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Application Series

DWDM Module: A Simple Solution for a Complex Network

Product Overview of the STT DWDM Module

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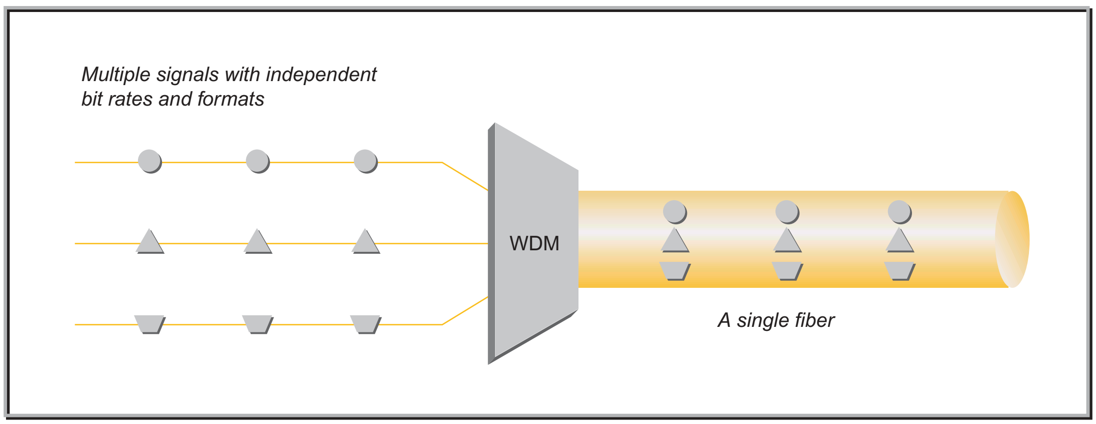
TECHNICAL BACKGROUND

To meet today's growing demands for bandwidth, Dense Wavelength Division Multiplexing (DWDM) technology has been developed to multiply the capacity of a single fiber. It increases the carrying capacity of the physical medium, whether existing or new fiber optic backbone, by carrying multiple light waves of different frequencies on a single fiber.

In a DWDM system, multiple signals with independent bit rates and formats are multiplexed into a single fiber with multiple wavelengths. The signals are then demultiplexed at the receiving side. Even though signals are multiplexed on a single fiber, DWDM carries each input signal independently of the others. This allows each channel to have its own dedicated bandwidth and to arrive at the receiving end simultaneously. Hence, each signal carried can be at a different rate (i.e. OC-3, OC-12...) or in a different format (i.e. SONET, Ethernet....).

This innovative technology not only takes us to the next level in bandwidth and speed, but also provides a convenient and economical solution. Because multiple signals can be transported on a single pair of fiber, less equipment is required, thereby reducing current equipment costs.

Although DWDM networks require less equipment, the complexity increases tremendously due to the multiple wavelengths. For a TDM system, critical factors affecting performance can be examined on a two-dimensional, power vs. time, representation. Because DWDM transports multiple wavelengths on a single fiber, a wavelength dimension must be factored into the representation, making it a power vs. time vs. wavelength representation. With multiple wavelengths, many more factors, including crosstalk, EDFA range, EDFA gain, and wavelength stability, become critical.



