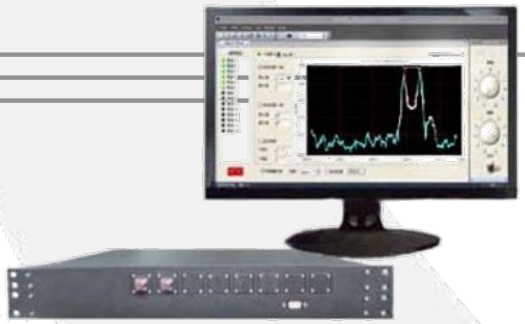
FBG Analyzer



DEVICE

Fiber Bragg Grating Analyzer

OVERVIEW

The Op1lab FBG Analyzer is a fully-automated testing and measurement Optical Spectrum Analyzer (OSA) system designed for Fiber Bragg Grating (FBG) applications. Featured high dynamic range, high wavelength resolution, and fully-integrated, one-button automatic operation in one or multiple channels, the Optilab FBG Analyzer greatly facilitate the analysis on FBG spectral characteristics. Besides analysis in bare FBG/FBG Array applications and FBG sensing systems, it is also ideal for laboratory testing and spectrum measurement of transmission and reflection. Optilab has developed an innovative software for FBG Analyzer: fully-automated C-based software program with customizable measurement parameters, data saving functions, and intuitive display interface, which is able to perform comprehensive spectrum analysis such as loss, center wavelength, 3dB bandwidth, 6dB bandwidth, side lobes, symmetry, etc. Please contact Optilab for more information.

FEATURES

- High wavelength resolution of +/- 1 pm
- Built in National Instruments (NI) DAQ Card
- Internal multiple wavelength reference
- High dynamic range up to 50 dB
- 0.02 dB loss accuracy
- Order from 1 to 8 FBG channel
- Fully automated C-based software

USE IN

- Packaged FBG manufacturing quality assurance
- Installation FBG system inspection and monitor
- FBG fabrication testing and measurement
- FBG Array testing and defect detecting
- Laboratory R&D

FBG Analyzer

SPECIFICATIONS

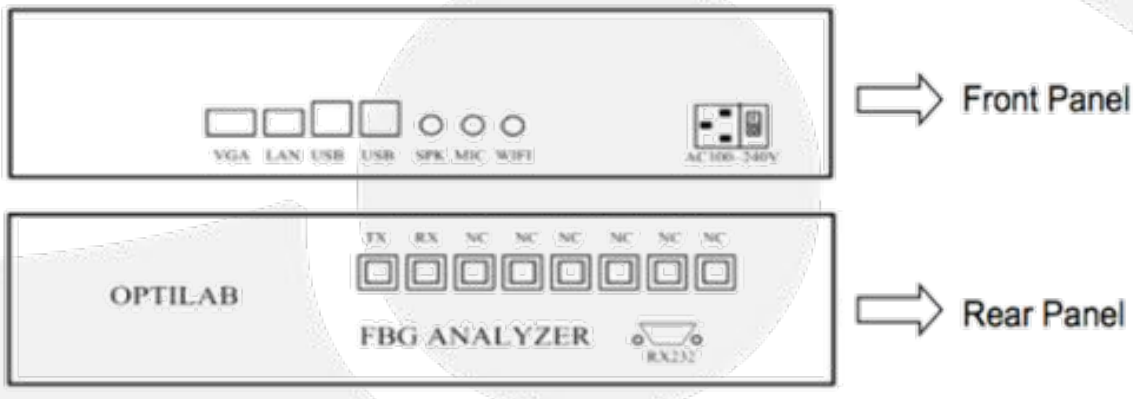
TECHNICAL

Number of Measurement Channels	1 – 8 standard, expansion available
Wavelength Range	1525 nm – 1570 nm, or customizable
Scan Frequency	8 Hz standard, customize to 100 Hz
Dynamic Range	> 50 dB
Wavelength Accuracy	± 1 pm
Loss Accuracy	0.01 dB
Optical Output Power	10 dBm, typ.
Measurement Mode	Reflection and transmission
Applicable FBG Type	All types

MECHANICAL

Input Voltage	100 – 240 VAC
Optical Connectors	FC/APC, or customize
Housing	2U Rackmount
Operating Temperature	10 °C to 60 °C
Operating Humidity	0 to 80%, non-condensing
Storage Temperature	-20 °C to 70 °C
Storage Humidity	0 to 95%, non-condensing
Dimensions	480 mm x 410 mm x 88 mm
Weight	23 kG

