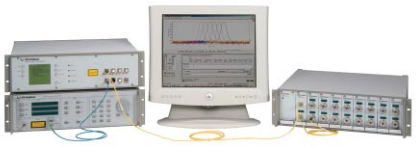
Swept Wavelength System
SWS2000 Series



Key Features

- Scalable architecture - add more stations any time
- ± 0.002 nm absolute wavelength accuracy
- Up to 128 detector channels available per station
- Remote source laser can be shared by up to 8 workstations
- High speed scanning (user controllable) up to 40 nm/s
- Flexible easy-to-use software
- Customized applications through dynamic link libraries (DLLs)
- 24/7 service and support

Applications

- Optical component and module characterization in both R&D and manufacturing environments
  - ROADMs, Wavelength Switches, Wavelength Blockers
  - Circuit Packs
  - Dense wavelength division multiplexing (DWDM)
  - Tunable Filters, Couplers, Splitters, Switches, Attenuators, Fiber Bragg Gratings (FBGs), Interleavers, Dichroic Filters
  - Micro-Electro-Mechanical Systems (MEMS) and Waveguide Devices
  - Complies with IEC 61300-3-29, IEC 61300-3-12

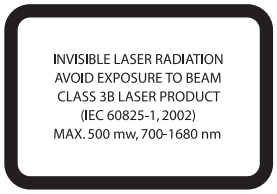
Safety Information

- Complies to CE requirements plus UL3101.1 and CAN/CSA - C22.2 No. 1010.1. The laser source in the Source Optics Module (SWS20010) is a class 1. The Tunable Laser Source (SWS17101) is a class 3B laser. Both are classified per IEC standard 60825-1(2002) and comply with 21CFR1040.10 except deviations per Laser Notice No. 50, July 2001.

The Swept Wavelength System SWS2000 series remains the industry standard solution for measuring insertion loss (IL), polarization dependent loss (PDL), return loss (RL) and directivity with high wavelength resolution in both research and development (R&D) and production environments. Currently used at more than 80 customer sites, with over 8500 detector channels deployed, the SWS test platform validates optical performance for the latest in optical components and modules including: ROADMs, Wavelength Switches, Tunable Filters and Circuit Packs. The SWS system consists of a tunable laser source, a source optics module (SOM), a control module, a receiver chassis, one or more detector modules and application software.

With a ± 0.002 nm absolute wavelength accuracy over the entire 1520 to 1630 nm range, a high sweep speed of 40 nm/s, and a deep dynamic range of > 70 dB, the SWS2000 provides excellent performance combined with a low cost of ownership; the distributed architecture supports up to eight separate, individually controlled measurement stations per source laser. Often purchased initially as an R&D tool, this scalability in the number of measurement stations provides customers the flexibility to transition the equipment from R&D to production.

Upgrade packages from legacy SWS systems to the SWS2000 platform are available to ensure that existing SWS users receive the maximum benefit from their existing capital infrastructure.





Continued

SWS directly measures IL, PDL and average loss as a function of wavelength. RL is measured with the optional RL modules (SWS20005). Using the raw IL and PDL data, the application software provides a comprehensive set of analysis tools that calculate:

- Loss at peak
- Center wavelength, from x dB threshold
- Loss at center wavelength
- Bandwidth at x dB threshold
- Crosstalk, left/right and cummulative
- Flatness

These parameters are calculated relative to the measured peak, ITU grid or user-defined grid.

The SWS is delivered with a set of DLLs that can be used to develop software to suit custom testing requirements. The DLLs function through the SWS receiver hardware, allowing access to all SWS functionality. Using the supplied DLLs, applications may be developed in Visual Basic™, C, C++, or LabView environments.

