The Resolution Bandwidth Analysis of Data Acquisition in Optical Spectrum Analyzer and WDM Analyzer

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Summary
This paper presents the analysis of resolution bandwidth (RB) of data acquisition in the Optical Spectrum Analyzer (OSA) and WDM Analyzer. Resolution bandwidth is the bandwidth of the IF filter, which determines the selectivity of the spectrum analyzer and the value of BR will affect the reading of data measurement. We introduced four values of BR in OSA and WDM analyzer and finally comparing the results. We observed significant difference from 1 to 6 dB according to the chosen BR values.

Key words:
Bandwidth Resolution, OSA, WDM analyzer, comparison.

1. Introduction

Historically, spectrum analyzers were very expensive units, the province of a few expert users. Today, spectrum analyzers operating up to 3 or 4 GHz are relatively inexpensive and nearly as commonplace as digital multimeters. However, an analysis of the key parameters and architectures of spectrum analyzers helps to ensure the right product at the right price [2,4].

Resolution bandwidth (RB) is the bandwidth of the IF filter, which determines the selectivity of the spectrum analyzer [4]. A wide resolution bandwidth is required for wide sweeps while a narrow filter is used for narrow sweeps. By using narrower resolution bandwidths, the instrument can reveal sidebands. The penalty for using higher resolution is a slower sweep speed.

Wide filters are used when the display needs to be updated rapidly or when wide modulation bandwidths are to be displayed. The minimum resolution bandwidth of a spectrum analyzer is a key measure of its ability to measure low level signals adjacent to high level signals - and to provide the lowest displayed noise floor.

2.Optical Spectrum Analyzer (OSA)

Optical spectrum analyzers (OSA) are able to divide a lightwave signal into its constituent wavelengths. This means that it is possible to see the spectral profile of the signal over a certain wavelength range. The profile is graphically displayed, with wavelength on the horizontal axis and power on the vertical axis. In this way, the many signals combine on a single fiber in a dense wavelength division multiplexing (DWDM) system can be taken apart to perform per-channel analysis of the optical signal and its spectral interaction with the other wavelengths [3].

Applications for OSAs include testing devices lasers and LED light sources for spectral purity and power distribution, and testing other optical devices for transmission quality. OSAs are ideal instruments for laser modes analysis, very high-resolution spectroscopic measurements, telecommunication device and system tests and other applications [1].

There are three categories of OSAs. These three are diffraction grating based optical spectrum analyzers, Fabry-Perot interferometer based optical spectrum analyzers, and Michelson interferometer based optical spectrum analyzers [1].

Diffraction grating based OSAs are used for measuring the spectra of lasers and LEDs. The resolution of these devices typically ranges from 0.1 nm to 10 nm. These types of OSAs use monochromators with diffraction gratings as tunable optical filters. The monochromator separates the different wavelengths of light, and allows only specific wavelengths to which the optical spectrum analyzer is tuned to reach its photodetector. The result is better wavelength resolution. Fabry-Perot interferometer based OSAs have a fixed, narrow resolution, typically in a specified frequency between 100 MHz and 10 GHz. Due to their narrow resolution, they can be used for measuring laser chirp (an abrupt change of the center wavelength of a laser, caused by laser instability.), but the range they can cover is smaller than that of the diffraction grating style. Due to their narrow resolution range, these devices may allow many wavelengths to pass through their filter at any one point, presenting an interference issue. Placing a monochromator in cascade with the OSA can lessen this effect [3].

Michelson interferometer based OSAs are used for direct coherence-length measurements as well as very accurate wavelength measurements. Other types of optical spectrum analyzers cannot make direct coherence-length measurements.

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3.WDM Analyzer

Analyzer is a breed of optical spectrum analyzer (OSA) for use in the testing and installation/maintenance of WDM system. A dense wavelength division multiplexing (WDM) system analyzer measures wavelength, power and optical signal-to-noise ratio in the range of 1450 to 1650 nm with 50-GHz/0.8-nm spacing. The Optical System Analyzer-155 is portable, battery-operated and suitable for remote operations when measuring optical parameters during installation and maintenance of dense WDM systems. Most of the WDM systems operate on the single mode fibre optics cables and the systems have different wavelength patterns which are coarse or also known as conventional and dense WDM.

