Related Agilent Literature

<http://www.agilent.com/comms/octspectral>

#### Phone or Fax

##### United States:

(tel) 1 800 829 4444  
(fax) 1 800 829 4433

##### Canada:

(tel) 1 877 894 4414  
(fax) 1 800 746 4866

##### Europe:

(tel) +31 20 547 2111  
(fax) +31 20 547 2190

##### Japan:

(tel) 120 421 345  
(fax) 120 421 678

##### Latin America:

(tel) +55 11 4197 3600  
(fax) +55 11 4197 3800

##### Australia:

(tel) 800 629 485  
(fax) 800 142 134

##### Asia Pacific:

(tel) +852 800 930 871  
(fax) +852 800 908 476

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