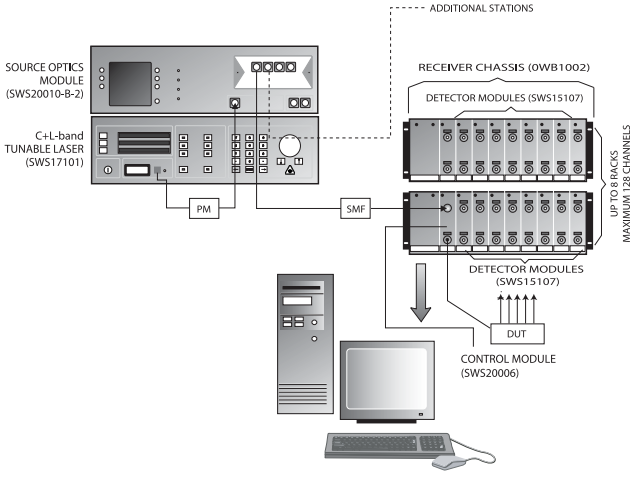
With a 4-State polarization controller located within the SOM, PDL and average loss are measured quickly as a function of wavelength. Four polarization states at 0°, 90°, - 45° and circular polarization are measured, and the Mueller matrix analysis is used to accurately determine PDL at all wavelengths scanned.

When the very highest accuracy PDL measurements are required, a special version of the detector module should be used. The SWS15107-A contains specially selected and tuned components to allow PDL measurement to an accuracy of better than ± 0.01 dB. This module is supplied with a fixed FC/APC connector.

All specifications listed are met simultaneously. No change in wavelength accuracy (± 2 pm) or scan speed (20 nm/s) is required to obtain a 70 dB dynamic range.

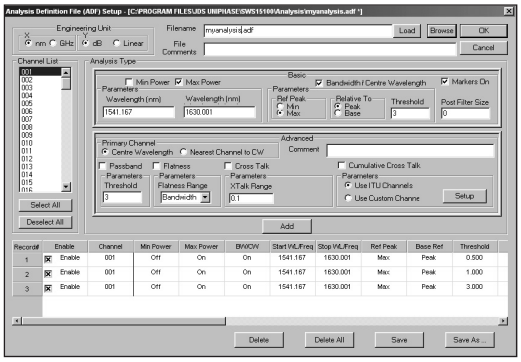
Typical Application of SWS2000



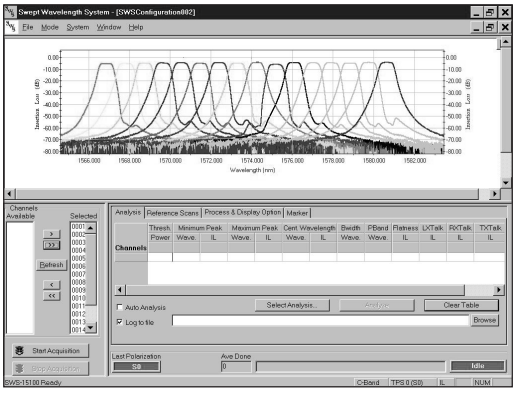


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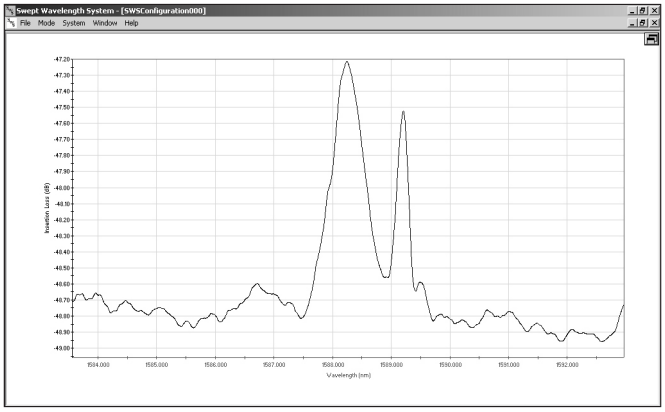
Analysis Setup Window