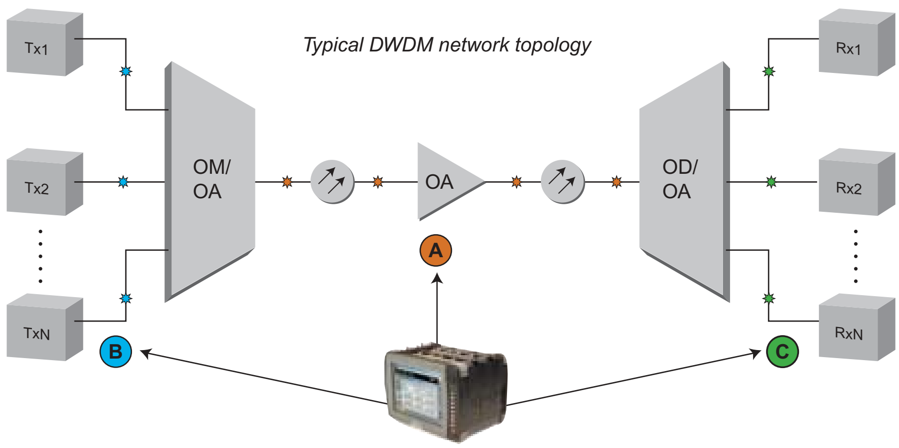
WDM Concept

STT DWDM MODULE

The STT, Scalable Test Toolkit, from Sunrise Telecom contains all the right features to tackle the toughest DWDM installation and maintenance problems. The STT is the next-generation modular platform that provides a versatile feature set for testing optical networks including advanced DWDM analysis, SONET/SDH testing, fiber characterization, and Ethernet testing. The STT DWDM Module supports three main features, which will be discussed in this paper. They are:

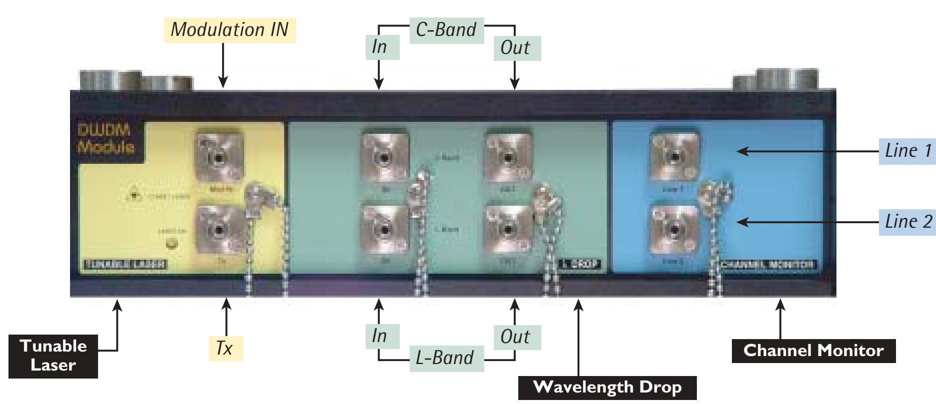
- DWDM optical channel monitoring
- DWDM wavelength drop
- Source and source converter via the tunable laser on the DWDM grid

With the STT, you can monitor from anywhere in the DWDM network. Referring to the figure below, you could monitor between the multiplexers (Point A) to check the DWDM network, as well as drop out any channel for further analysis with a SONET or SDH network analyzer, such as STT's Network Analysis Module. At Point B, you can insert signals onto the network and receive signals at Point C for testing.



