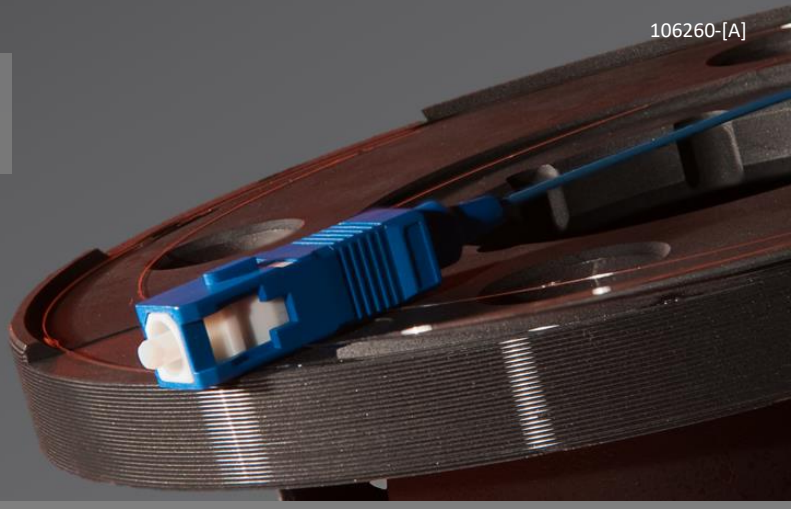
Application Note



Chirped Fiber Bragg Gratings – key elements for optical network optimisation and optical sensing

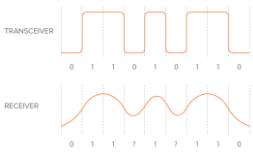
THE PRODUCT

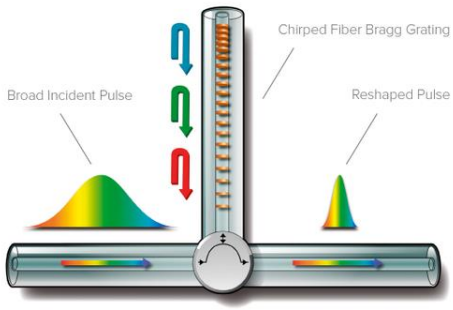
A Fiber Bragg Grating (FBG) is a wavelength selective filter inscribed into the core of a singlemode optical fiber. A single unique wavelength is reflected that is proportional to the period of the grating. FBG technology has found numerous commercial applications in telecommunications and sensing over several decades.
A chirped Fiber Bragg Grating (CFBG) is a special type of FBG in which the period of the grating varies linearly along its length. The result is a wavelength selective filter where a broad range of wavelengths are reflected from different locations along the CFBG. In this way, the CFBG can be designed to modify the characteristics of a spectrum, such as narrowing or broadening.
The unique characteristics of the CFBG can be used in numerous applications within the telecoms and optical sensing industries. Proximion AB is the world-leading manufacturer of CFBGs and has developed a unique, fully customisable manufacturing capability in its Stockholm laboratories.

THE TELECOMS APPLICATIONS

DISPERSION COMPENSATION

Dispersion in optical networks occurs when a narrow pulse of light broadens in the time domain due mainly to different wavelengths traveling at different speeds. In long haul networks, this causes bit errors and limits the speed of data transmission.





A CFBG corrects for dispersion

Adding a Proximion CFBG before the receiver reshapes the light pulse by delaying the faster wavelengths and allows higher speed, error-free communication. Even in the latest coherent networks, where DSPs electronically correct for dispersion, additional FBG dispersion compensation bring the benefits of reduced power consumption, latency and complexity as shown in this 100G coherent upgrade case study: www.proximion.com/s/Case-study-AARNet-150622-znnt.pdf.

Thousands of Proximion's continuous band dispersion compensation modules have been used to improve optical networks across the globe, and their development has made Proximion world leaders in customised CFBG design and manufacture, boasting a unique ability to manufacture CFBGs tens of meters long able to operate between 990 and 1700 nm. Find out more about Proximion's dispersion compensation modules at www.proximion.com/dispersion-compensation

DISPERSION EMULATION

When implementing any new transmission concepts or technology, careful consideration needs to be taken to dispersion effects. In order to test a system design before implementation, a Proximion dispersion emulation module can be used to create the exact amount of dispersion that the design must be able to withstand or cope with by simulating the wavelength dependent delay an optical transmission span will experience. A dispersion emulation module is also an ideal component for production testing of devices that have dispersion compensation features.