Data Display and Control Window



RL Measurement with SWS2000



SWS2000 Specifications

Parameter	Single Output Source Optics Module
Wavelength range	C+L-band 1520 to 1630 nm
Absolute wavelength accuracy	± 2 pm
Measurement resolution[1]	1 pm
Wavelength sampling resolution	3 pm
Insertion loss (IL) measurement accuracy[2,3]	± 0.05 dB (0 to 25 dB device IL)
including polarization state averaged IL	± 0.10 dB (25 to 45 dB device IL), ± 0.20 dB (45 to 65 dB device IL)
Dynamic range[3]	> 70 dB
Loss measurement repeatability[2]	± 0.02 dB
Loss measurement resolution	0.01 dB
Return loss (RL) measurement range[3,4]	60 dB
Polarization dependent loss (PDL) measurement accuracy[2]	± 0.05 dB (0 to 20 dB device IL)
using standard detector module SWS15107	± 0.10 dB (20 to 40 dB device IL)
PDL measurement accuracy[2]	± 0.01 dB (0 to 20 dB device IL)
using tuned PDL detector module SWS15107-A	± 0.03 dB (20 to 40 dB device IL)
with 13-point smoothing and 4 averages[1]	
PDL measurement repeatability[1]	± 0.01 dB
PDL measurement resolution[1]	0.01 dB
Maximum slope resolution	10 dB/pm (0 to 35 dB device IL)
Measurement time	9 seconds + 0.5 seconds per channel
Maximum scan speed[5,7]	40 nm/s
Fiber type (to device-under-test)	SMF-28
Maximum outputs from device under test (DUT) measured	128
Measurement stations per transmitter	Up to 8, in 1, 2, 4, or 8 steps
Detector adapters[6]	FC, SC, ST, LC, bare fiber
Input voltage	110 to 230 V AC , 50 to 60 Hz
Receiver control	Custom interface for Win95/98/2000/XP
Receiver communication with computer	National Instruments™ PCI interface card
Operating temperature	15 to 35 °C
Storage temperature	0 to 70 °C
Operating humidity	80 % RH maximum, non-condensing
Dimensions (W x H x D)	
Source optics module(SOM) (SWS20010-B-2)	48.3 x 13.3 x 37.5 cm
Tunable laser source (SWS17101)	48.3 x 13.3 x 43.2 cm
Receiver chassis (OWB10002)	48.3 x 13.3 x 46.0 cm
Control and detector modules	Plugged into chassis

1. Wavelength resolution defined as the minimum calculated center wavelength shift.
2. Does not include influence of connector.
3. Device IL range/dynamic range both reduced for multiple output SOM.
4. RL module SWS20005 required.
5. 10 and 20 nm/s also selectable.
6. High PDL accuracy Detector Module SWS15107-A using FC/APC only.
7. All other specifications are maintained when using a scan speed of 20 nm/s.

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Ordering Information

SWS2000 Core System

Product Code	Description
SWS17101	C+L-band Tunable Laser
SWS20010-B-2	Dual output integrated source optic module (SOM)
SWS20010-B-4	Four output integrated source optic module (SOM)
SWS20010-B-8	Eight output integrated source optic module (SOM)
SWS20006-A	All-band control module: computer and PCI kit included
OWB10002	Receiver chassis
SWS15107	All-band detector module

SWS2000 Optional Equipment and Accessories

Product Code	Description
SWS15107-A	Polarization dependent loss (PDL) Optimized all-band detector module
SWS15107-M	All-band detector module, multimode (MM)
SWS20004	PCI Interconnect card and cable kit
SWS20005	Return loss (RL) cassette (single channel)
SWS20006-B	All-band control module: PCI kit included
SWS20013	All-band calibration kit
OWB10001-A	Dual Laser + SOM transmission cabinet
AC100	Detector cap
AC101	FC detector adapter
AC102	ST detector adapter
AC103	SC detector adapter
AC118	LC detector adapter
AC120	Magnetic detector adapter
AC121	Bare fiber holder (requires AC120)
AC320	Integrating sphere

Swept Wavelength System (SWS-OMNI Expansion Series)