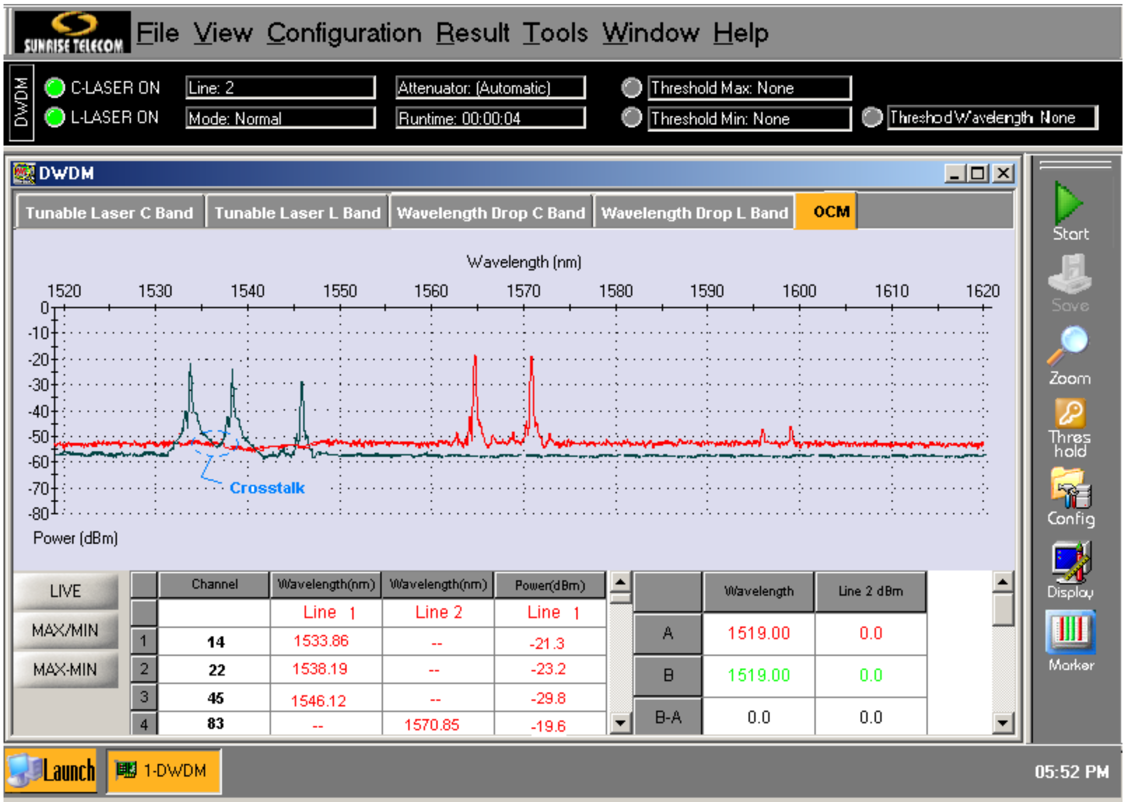
DWDM Module and DWDM Network

The DWDM module offers a complete testing package for DWDM systems, from source, to monitoring, to dropping out a specific wavelength to a network analysis instrument for further BER testing. Connecting a SONET/SDH signal to the "Mod IN" port on the DWDM module, the signal can be converted to a wavelength on the standard ITU WDM grid.



DWDM Module Connector Panel

Optical Channel Monitor



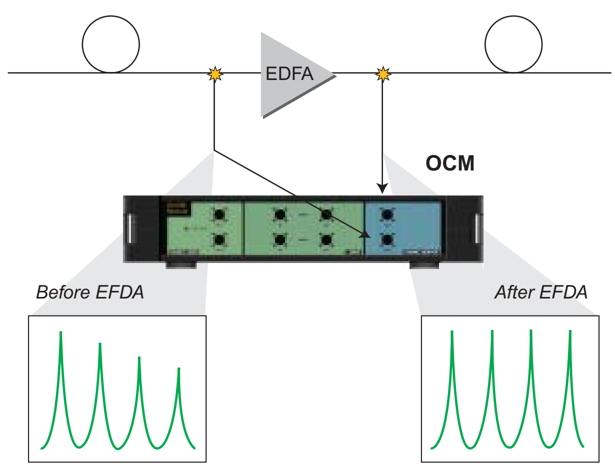
OCM Screen

The OCM feature is essential for checking the overall performance of a DWDM signal. The DWDM Channel Monitor provides visibility into the DWDM network. It simultaneously measures spectrum across the C-band & L-band wavelengths (1520 nm to 1620 nm). In the screen above, the spectrum is displayed. The wave-length peaks are shown and the wavelength, power, and OSNR values are calculated and displayed in a table.

These measurements provide critical data to determine a signal's health and integrity.

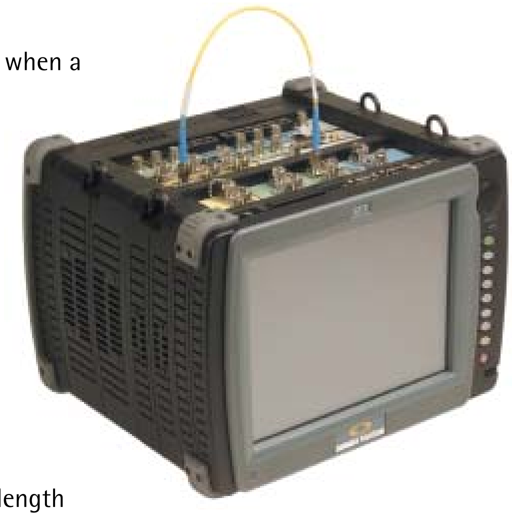
- Wavelength spacing information shows if there are any possible wavelength shifts for a wavelength source.
- Power level shows the active and dropped channels.
- OSNR data shows the quality/degradation of the signal.