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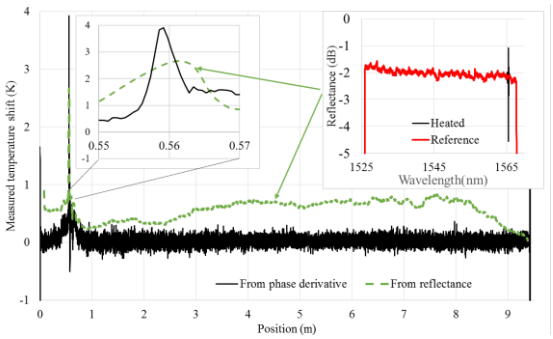
> APPLICATION NOTE The Chirped fiber Bragg grating – a key element for communications network optimisation and optical sensing

THE SENSING APPLICATIONS

DISTRIBUTED STRAIN AND TEMPERATURE SENSING

Quasi-distributed strain and temperature sensing is often performed with arrays of different wavelength FBGs at discrete positions. However, in some circumstances a truly distributed measurement is required. Proximion has demonstrated how a 9.5m long CFBG can provide distributed strain and/or temperature measurement along its length with a spatial resolution of 4mm and a measurement noise of 0.1K / 1 microstrain. The work is presented at ieeexplore.ieee.org/document/7961003.

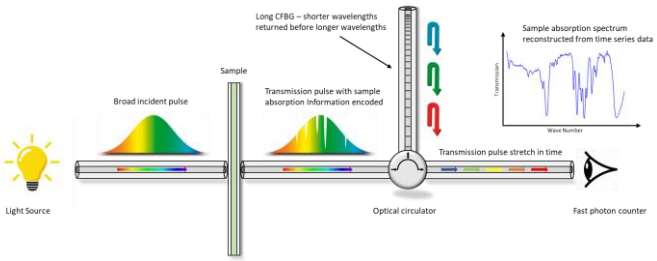


Distributed temperature sensing via phase or amplitude using a 9.5m CFBG

INFRA-RED SPECTROSCOPY

Infra-red spectroscopy is a hugely important way of identifying the chemical composition of sample matter by analysing the absorption of different light wavelengths by the sample. A traditional IR spectrometer uses a diffraction grating and linear detector array to measure the transmission spectrum. Whilst effective, such apparatus can be expensive and sensitive to environmental factors.

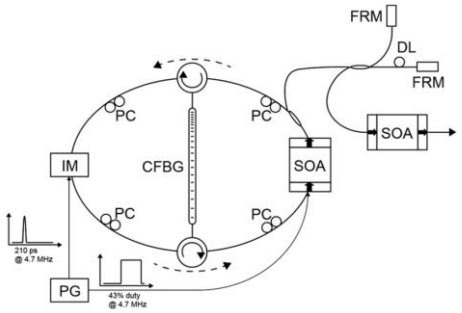
An alternative method of time stretched spectroscopy, where the spectral information is encoded into a time series by a long CFBG and then decoded by a single fast photodetector, offer a low cost and highly robust spectrum analyser.



Showing a CFBG used in a simple time stretched spectroscopy apparatus

OPTICAL COHERENCE TOMOGRAPHY

Optical Coherence Tomography (OCT) is a key technique for medical research. OCT benefits from fast imaging and speed increases have been gained using rapidly tuned mechanical optical filters, but to achieve the target speeds of 10 MHz non-mechanical tuning is required. A Proximion chirped FBG has been proven to be a suitable part of a 9.4 MHz pulsed 1300 nm source of a stretched-pulse active mode-locking (SPML) OCT. The system development and OCT results, obtained via a collaboration between Korea Advanced Institute of Science and Technology, Massachusetts General Hospital and Harvard Medical School, are presented at www.nature.com/articles/s41598-020-66322-0.



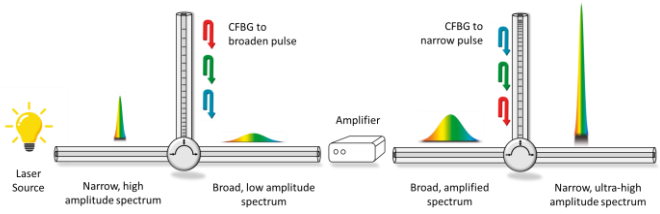
Showing a Proximion 1300nm CFBG in an SPML OCT apparatus

OTHER APPLICATIONS

LASER PULSE BROADENING FOR AMPLIFICATION OR TRANSMISSION

In certain applications, it is often required to further amplify the narrow, high amplitude output of a laser. Such amplification is far easier to achieve if the laser power is first spread into a broader, lower amplitude spectrum. This can be conveniently done with two chirped FBGs before and after the amplifier, as shown to the right.

The same concept can also be used to enable high amplitude laser transfer through a transmission link which does not support the amplitude of the original pulse, wherein the broadened pulse is transmitted and then narrowed again at the receiver.



Showing a CFBG pair in an laser power amplification system

THE COMPANY

Part of the huge Hexatronic Group, Proximion AB designs and manufactures customized, high performance fiber optic systems for use in the telecoms and industrial sensing sectors. Proximion technical experts have decades of experience applying the unique advantages of FBG technology to a wide range communication and industrial assets management applications. proximion.com

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