MECHANICAL DRAWING



FBG Analyzer

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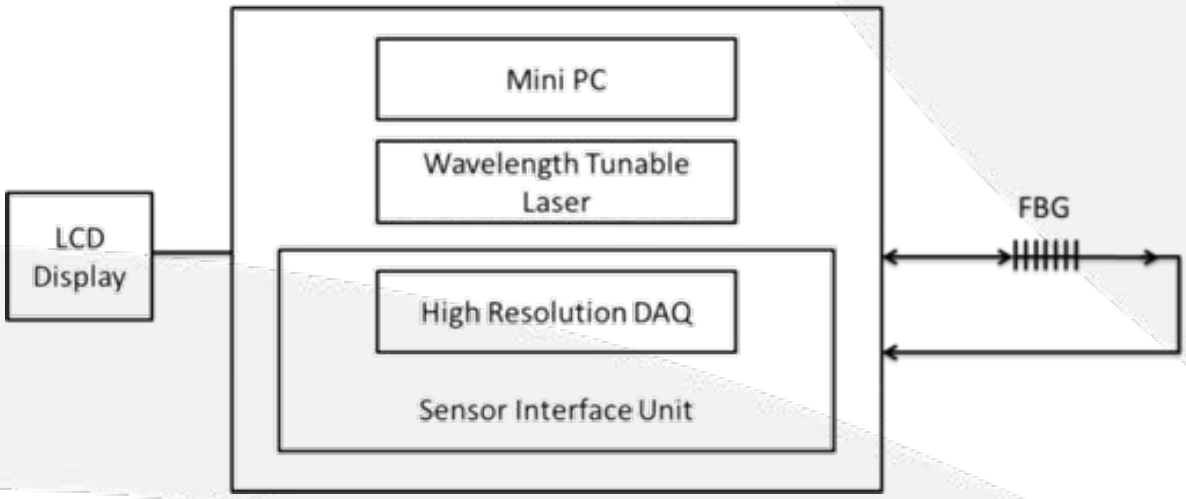
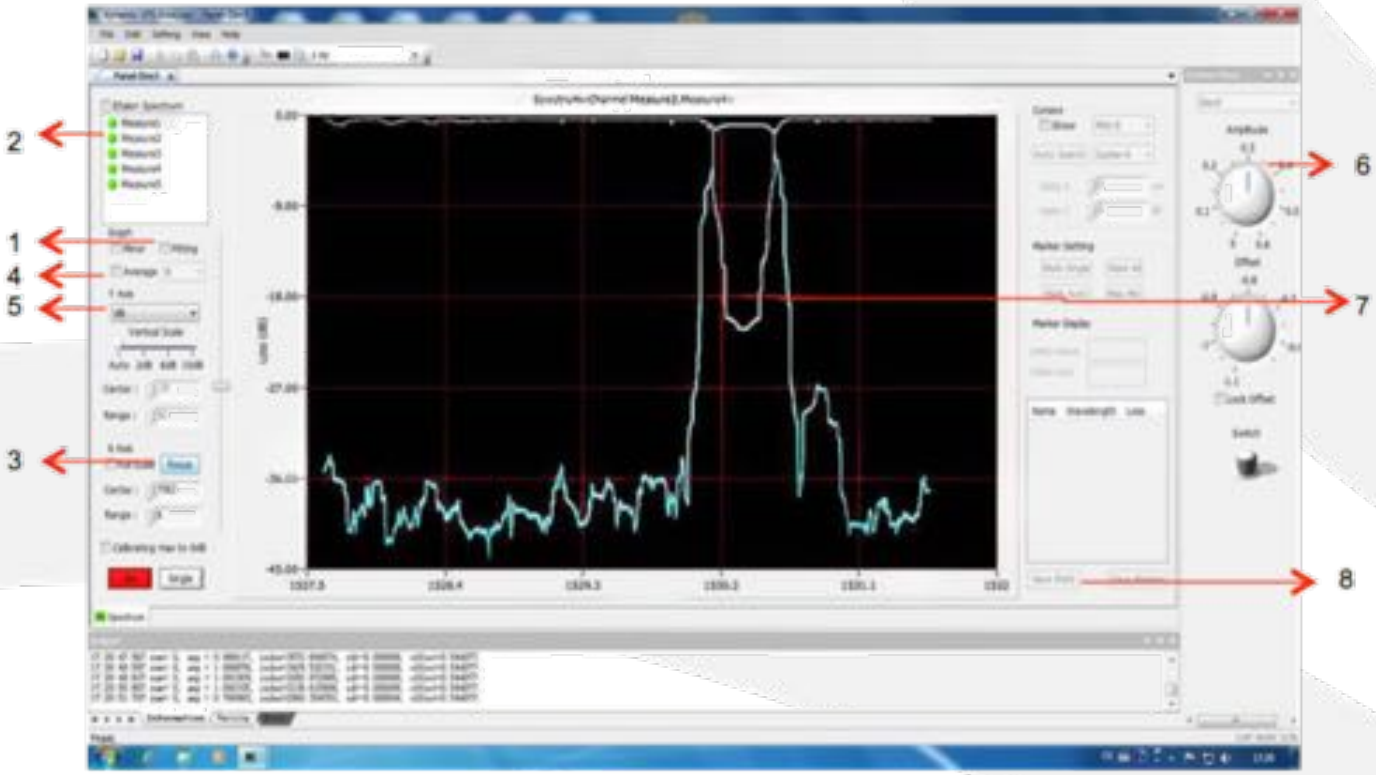