In addition, the DWDM Module offers dual port monitoring allowing you to monitor two signals at the same time. This feature is especially useful for testing network elements or for testing a specific length of fiber. For example, the following diagram illustrates how this feature can be used to test an EDFA (Erbium-Doped Fiber Amplifier). One line is connected to the input (connected to the fiber before the EDFA), the other to the output (connected to the fiber after the EDFA). Comparing the OCM data for both lines easily shows if the EDFA is functioning properly.



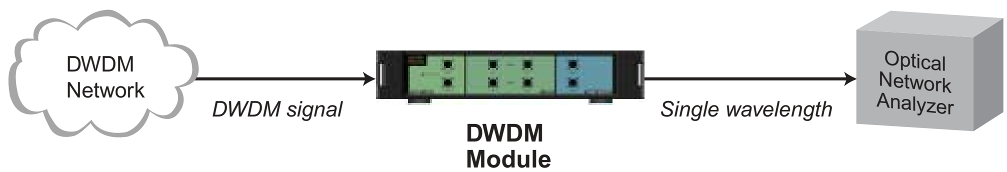
Dual Line Monitoring

Wavelength Drop



The OCM feature is a great tool for monitoring the overall signal. But when a single specific channel in the signal must be analyzed in detail, that's when the STT's Wavelength Drop feature steps in. It drops any DWDM channel to a SONET/SDH analyzer for detailed analysis. For example, the wavelength drop can send a signal to the STT's own Network Analysis Module for BER testing, overhead byte analysis, or performance monitoring. This is particularly useful for analyzing the SONET/SDH signal from a location where there is access to only the DWDM signal, such as at an optical amplifier.

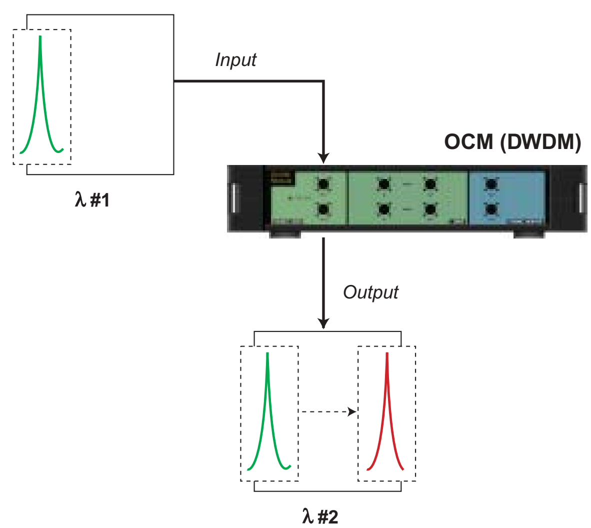
To perform a wavelength drop, you simply insert the DWDM signal to the DWDM Module. The DWDM Module isolates the selected wavelength from the DWDM signal. A short optical jumper sends the dropped wavelength out the "OUT" port to the STT's Network Analysis Module or any optical network analyzer for further testing. The wavelength drop only introduced a 4 dB loss in signal, making the STT's DWDM wavelength drop more useful than others on the market that introduce up to 7 dB of loss.



