Agilent 81910A
Photonic All-parameter Analyzer

Technical Specifications
March 2005

The fastest and most accurate way to test optical components
The Agilent 81910A Photonic All-Parameter Analyzer is a fully equipped test solution for optical components and modules – measuring spectral Loss, Polarization Dependent Loss, Group Delay, and Differential Group Delay for both transmission and reflection in a single connection setup.

Warranted Specifications
Each 81910A is individually tested for each specification and has passed test limits which are tighter than what is displayed as specification. The test and specification process follows strict guidelines and is controlled by our metrology laboratory. The system specifications are traceable to national standards or equivalent according to Agilent guidelines. Offering a thorough data sheet backed by stringent quality control measures guarantees best performance and application fit over time.

Agilent Technologies

Agilent 81910A Photonic All-Parameter Analyzer
The Agilent 81910A enables exhaustive analysis of advanced photonic devices, covering all physical properties relevant to DWDM components in a single solution:

- Simultaneous all-optical measurement of spectral loss (IL)/ return loss (RL), polarization dependent loss (PDL), group delay (GD) and differential group delay (DGD)
- Display of chromatic dispersion (CD) and polarization mode dispersion (PMD)
- Simultaneous transmission and reflection measurement
- All measurements made in swept-wavelength mode for shortest test time at picometer wavelength resolution
- Non-ambiguous loss and GD results by calculation from the true average of their polarization dependency
- The unique combination of Mueller Matrix method for loss measurement and Jones Matrix method for interferometric dispersion measurement yields best accuracies in all axes
- Real-time trace updates enable the adjustment of all device parameters, and feedback to automated process control
- Direct access to Mueller Matrix and Jones Matrix for deepest insight into a device's transmission and reflection properties: eigenvalues, TE/TM mode traces, impulse response, second order PMD and more
- Application-Programmable Interface (API) for custom analysis, remote control and automation, and integration with simulation software solutions
- Optional Agilent 81600B #200 all-band laser extends the measurement range to 1477 nm to 1620 nm, and allows up to 120 nm wavelength scan range.
- Software-enabled multi-port testing and noise threshold feature for more convenient analysis of multichannel devices
- Newly released version offers fast sweep speed of 80 nm/s for reduced noise floor, and low sweep speed mode for extended device length up to 100 meters.

Faster development cycles and enhanced productivity
Easy configuration and setup, and high measurement throughput, ensure results are available earlier:

- Quick and easy reference measurement with excellent long-term stability minimizes the measurement process overhead
- Connecting devices only once for all tests, including transmission and reflection, reduces test time and uncertainties
- Measurement time can be optimized by the operator according to device specific test needs by selecting an appropriate resolution and accuracy
- Extreme measurement accuracy and resolution can be chosen while maintaining an affordable measurement time
- Integrated optical bench for convenient workspace and fiber management
- Easy-to-use, comfortable viewing and marker functions for fast and certain result analysis

Lowest Cost of Ownership:
The complete solution consists of an 81600B tunable laser with 8164B mainframe and 81634B power meters, an 8169A polarization controller, licensed software, accessories, a system controller and the optical test head.

- For those customers who already own loss test equipment (e.g. an 81640A or 81680A tunable laser), options allow an easy and affordable upgrade to a full-featured 81910A
- New options allow configuring systems that fit into almost any budget
- A recommended re-calibration period as long as 2 years helps to reduce cost of ownership
- Free installation service is included with the product
- Optional productivity assistance provides your operators with on-site training.