Key Features

- **Virtual Modulation Frequency Feature (VMFF) - flexible post-processing**
- **Measures IL, PDL, GD, DGD with a single bench or rack mountable receiver**
- **Distributed Architecture - Add additional measurement stations at any time**
- **Wideband scanning 1520 to 1630 nm, in one sweep**
- **High speed; two-channel device characterization over C-band or C+L-bands for simultaneous measurement of all parameters**
- **Calibrated to NIST CD and Polarization Mode Dispersion (PMD) standards**
- **Powerful engineering software package + DLL library - custom software applications**

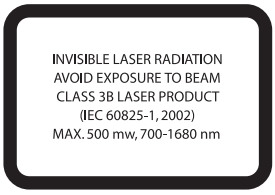
Applications

- Passive optical component and fiber characterization in lab and manufacturing environments.

Safety Information

- Complies to CE requirements plus UL3101.1 and CAN/CSA-C22.2 No. 1010.1. The laser source in the Source Optics Module is a class 1 laser. The Tunable Laser Source (SWS-17101) is a class 3B laser. Both are classified per IEC standard 60825-1 (2002) and comply with FDA standard 21CFR 1040.10 except deviations per Laser Notice No. 50, July 2001.





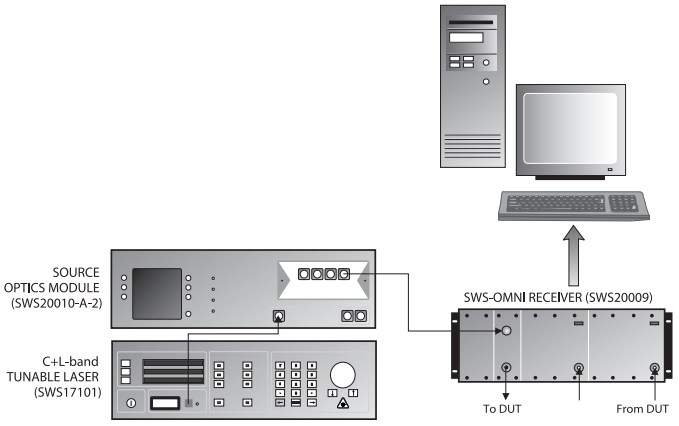
With the simple addition of an RF modulator within the SOM and an OMNI receiver, an existing Swept Wavelength System SWS2000 system can be used to measure group delay (GD) and differential group delay (DGD). Existing test stations can still be used.

SWS-OMNI adds to the SWS family of test systems and provides leading-edge performance for fast all-parameter testing for efficient engineering, research and development (R&D) and production testing operations. SWS-OMNI rapidly and accurately measures insertion loss (IL), polarization dependent loss (PDL), GD and DGD characteristics of a wide range of passive optical components and optical fiber using a dual channel receiver for higher-throughput and lower-cost testing.

The modular architecture of the SWS-OMNI enables a user to add the SWS-OMNI receiver to an existing SWS transmitter to provide a stand-alone all parameter test station without the added expenditure of another tunable laser and wavelength meter. These additional test stations are purchased at a relatively low incremental cost providing best multi-station capital expenditure economics in the industry.

From phase and IL measurements, SWS-OMNI software calculates CD, PDL, GD and DGD as a function of wavelength or frequency. Displayed data may be further analyzed on-screen using markers, or setup to automatically analyze the data in the parameter ranges defined. This data can be exported for further analysis. The software also has dynamic link libraries (DLLs) that can be used to easily develop custom software in LabVIEW, Visual Basic or C+ a feature that is especially useful in a production environment.