Frequency Drop

Tunable Laser and Wavelength Converter

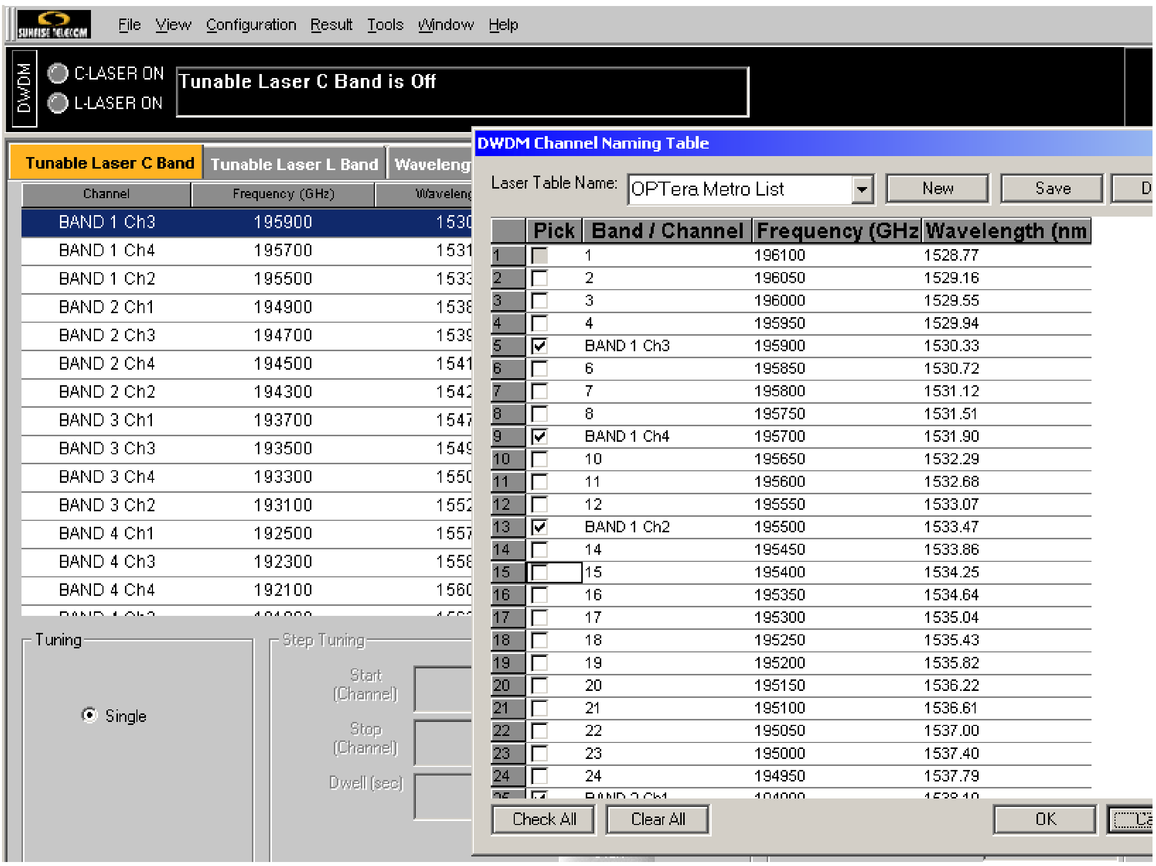
The DWDM Module also provides a tunable laser source and signal converter. The module provides a continuous wave tunable laser source across the C-band and L-band, with 50 GHz ITU-T grid wavelength steps (See Appendix for ITU-T WDM grid). If an input signal is a non-ITU-T grid wavelength, it is then converted to a wavelength on the ITU-T grid. The wavelength converter takes the input at one optical wavelength and transmits it at another wavelength on the ITU-T WDM grid, maintaining the same pattern and framing after conversion. This allows non-ITU WDM grid wavelengths to be tested and analyzed, as well as allows traditional 1310/1550 nm test equipment to generate signals on DWDM wavelengths. The wavelength converter is an economical alternative to maintaining an inventory of transmission equipment for each ITU wavelength. The wavelength converter also converts SONET/SDH test sets (even existing ones with 1310 nm transmitters) to be able to transmit into DWDM equipment test sets that require inputs on the ITU grid.