Agilent 81910A - A quantum leap for the test of fiberoptic components
As networks move to 10 Gbit/s and beyond, not only spectral loss but also pulse shape properties of the signal become important; components for advanced networks must meet stringent specifications of all of their optical performance parameters. However, since most passive components are used to route or redirect optical signals, all-parameter test solutions must not compromise spectral loss measurement performance. Moreover, the loss characteristics of state-of-the-art components often go hand in hand with strong dispersion properties. As a result, test requirements for advanced components are best described as "high accuracy, high dynamic range, and high resolution" - both for loss and dispersion.
The Agilent 81910A, designed for those customers who deal with advanced optical components, allows for precise characterization of all optical device parameters in a single setup with the highest accuracy.
Combining the best of two worlds, the Agilent 81910A utilizes the Mueller Matrix method to determine the loss parameters from highly accurate and linear power meter readings, and swept homodyne interferometry (SHI) with the Jones Matrix method to determine the dispersion properties. SHI employs an innovative optical test head to host a fiber interferometer for all-optical mixing of signals, as well as a sophisticated data acquisition engine, all geared towards narrow wavelength resolution at high accuracy and measurement speed.

A solid foundation
The Agilent 81910A, and the Photonic Analysis Toolbox software supplied with it, are based on Agilent's established and proven Photonic Foundation Library (PFL). This library provides a rich set of functionalities that make it quick and easy to implement specific tests, tasks and analysis. The comprehensive collection of basic and advanced functions helps you run the tests you require, and get exactly the results you need, to support your development or manufacturing processes.

Agilent 81910A Photonic All-parameter Analyzer - Configuration for Measurement of Spectral Loss, Polarization Dependent Loss, Group Delay and Differential Group Delay

Specifications describe the instrument's warranted performance. The specifications given in this section are valid after warm-up, at the stated operating conditions and measurement settings, at uninterrupted line voltage, and after a reference measurement. Constant ambient temperature ±1 K after reference measurement. All optical patchcords and fibers fixed and settled for ≥ 3 minutes.

	Technical Specifications
Wavelength range for warranted operation	1520 nm to 1620 nm
Operating wavelength range	1498.1 nm to 1620 nm (with options 001 and 002) 1477 nm to 1620 nm (with options 003 and 004)
Operating conditions	Ambient temperature 5°C to 45°C, relative humidity <80%, non-condensing conditions; environmental conditions suitable for precise optical measurements
Conditions for specified operation	Ambient temperature 23°C ±5 K, relative humidity <80%, non-condensing conditions; environmental conditions suitable for precise optical measurements
Warm-up time	1 hour
Environmental storage conditions	-40 to +50°C
Measurement time	Typically 60 seconds for a fully specified measurement of a narrow-band device, including all loss and dispersion measurements in transmission and reflection. Includes instrument initialization, measurement of device under test, data acquisition and display. Reference measurements excluded.

Loss and Polarization Dependent Loss Measurement Specifications [a]:

	Transmission	**Reflection [b]**
Loss uncertainty [c]		
loss ≤ 0.5 dB	±0.010 dB	±0.020 dB
loss ≤ 10 dB	±0.015 dB	±0.025 dB
loss ≤ 30 dB [d]	±0.025 dB	±0.040 dB
loss ≤ 40 dB [d]	±0.050 dB	
Loss range (typical)	> 55 dB	> 45 dB

Polarization dependent loss (PDL) uncertainty [e]		
loss ≤ 0.5 dB	±(0.040 dB + 3% of device PDL) typ.: ±(0.030 dB + 3% of device PDL)	±(0.040 dB + 3% of device PDL) typ.: ±(0.030 dB + 3% of device PDL)
loss ≤ 10 dB	±(0.050 dB + 3% of device PDL)	±(0.055 dB + 3% of device PDL)
loss ≤ 30 dB	±(0.060 dB + 3% of device PDL)	±(0.100 dB + 3% of device PDL)
Absolute wavelength uncertainty [f]	±4 pm (±1.5 pm typ.)	
Relative wavelength uncertainty [f]	±3 pm (±0.8 pm typ.)	
Wavelength repeatability (typical)	±0.3 pm	

a Measurement settings as follows: 2 pm step size; ≤ 5 nm/s sweep speed; coherence control off; after zeroing of power meters.
For measurements of, and around, steep slopes, choose sweep speed in nm/s ≤ 200 divided by slope in dB/nm for a device loss ≤ 10 dB, else sweep speed in nm/s ≤ 50 divided by slope in dB/nm.
Device PDL ≤ 1 dB

b Loss results are relative to the loss of a reference reflector (with return loss ≤ 0.3 dB) used in the reference measurement.
Note: the reference gold reflector supplied with the test head has a return loss of typ. (0.16 ± 0.13) dB.