Coarse WDM system and DWDM system operates in the same 3rd transmission window of silica fibres around 1550nm. However in contrast to the coarse WDM system which provides up to 16 channels, DWMD systems channels vary. Common systems use 40 channels at 100GHz channels spacing or 80 channels with 50GHz spacing. Even though there are few types of WDM systems, they are all based on the same concept of using multiple wavelengths on a single fibre optic cable, but differ in the spacing of the wavelengths, number of channels, and the ability to amplify the multiplexed signals in the optical space. [7]

There are various parameters required in order to characterize the performance of a WDM systems. This including the channel count, signal wavelength, signal power, optical signal to noise ratio (OSNR), and spectral flatness. The main key to characterize the performance of WDM system is the accuracy of measurement of its Optical Signal to Noise Ratio (OSNR). [6]

4.Analysis

Figure 1 shows the difference of reading measured using 2 equipments (OSA and WDM analyzer) at different bandwidth resolution. The measurement is in terms of output power for different distance measure in Fiber-to-the Home network. At RB of WDM analyzer at 0.1 nm, we observed the difference in reading measured by OSA at RB 0.01 nm and 0.1 nm is about 3 dB and 4 dB respectively. The significant difference gives much effect in system reliability. The degradation rate of OSA at different RB is about 0.27 dB/km.

The difference in reading for WDM analyzer and OSA with BR 0 nm is 2.0 dB to 2.5 dB. The degradation rate for WDM analyzer is 0.25 dB/km and the values are different when measured using OSA.

4. Conclusions

Optical Spectrum Analyzer (OSA) and WDM analyzer have been used vastly in research and development (R&D) as well as in optical network installation. When taking the measurement, there is parameter that needs to be considered in which influences the data reading. This paper presented the analysis of resolution bandwidth (RB) of data acquisition in OSA and WDM Analyzer. RB is the bandwidth of the IF filter, which determines the selectivity of the spectrum analyzer and the value of BR will definitely affect the reading of data measurement. We introduced four values of BR in OSA and WDM analyzer and comparing the results. The graph shows the significant difference from 1 to 4 dB according to the chosen BR values. The 6 dB difference of output power were measured using both equipments with same RB values (0.1 nm). We hope our analysis will provide good reference and guide to users who will be handling both equipments.

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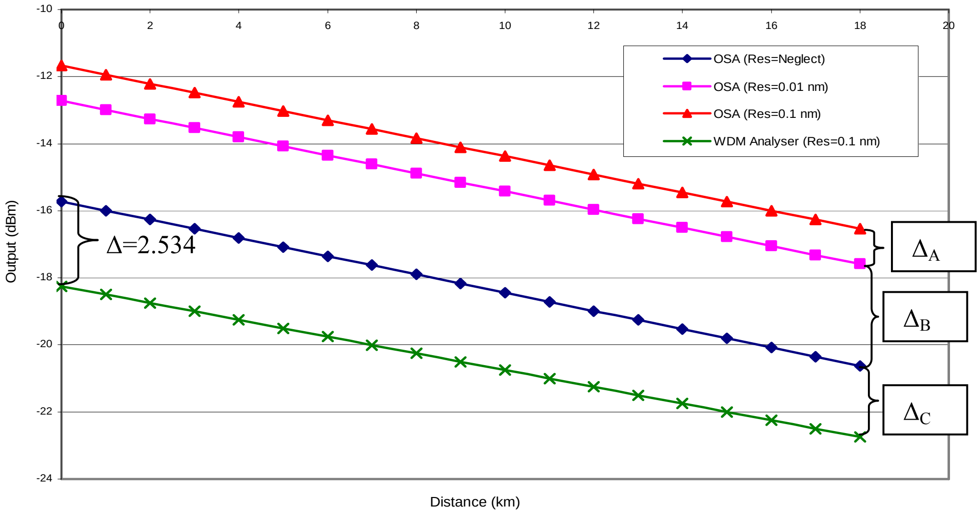

y = -0.2703x - 11.674 (OSA Resolution = 0.1 nm)
y = -0.2704x - 12.723 (OSA Resolution = 0.01 nm)
y = -0.2725x - 15.72 (OSA Resolution = neglected)
y = -0.2499x - 18.254 (WDM Analyzer Resolution = 0.1 nm)

Δ_A=1.049
Δ_B=2.997
Δ_C=2.119

Figure 1 Effects of transmitted distance towards output power measured using a WDM analyzer (Res=0.1 nm) and the optical spectrum analyzer (OSA) at three different resolutions.

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