Source Conversion

Automatic Name Conversion

This patent pending feature allows you to rename the channels on the ITU-T WDM grid. Each vendor or working crew might have its own naming system for the channels. For instance, channel 2 can be Vendor X's "New Band 17". In this case, you can rename the channels according to Vendor X's naming system. The measurement results will then be displayed with the new labels, i.e. "New Band 17", instead of the original default channel numbers. This eliminates the need to memorize the exact wavelength or frequency of each WDM channel. The DWDM Module is loaded with the naming tables of some of the typical equipment vendors. Refer to the screen below for a sample naming table of Nortel's OPTera[1]. The DWDM Module performs this conversion chore, saving time and preventing confusion. This feature is especially handy in the field where the necessary naming documents aren't readily available.



Naming Conversion Screen

SUMMARY

The increased complexity associated with DWDM networks requires a multi-player approach to testing. The STT DWDM Module answers this need. It offers an overview of the entire DWDM signal, as well as provides access to each individual wavelength for thorough analysis, such as BER testing.

[1]OPTera is a trademark of Nortel Networks. All other trademarks are property of their respective owners.

APPENDIX

The table below, from ITU-T G.692 standard, shows the nominal central frequencies based on the 50 GHz minimum channel spacing anchored to the 193.10 THz reference.

Nominal central frequencies (THz) for spacings of 50 GHz	Nominal central frequencies (THz) for spacings of 100 GHz and above	Nominal central wavelengths (nm)
196.10	196.10	1528.77
196.05	—	1529.16
196.00	196.00	1529.55
195.95	—	1529.94
195.90	195.90	1530.33
195.85	—	1530.72
195.80	195.80	1531.12
195.75	—	1531.51
195.70	195.70	1531.90
195.65	—	1532.29
195.60	195.60	1532.68
195.55	—	1533.07
195.50	195.50	1533.47
195.45	—	1533.86
195.40	195.40	1534.25
195.35	—	1534.64
195.30	195.30	1535.04
195.25	—	1535.43
195.20	195.20	1535.82
195.15	—	1536.22
195.10	195.10	1536.61
195.05	—	1537.00
195.00	195.00	1537.40
194.95	—	1537.79
194.90	194.90	1538.19
194.85	—	1538.58
194.80	194.80	1538.98
194.75	—	1539.37
194.70	194.70	1539.77
194.65	—	1540.16
194.60	194.60	1540.56
194.55	—	1540.95
194.50	194.50	1541.35
194.45	—	1541.75
194.40	194.40	1542.14
194.35	—	1542.54
194.30	194.30	1542.94
194.25	—	1543.33
194.20	194.20	1543.73
194.15	—	1544.13
194.10	194.10	1544.53

ITU-T G.692 Table A.1/G.692 Nominal central frequencies

Nominal central frequencies (THz) for spacings of 50 GHz	Nominal central frequencies (THz) for spacings of 100 GHz and above	Nominal central wavelengths (nm)
194.05	—	1544.92
194.00	194.00	1545.32
193.95	—	1545.72
193.90	193.90	1546.12
193.85	—	1546.52
193.80	193.80	1546.92
193.75	—	1547.32
193.70	193.70	1547.72
193.65	—	1548.11
193.60	193.60	1548.51
193.55	—	1548.91
193.50	193.50	1549.32
193.45	—	1549.72
193.40	193.40	1550.12
193.35	—	1550.52
193.30	193.30	1550.92
193.25	—	1551.32
193.20	193.20	1551.72
193.15	—	1552.12
193.10	193.10	1552.52
193.05	—	1552.93
193.00	193.00	1553.33
192.95	—	1553.73
192.90	192.90	1554.13
192.85	—	1554.54
192.80	192.80	1554.94
192.75	—	1555.34
192.70	192.70	1555.75
192.65	—	1556.15
192.60	192.60	1556.55
192.55	—	1556.96
192.50	192.50	1557.36
192.45	—	1557.77
192.40	192.40	1558.17
192.35	—	1558.58
192.30	192.30	1558.98
192.25	—	1559.39
192.20	192.20	1559.79
192.15	—	1560.20
192.10	192.10	1560.61

ITU-T G.692 Table A.1/G.692 Nominal central frequencies (continued)