c For polarization dependent devices, the measurement result corresponds to the loss for unpolarized light.
Valid for PDL ≤ 0.1 dB if loss ≤ 0.5 dB, and PDL ≤ 0.4 dB if loss ≤ 10 dB.

d Source spontaneous emission (SSE) of tunable laser sources (TLS) limits the measurable loss dynamic range of components with narrow stop band and broad transmission band (like Fiber Bragg Gratings in transmission). This means an additional loss uncertainty in the stop band depending on the amount of total SSE of the source used. The Signal-to-total-SSE ratio of the Agilent 81600B #160 TLS at wavelengths up to 1610 nm is ≥ 55 dB.

e Excludes the polarization dependent loss of all optical connections to the optical test head. In reflection, PDL uncertainty specifications are typical if the straight or angled reference kit has been used.

f Valid in the wavelength range of an $H^{13}C^{14}N$ molecular gas cell (NIST SRM 2519), 1528.5 - 1561.6 nm. Outside this range add typ. ±1 pm.

Dispersion Measurement Specifications:

Group Delay (GD)	Transmission	Reflection
Group Delay dynamic range (typical)	10 ns	
Group Delay loss range (typical)	30 dB	
Group Delay resolution	<0.1 fs	
Group Delay uncertainty [a b]		
Group Delay noise [c d]	<±50 fs (<±35 fs typ. [h])	
Group Delay relative uncertainty [e]	±1.5 % of device relative Group Delay	

Differential Group Delay (DGD)	Transmission	Reflection
Differential Group Delay measurement range (typical)	0.5 ns	
Differential Group Delay loss range (typical)	30 dB	
DGD resolution	<0.1 fs	
Differential Group Delay uncertainty [a]		
Differential Group Delay noise [c d]	<±80 fs (<±55 fs typ. [h])	
Polarization Mode Dispersion (PMD) uncertainty [f] (typical)	<±5.0 fs	n/a

Absolute wavelength uncertainty [g]	±1.5 pm
Maximum device optical path length (typical)	15 m (80 nm/s sweep speed) 30 m (40 nm/s sweep speed) 60 m (20 nm/s sweep speed) 100 m (10 nm/s sweep speed)

a Any 50 nm within 1520 and 1620 nm.

b For polarization dependent devices, the measurement result corresponds to the GD for unpolarized light.

c 30 measurements averaged, wavelength resolution bandwidth 30 pm, 40 nm/s sweep speed.
For a detailed relation between uncertainty, resolution and number of averages, please refer to the supplementary dispersion measurement characteristics. This relation allows you to choose the best parameter fit for an individual application.

d Measuring a patch cord, made of 2 m standard single mode fiber and a 0.1 m section of polarization maintaining fiber with ~0.1 ps DGD in transmission. In reflection, measuring a patch cord, made of 1 m standard single mode fiber and a 0.1 m section of polarization maintaining fiber with ~0.1 ps DGD, terminated by a gold reflector.

e Measuring a GD peak of ~16.5 ps amplitude at wavelength 1550.515 nm of a $H^{13}C^{14}N$ molecular gas cell (NIST SRM 2519).
The peak GD value is derived from spectral loss data using the Kramers-Kronig relation. Double pass of the cell in reflection.
30 measurements averaged, wavelength resolution bandwidth 10 pm.

f Measurement of NIST Standard Reference Material 2518 (Mode-coupled PMD artifact, wavelength range lies within 1520 and 1570 nm, PMD ~300 fs).

g Valid in the wavelength range of an $H^{13}C^{14}N$ molecular gas cell, 1528.5 - 1561.6 nm. Outside this range uncertainty values are typical.
Between 1595 nm and 1620 nm uncertainties are as given in the Loss and PDL section.

h 30 measurements averaged, wavelength resolution bandwidth 30 pm, 80 nm/s sweep speed over full operating wavelength range.

