Optical spectrum analyzer methods

The need for optical spectrum analyzer (OSA) in the field: different technologies available

Executive summary

The pressures imposed by a competitive market entail that service providers upgrade and maintain their networks continuously to ensure that they are capable of delivering higher-speed, higher-quality applications and services to customers. This creates a need to verify and make sure that the network's fiber infrastructure and equipment can meet exacting performance standards and operate reliably. As a result of the emergence of DWDM networks, some important changes were made in the optical fiber characterization and system turn-up. Consequently new test tools and procedures were needed. These are explained in the JDSU white papers: "1625nm requirements", "Chromatic dispersion requirements", and "Polarization mode dispersion requirements".

This paper discusses one particular aspect of the evolving requirements in system turn-up, namely, the need for an optical spectrum analyzer, a critical tool to characterize DWDM, that is, multiple channel systems. The different technologies to realize the spectrum analyzer are described, together with their benefits and limits, herein.

Optical spectrum analyzer definition

As multiple wavelengths are used in a DWDM system, it is important to know the following parameters for each wavelength/channel: exact wavelength, power level, dynamic range or optical signal over noise ratio (OSNR). Most of the DWDM parameters are defined in the ITU-T recommendation G.692 "Optical interfaces for multi-channel systems with optical amplifiers". The optical spectrum analyzer (OSA) provides these parameters and a trace of power as a function of wavelength.

The optical spectrum analyzer can also provide, together with a broadband source at the opposite end, a spectral attenuation trace for fiber characterization, which is an important parameter for DWDM installation.

Optical spectrum analyzer methods

There are three different optical spectrum analyzer methods that can be used in the field. They are

the interferometric method, the diffraction-grating method and the Fabry-Perot method. Calibration of the OSA is defined by IEC 62129 "Calibration of optical spectrum analyzer". See also IEC 61290 "Optical fiber amplifiers", which includes TIA/EIA 455-206 and 209. Telcordia GR-2952-CORE "Generic requirements for portable wavelength division multiplexer analyzers" provides the main specifications of an OSA.

A. OSA with the interferometric method

Principle

The principle of the interferometric method is that the equipment counts the interference maxima and minima amplitude which are produced by a fixed mirror and a moving mirror (Michelson interferometer). Individual wavelengths can be selected through subsequent computation of the spectrum using a fast Fourier transform (FFT). This principle can be also used for multi-wavelength meters, instruments which are mainly providing wavelength and power levels information, and no dynamic range/OSNR values (schematic shown in figure 1).

Benefits and limits

The benefits of this method are its wavelength range, accuracy and stability (a typical reference source for calibration is the HeNe source). It also has a good dynamic range and OSNR values, but these tend to be less than diffraction-grating based OSAs. As there are moving parts, this method is not fully optimized for the field or outside plant applications, but more optimized for inside plant applications. This is also the most expensive technology.

Standards	Description
G.692	Optical interfaces for multi-channel systems with optical amplifiers
IEC 62129	Calibration of optical spectrum analyzer
IEC 61290	Optical fiber amplifiers
TIA/EIA 455-206	Optical fiber amplifiers – basic specification part 1-1: test methods for gain parameters – optical spectrum analyzer
TIA/EIA 455-209	Optical fiber amplifiers – basic specification part 2-1: test methods for optical power parameters – optical spectrum analyzer
GR-2952-CORE	Generic requirements for portable wavelength division multiplexer analyzers

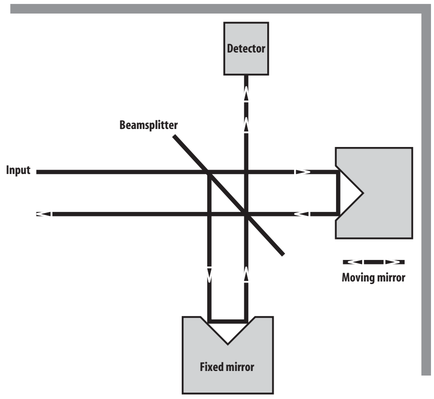

figure 1 Interferometric method

B. OSA with the diffraction-grating method

Principle

The principle of the diffraction-grating method is based on the fact that the light is broken into its spectral colors by a grating. The grating rotates so that different wavelengths are brought to the detector at different times and analyzed. Such a combination can also be called a monochromator. Double pass monochromators (the light is reflected twice to the grating) provide better accuracy and higher dynamic range than single-pass monochromators (see schematic shown in figure 2).

