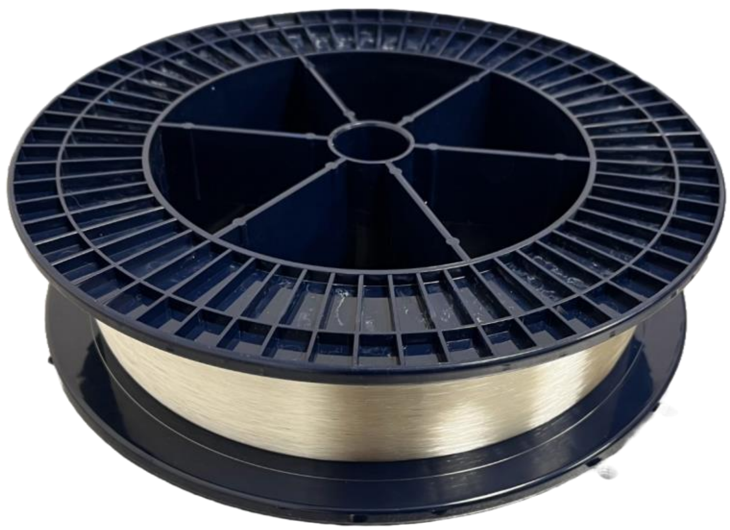
SENTEK INSTRUMENT LLC

Broadband Fiber Bragg Grating Arrays



In recent years, optical fiber has found a new application in long-distance distributed acoustic sensing (DAS). The principle involves launching a laser pulse into a fiber, where a small portion of the pulse's energy is backscattered via Rayleigh scattering. An acoustic wave affecting any part of the fiber alters the optical phase of these backscatters, allowing detection through an optoelectronic interrogation device. Today, numerous DAS interrogators employ different hardware designs and signal processing algorithms. However, two common issues plague Rayleigh DAS systems. The first is limited sensitivity due to the extremely weak Rayleigh backscatters, with a backscatter strength of only -82dB or 6 parts per billion for a one-nanosecond laser pulse in typical telecommunication fiber. Consequently, acoustic wave detection sensitivity is restricted to nanostrains. Secondly, Rayleigh coherent backscatters exhibit random variations both along the fiber and over time. At any given moment, significant portions of the sensing fiber may exhibit poor acoustic detection sensitivity, and these underperforming sections may shift randomly along the fiber with time.

To address these challenges, various scattering-enhanced optical fibers have been developed, primarily based on phase mask fiber Bragg gratings (FBGs) that require germanium dopant in the fiber core. However, these fibers often experience gradual loss increases when used in harsh environments, such as oil and natural gas wells. To mitigate this fiber darkening effect, pure-silica-core fibers are necessary, but the absence of germanium dopant renders the traditional phase mask method inapplicable. To inscribe FBGs in such pure silica core fibers, femtosecond lasers can be employed to write FBGs using a point-by-point method. These gratings are thermally stable and can be made broadband. However, a significant limitation of this method is the limited control over FBG quality, particularly for long FBG arrays, where reflected powers typically vary by over 10dB.

Sentek Instrument LLC recently achieved a breakthrough in manufacturing ultrahigh-quality broadband FBGs in any fiber, including pure silica core fiber with various coating options. The quality of each FBG is continuously monitored during fabrication to ensure uniform optical power reflection within tight tolerances. Precise control over fiber and upstream grating loss compensation is maintained at an individual grating level. Customers can request broadband reflectance-weighted gratings with either constant or varying spacing. Moreover, a fiber can incorporate multiple grating zones, each containing numerous FBGs, and these zones can be arranged according to the customer's requirements.