Ordering instructions: 81910A Photonic all-Parameter Analyzer - must be ordered with option 001, 002, 003, or 004.

81910A #001: complete system. Includes 81600B #160 tunable laser, 8164B mainframe, 8169A polarization controller, 81634B power meters, system controller, licensed software, three reference kits, accessories and optical test head. Each reference kit consists of transmission and reflection references, equipped with straight or angled connectors or with bare fibers. System controller may be used as host PC. Free installation service included: after delivery of the product, you will be contacted by an Agilent engineer to schedule the installation.

81910A #002: same as #001, but integrates a pre-owned tunable laser. Customer sends back either one tunable laser source 81640A, 81680A, or 81480A for conversion into an 81600B #160 tunable laser and integration in the system, or a tunable laser source 81600B #160, or 81640B, for integration.

81910A #003: same as #001, but includes a 81600B #200 tunable laser.

81910A #004: same as #003, but integrates a pre-owned 81600B #200 tunable laser. Customer sends back one tunable laser source 81600B #200 to Agilent Technologies for integration in the system.

After you order an Agilent 81910A, you will be offered optional productivity assistance. i.e. startup training, by an Agilent knowledge services representative. Optional: if a second PC is used as a host, the following performance is required: PC with min. 500 MHz CPU, 192 MB RAM or more, Windows XP, Windows 2000 or Windows NT with SP6, 200 MB free hard disk space; 2 free PCI slots; 81910A operated by a SW revision of 2.5 or later.

Supplementary dispersion measurement characteristics [a]:

Group Delay and Differential Group Delay measurement uncertainty can be customized to any application requirements in terms of accuracy, resolution, and measurement time by adjusting resolution bandwidth and number of averaged sweeps. The relation between accuracy, resolution bandwidth and averages is shown in Figures 1 and 2.

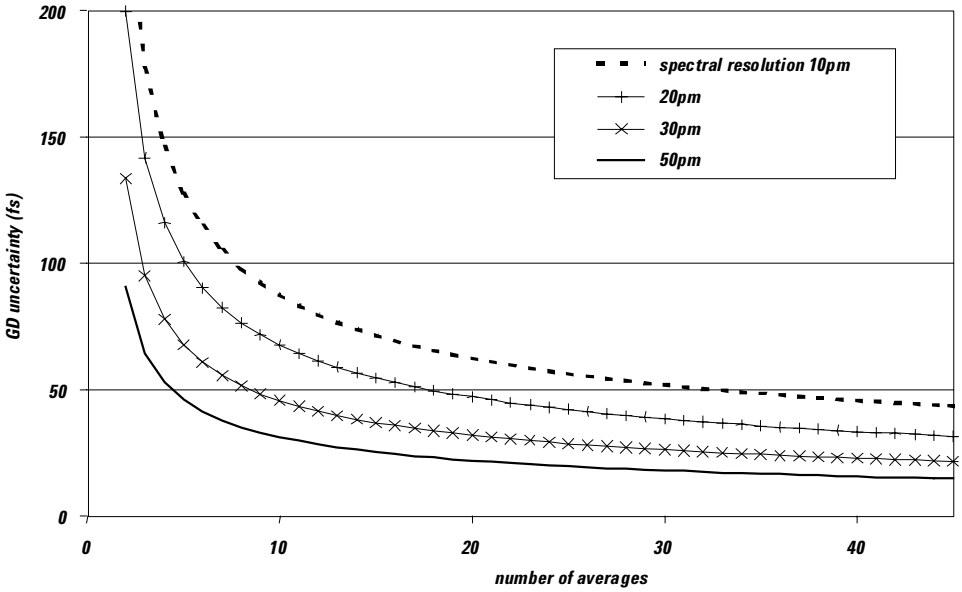

Figure 1: Group Delay noise as a function of resolution bandwidth and number of averages