FULLY AUTOMATED C-BASED SOFTWARE FOR FBG ANALYZER

UnionOpt has developed a fully-automated C-based software interface for spectrum analysis of Op1lab FBG analyzer. The software interface features one button one 1me automa1c tes1ng and measurement. Similar to func1ons of Op1cal Spectrum Analyzer (OSA) , the software can be used to measure various FBGs and analyze large scale of FBG sensing data, for example, FBG loss and center wavelength, side mode suppression ra1o, 3dB bandwidth and 6dB bandwidth, symmetry, etc. The sensing data can be streamed to computers and mobile devices in a numerical, graphical visual interface. Various customizable control and display func1ons can be achieved in this software:

- One button automatic testing
- Auto/manual scale
- Drag to zoom in
- Data save and recall

FBG Analyzer



DETAILED SOFTWARE INTERFACE

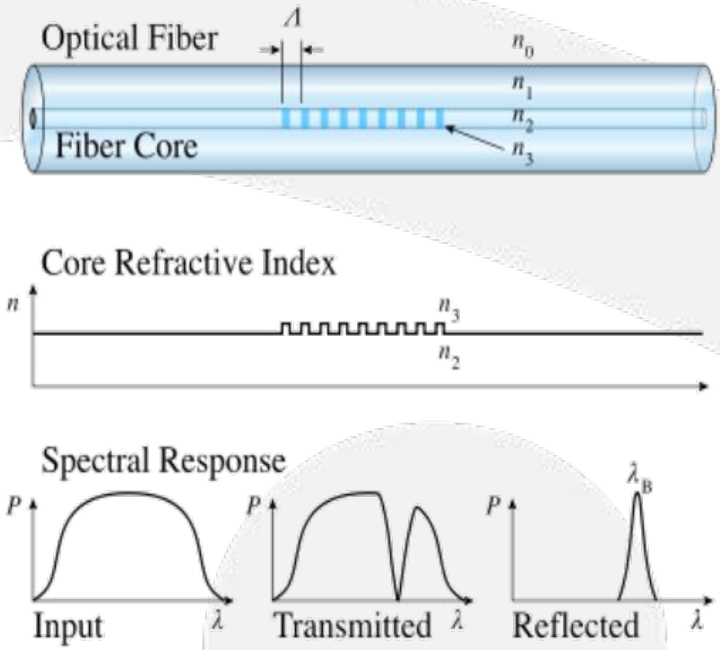
1. Fitting function
2. Simultaneous mul1ple channel measurements
3. Focus button: automa1c detect center wavelength and zoom in to display the spectrum of interest
4. Average function
5. Y Axis: Display the optical loss or transmission of each channel.
6. Swept wavelength laser parameter adjustment
7. Transmission and reflec1on spectrum display
8. Save data

This fully-automa1c C-based software can also be used to test and measure bare FBGs, FBG array, various FBG sensors.