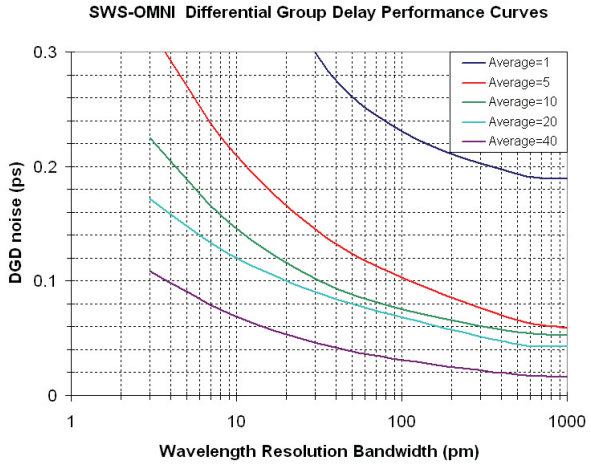
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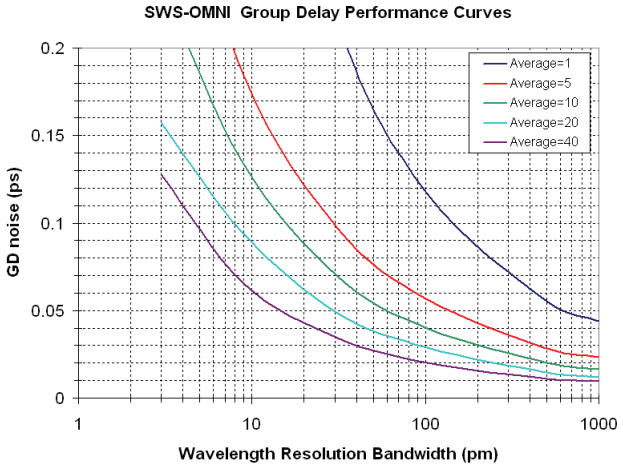
SWS-OMNI Virtual Modulation Frequency Feature (VMFF)

To improve the group delay noise and resolution, conventional modulation phase measurement techniques often employ an adjustable modulation frequency, which needs to be set before measurements are made. In contrast, the SWS-OMNI system uses the proprietary VMFF. All swept group delay measurements are made at a fixed modulation frequency (192 MHz) optimized for the 3 pm wavelength sampling step of the SWS. The data is then post-processed to achieve higher effective modulation.

Performance Curves



Typical Differential Group Delay Performance Curves (3σ)



Typical Group Delay Performance Curves (3σ)

Specifications

Parameter	Specification
Wavelength	
Measurement range C+L-band	1520 to 1630 nm
Wavelength span	110 nm
Absolute accuracy	± 2 pm
Wavelength sampling resolution	3 pm
Measurement resolution[1]	1 pm
Insertion loss (IL)[2, 3]	
Dynamic range	45 dB
Accuracy	
(0 to < 5 dB)	± 0.05 dB
(5 to < 25 dB)	± 0.10 dB
(25 to 45 dB)	± 0.25 dB
Resolution	0.01 dB
Group delay[2, 3]	
Dynamic range	20 dB
Accuracy (at < 10 dB IL)[4]	1.5 % typical
Uncertainty[5]	See attached performance curves
Modulation frequency[6]	192 MHz or greater
Maximum slope	800 ns/nm
Polarization dependent loss (PDL)[2]	
Dynamic range	45 dB
Accuracy (0 to < 10 dB)	± 0.05 dB
Resolution	0.01 dB
Differential group delay[2]	
Dynamic range	20 dB
DGD uncertainty[5]	See performance curves below
Polarization mode dispersion (PMD) accuracy (typical)[7]	± 0.02 ps

1. Measurement resolution is defined as the smallest shift in wavelength that can be detected using the analysis function.
2. Measured using SWS-OMNI transmitter under optimal power output.
3. Polarization state averaged.
4. Maximum deviation from NIST standard reference 2524.
5. Indicated uncertainty at 99.7% confidence level (3σ).
6. Theoretically no upper limit.
7. Based on the measurement of NIST standard reference 2518 (Mode-coupled PMD artifact, wavelength range 1520.5 to 1568.5 nm, DGD ~ 329 fs).

Ordering Information

SWS-OMNI	
SWS17101	C+L-band Tunable Laser
SWS20010-A-2	Dual output integrated source optic module (SOM) - OMNI version
SWS20009-A	SWS-OMNI Dual Channel Receiver: PCI kit included
SWS20009-B	SWS-OMNI Dual Channel Receiver: computer and PCI kit included

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