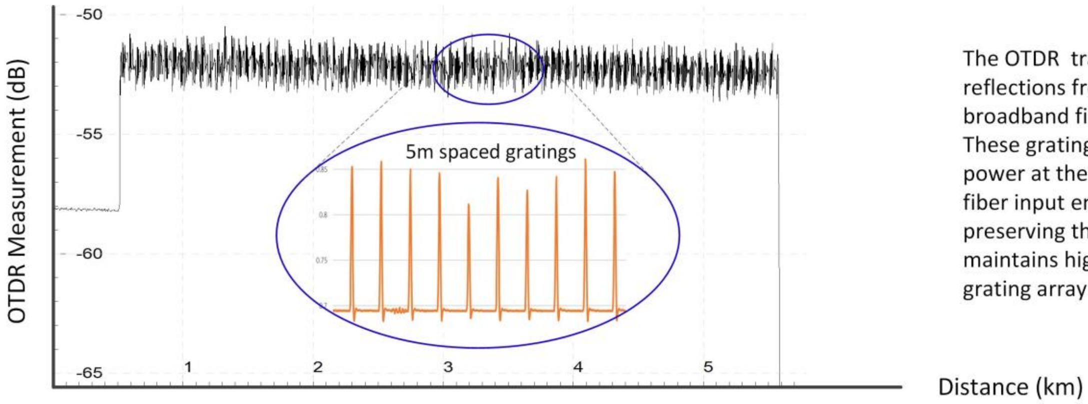
Our gratings demonstrate exceptional thermal stability, even at temperatures exceeding 300°C. Sentek's state-of-the-art gratings offer several major benefits for Rayleigh ϕ-OTDR or DAS interrogators, including:

1. Significant sensitivity enhancement.
2. Suppression of random sensitivity fluctuations across fiber segments and over time.
3. Large bandwidth.
4. Customer-specified varying grating reflectivities with individual grating tailorability and their distributions along the fiber.
5. Minimum polarization dependence.
6. Excellent thermal stability.
7. Precision grating spacing control.

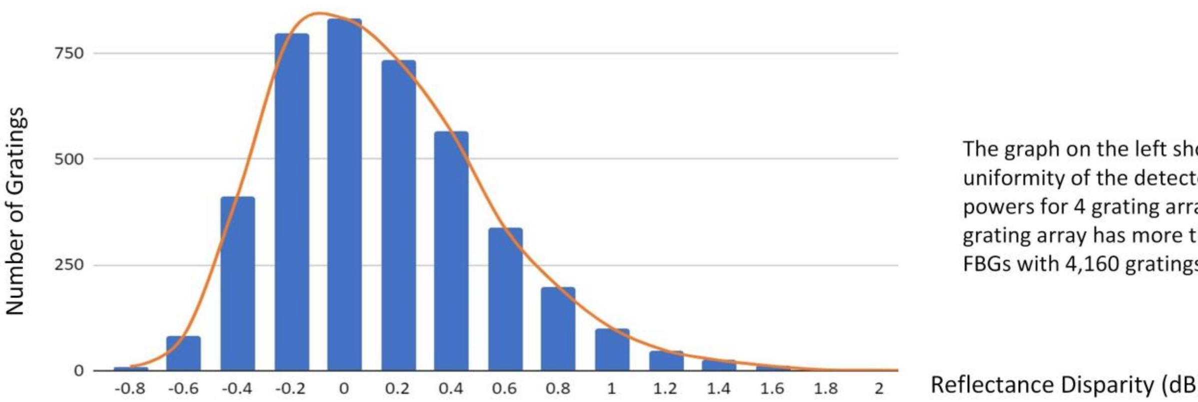
Sentek's cutting-edge grating array manufacturing technology with individual grating quality control can instantly elevate the performance of your DAS interrogators to the highest level.

TECHNICAL SPECIFICATIONS

FBG Reflecting Strength	-40 to -55dB
3dB Bandwidth	>20nm
Grating Spacing	1 to 50m or custom
Grating Spacing Precision	±2mm or 0.2% of spacing, whichever gives greater uncertainty
Grating Reflectance Distribution	Uniform reflectance or uniform reflected power
Standard Deviation of Reflected Powers	0.5dB typical
Fiber Types	Pure silica core fiber, telecom fiber such as SMF-28
Fiber Coatings	Standard and high-temperature acrylate
Grating Zone Partition Options	Any
Maximum Fiber Length	10km, actual max length dependent on grating quantity and reflectance



The OTDR trace on the left shows the reflections from 1,065 serial broadband fiber Bragg gratings. These gratings offer constant optical power at the photodetector on the fiber input end. Additionally, preserving the original fiber coating maintains high tensile strength of the grating array.



The graph on the left shows the uniformity of the detected relative powers for 4 grating arrays. Each grating array has more than 1,000 FBGs with 4,160 gratings total.

ORDERING INFORMATION

Please send your quote request to sales@sentekinstrument.com and specify your requirements on number of gratings, their reflectance, bandwidth, spacing and fiber if different from standard telecommunication grade singlemode fiber such as acrylate coated SMF-28.