FBG Analyzer

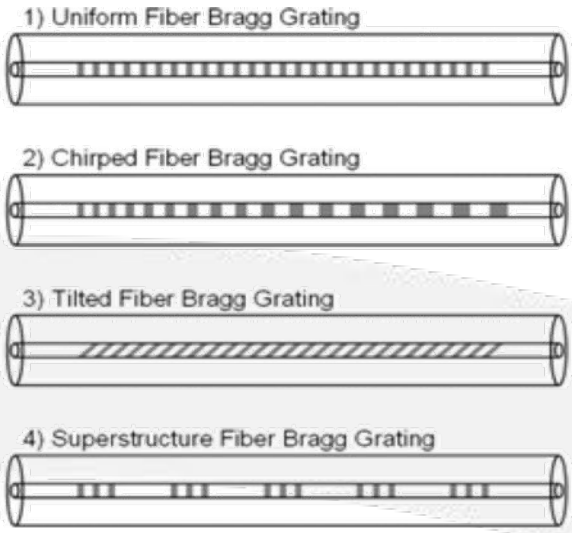
WHAT IS AN FBG?

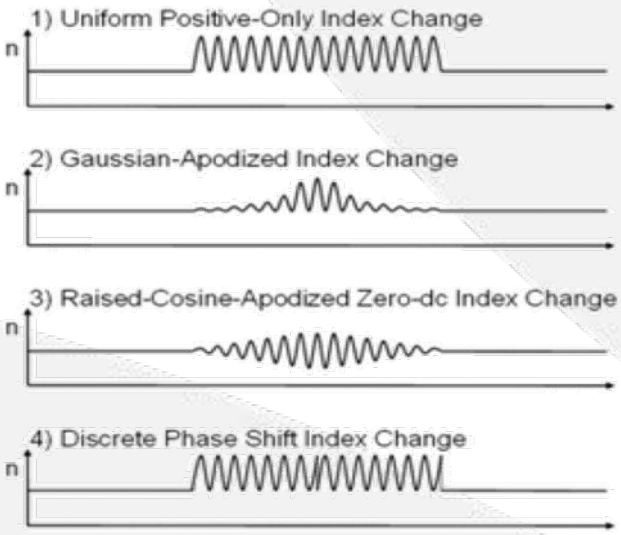
FBG stands for Fiber Bragg Grating. It is a type of distributed Bragg reflector constructed in a short segment of optical fiber that reflects particular wavelengths of light and transmits all others. This is achieved by creating a periodic variation in the refractive index of the fiber core, which generates a wavelength specific dielectric mirror. A Fiber Bragg Grating can therefore be used as an inline optical filter to block certain wavelengths, or as a wavelength-specific reflector. The peak reflection wavelength of FBG is sensitive to the environmental conditions such as temperature, strain, displacement and pressure. Therefore FBG is also widely used in sensor applications.



FBG Analyzer

TYPES OF FBGs





STRUCTURE OF THE REFRACTIVE INDEX CHANE IN:

1) a uniform FBG
2) a chirped FBG
3) a tilted FBG
4) a superstructure FBG

REFRACTIVE INDEX PROFILE IN THE CORE OF:

1) a uniform positive-only FBG
2) a Gaussian-apodized FBG
3) a raised-cosine-apodized FBG with zero-dc change
4) a discrete phase shift FBG

FBG Analyzer

CHARACTERISTICS OF FBG

1. Sensor Wavelength

The sensor wavelength is the peak wavelength of the FBG reflection spectrum. The peak wavelength will shift with the change of temperature and strain. Typically, the increase of either temperature or strain can cause redshift of the FBG wavelength. Fig. 1 shows the redshift of FBG reflection spectrum from 1535.050 nm to 1535.150 nm when heated up from 25 to 35 °C. Most FBG interrogator works in a wavelength range from 1520 to 1570 nm.