Benefits and limits

The benefits of this method are its wave-length range, good dynamic range and OSNR values, but it is limited for the resolution and wavelength accuracy parameters. As there are moving parts, this method is not fully optimized for the field or outside plant applications, but more optimized for inside plant applications.

C. OSA with the Fabry-Perot method

Principle

The principle of the Fabry-Perot method is the use of a cavity resonator. It is made of two partially mirrored plates, arranged at an adjustable distance using piezo elements, thereby forming a resonant cavity. The selectivity is directly determined by the transfer properties of the Fabry-Perot filter. It is transparent when all the sub-beams arising between the plates due to multiple reflections are constructively superimposed. At all other wavelengths high attenuation occurs (see schematic shown in figure 3).

Benefits and limits

This method provides good wavelength accuracy, but is limited as far as the dynamic range/OSNR and wavelength range values are concerned. If the wavelength range is extended, using similar component specifications, then the dynamic range will be reduced.

Its small filter bandwidth means very close channels can be detected (down to 12.5 Ghz). Even the modulation or laser chirp of a given channel can be seen. It has no moving parts, making

it rugged (not sensitive to drop, vibration, etc) and ideal for field and outside plant use, but also for DWDM system monitoring purposes. It is also compact and lightweight, as it uses only components, and does not need free-air mechanics. Moreover, it has a low power requirement making it ideal for battery-operated instruments.

When shall I use an OSA with my links?

OSA measurements are only used when DWDM systems are installed or maintained. Consequently it will be required for:

– Fiber installation for spectral attenuation measurements

– Upgrade of classical TDM 1310/1550nm networks to DWDM applications

– Maintenance and troubleshooting of DWDM networks

– DWDM network monitoring and surveillance

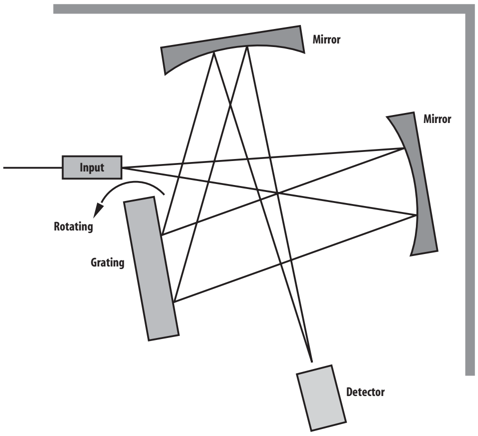

figure 2 Diffraction grating

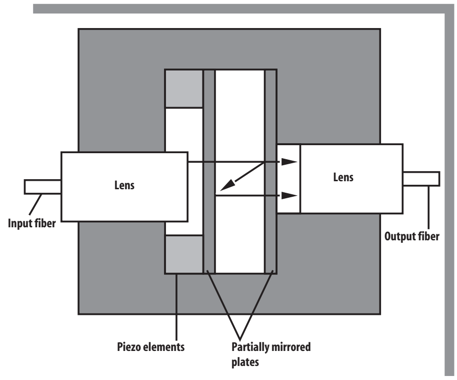

figure 3 Fabry-Perot

Test & Measurement Regional Sales

NORTH AMERICA	LATIN AMERICA	ASIA PACIFIC	EMEA	www.jdsu.com/test
TEL: 1 866 228 3762	TEL: +55 11 5503 3800	TEL: +852 2892 0990	TEL: +49 7121 86 2222	
FAX: +1 301 353 9216	FAX: +55 11 5505 1598	FAX: +852 2892 0770	FAX: +49 7121 86 1222	