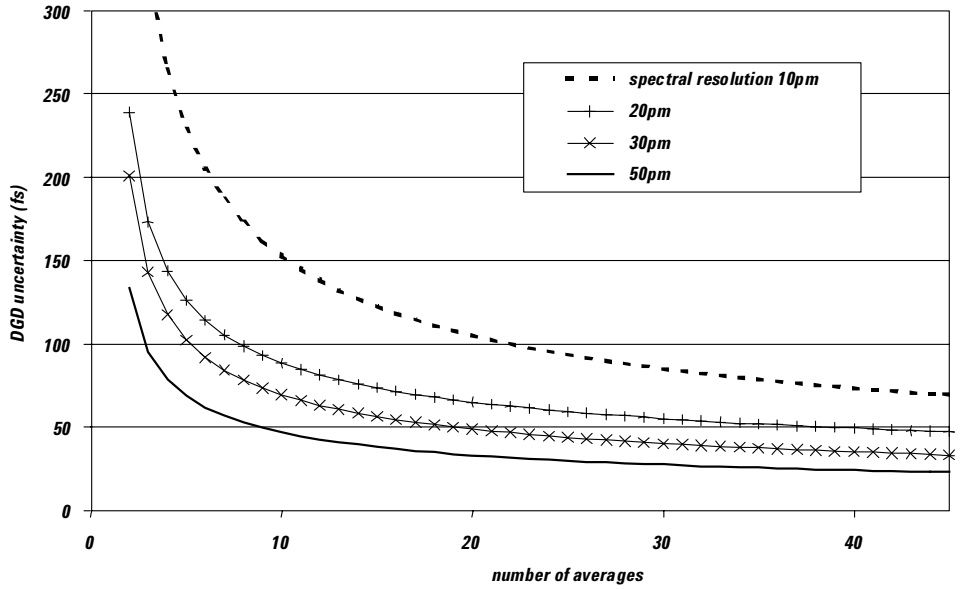

Figure 2: Differential Group Delay noise as a function of resolution bandwidth and number of averages

aGraphics depict the performance of a representative unit measured on an optical bench. Note that with 30 pm spectral averaging and 30 averages a Group Delay uncertainty of 25 fs is achieved. Valid between 1520 and 1620 nm.

Agilent Technologies' Test and Measurement Support, Services, and Assistance

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."

Our Promise

Our Promise means your Agilent test and measurement equipment will meet its advertised performance and functionality. When you are choosing new equipment, we will help you with product information, including realistic performance specifications and practical recommendations from experienced test engineers. When you use Agilent equipment, we can verify that it works properly, help with product operation, and provide basic measurement assistance for the use of specified capabilities, at no extra cost upon request. Many self-help tools are available.

Your Advantage

Your Advantage means that Agilent offers a wide range of additional expert test and measurement services, which you can purchase according to your unique technical and business needs. Solve problems efficiently and gain a competitive edge by contracting with us for calibration, extra-cost upgrades, out-of-warranty repairs, and on-site education and training, as well as design, system integration, project management, and other professional engineering services. Experienced Agilent engineers and technicians worldwide can help you maximize your productivity, optimize the return on investment of your Agilent instruments and systems, and obtain dependable measurement accuracy for the life of those products.

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(fax) (31 20) 547 2390

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(fax) (81) 426 56 7840

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(fax) (305) 269 7599

Australia:
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(fax) (61 3) 9210 5947

New Zealand:
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Asia Pacific:
(tel) (852) 3197 7777
(fax) (852) 2506 9284

Related Agilent literature:

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

81910A Photonic All-parameter Analyzer
Product Note
5988-4565EN

Optical Component Test Solutions,
Brochure
5988-1930EN

State of the art characterization of optical components for DWDM applications,
Application Note
5980-1454E

Polarization dependent loss measurements of passive optical components,
Application Note
5988-1232EN

PDL Measurements using the 8169A polarization controller,
Application Note
5964-9937E

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5988-5870EN

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