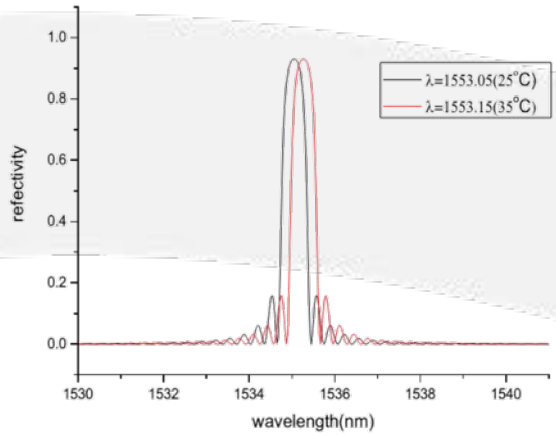


Fig. 1 FBG sensor wavelength

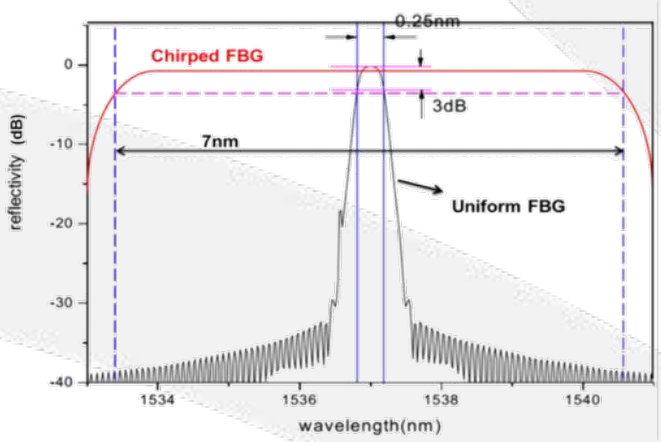


Fig. 2 Reflection spectra of a uniform FBG and a chirped FBG

2. Sensor bandwidth

The sensor bandwidth is the 3 dB bandwidth of the FBG reflection spectrum. The smaller bandwidth is preferred as a result of higher measurement accuracy, but it is also more difficult to fabricate and costs much higher. The typical FBG sensor bandwidth is around 0.2 to 0.3 nm. In some special applica1ons, high bandwidth is required. Chirped FBG adds linear variation into the grating thus broaden its reflection spectrum. Fig. 2 shows the reflection spectrum of a uniform FBG sensor (black) of 0.25 nm bandwidth and a chirped FBG (red) of 7 nm bandwidth.

3. Reflectivity

Reflectivity is the peak reflectivity of FBG sensor. Higher reflectivity means more optical power can reach the detection system, thus good for high signal to noise ratio. It is usually recommended to use FBG sensors with reflectivity higher than 90%. However, in some cases higher reflection rate might lead to problems if side mode suppression is not taken care of.

CHARACTERISTICS OF FBG

4. Side mode suppression

Some FBG sensors have many side lobes, as shown in Fig. 3. FBG sensor interrogator may treat these side lobes as the peak of another FBG sensor, especially when detection system has a high gain. To avoid such mistake, it is important to control the side mode suppression ratio, since it usually determines the signal to noise ratio in the entire sensor system. The typical requirement of side mode suppression ratio is higher than 15 dB when the peak reflectivity is higher than 90%. Apodization is a technique to smooth the FBG spectrum. By using high quality holographic phase mask, apodization can eliminate the side lobes, thus no disturbance to the main peak detection. The traditional apodization method is effective in eliminating the side lodes at long wavelength side but helpless on the short wavelength side. To suppress side modes on both sides, apodization compensation technique has been developed and proven effective. Fig. 4 left panel shows the reflection spectrum of a FBG sensor fabricated with Gaussian apodization, in comparison with the right panel, which is fabricated with apodization compensation, showing smooth feature on both sides.

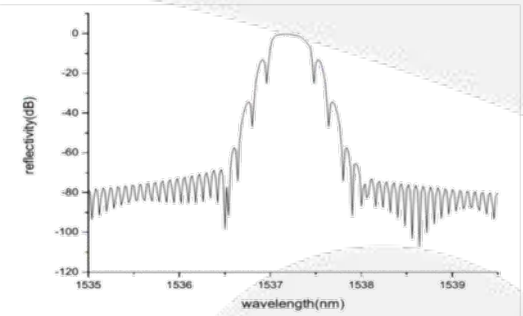


Fig. 3 Non-apodized FBG

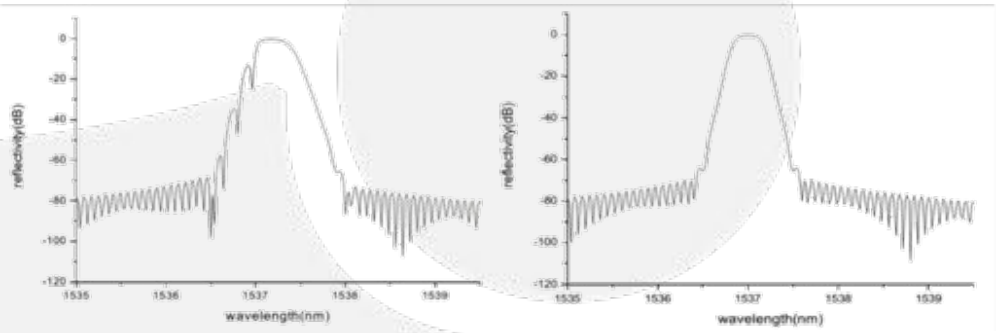


Fig. 4 Gaussian-apondized FBG (left) and apodization compensation FBG (right)