FBG Sensor

Bare FBG
Weldable FBG
Embedded FBG
Temperature FBG
FRP-FBG
Pressure FBG
Displacement FBG
Acceleration FBG
Earth Pressure FBG
Rebar FBG
Load FBG
Tilt FBG
BARE FBG (BARE Fiber Bragg Grating Sensor)
Application: Structural Health Monitoring, Strain Monitoring, Composite Strain Monitoring

We manufacturer bare FBG and supply to world wide, our FBG is specially designed for civil engineering, bridge monitoring, structural health monitoring.

To measure microstrain, 1.2pm(0.0012nm)=1µε.

Bare FBG Strain Sensor
- Center Wavelength: any wavelength between 1510 to 1590nm
- Grating Length: 10 mm (standard), 1mm, 2mm, 3mm, 5mm, 15mm
- Stripping Area: 30mm
- FBG Type: Apodized
- Strain Range: +/-3000µε (+/-5000µε as option)
- Tolerance: +/-0.5nm

<table>
<thead>
<tr>
<th>Grating Length:</th>
<th>1mm</th>
<th>2mm</th>
<th>3mm</th>
<th>5mm</th>
<th>10mm</th>
<th>15mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflectivity:</td>
<td>&gt;70%</td>
<td>&gt;70%</td>
<td>&gt;70%</td>
<td>&gt;75%</td>
<td>&gt;90%</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>Bandwidth at -3dB nm:</td>
<td>&lt;0.7</td>
<td>&lt;0.7</td>
<td>&lt;0.7</td>
<td>&lt;0.6</td>
<td>&lt;0.3</td>
<td>&lt;0.25</td>
</tr>
</tbody>
</table>

- SLSR: >15dB
- Proof Test: >100kpsi
- Coating: none, acrylate or polyimide
- Fiber Type: Acrylate SMF-28e or Polyimide SMF28e (OFS BF04446)
- Pigtail Length: 1m
- Operating Temperature: Acrylate SMF-28 fiber (5-120degC), Polyimide SMF28e (-40 to 300degC)

Bare FBG
Noted: Suitable for strain or temperature measurement

We can write the multi FBG on one fiber, distance between the fbg can be followed by customer's requirement.

FBG Array

Grating Reoating Thickness:
1. No coating 2. Acrylate 3. Polyimide

Acrylate SMF28c fiber 250um

125um (without coating)

Acrylate SMF28e fiber 250um

255um (with acrylate coating)

Acrylate SMF28e fiber 250um

165um (with polyimide coating)

Polyimide SMF28e fiber 155um

125um (without coating)

Polyimide SMF28e fiber 155um

135um (with polyimide coating)
Pigtails (cable)

Cable: 0.9mm loosen tube
Cable: Polyimide Fiber
Cable: SMF28-e Fiber
Cable: 3mm jumper cable

Ordering Code

- **FBG**-Bare
- Fiber length (m)
- Cable type: B=bare, T=0.9mm loosen tube, J=3mm jumper cable
- Connection: N=no connector, A=FC/APC, B=FC/PC

- Wavelength
- Left pigtails
- Right pigtails
- Connection: N=no connector, A=FC/APC, B=FC/PC
- Fiber length (m)
**WELDABLE FBG**

**Weldable FBG (Weldable Fiber Bragg Grating Sensor)**

Application: Structural Health Monitoring, Strain Monitoring, Composite Strain Monitoring

The weldable FBG is specially designed for outdoor applications for strain monitoring, particularly on structure with weldable surface. The obvious feature of this product make it can be either fixed with the bolt for temporarily monitoring or fixed by welding for long term monitoring. It has advantages of easy implementation, rugged and high reliability.

**Weldable FBG Strain Sensor**

- Center Wavelength: any wavelength between 1510 to 1590nm
- Strain Range: +/-3000µε (+/-5000µε as option)
- Resolution: 1µε
- Installation: Arc Weldable
- Dimension: 65x35mm
- Operating Temperature Range: -30 to 80 degC
- Option: with temperature compensation design (i.e. built-in 2 fbg inside, one for strain measurement, another for temperature compensation)
- Dimension: 130x35mm

**Typical Calibration Curve**

![Typical Calibration Curve](image)

**Ordering Code**

- **Model:** FBG-Weldable-1540.5-L4AA-R10AA
- **Left pigtail:** Armor cable with FC/APC connector, 4m long
- **Right pigtail:** Armor cable with FC/APC connector, 10m long

**Example:**

- Model: FBG-Weldable-1540.5-L4AA-R10AA
- Left pigtail: Armor cable with FC/APC connector, 4m long
- Weldable FBG with wavelength 1540.5nm
- Right pigtail: Armor cable with FC/APC connector, 10m long

**Spectrogram**

![Spectrogram](image)
EMBEDDED FBG

Embedded FBG (Embedded Fiber Bragg Grating Sensor)
The embedded FBG is designed for embedded into the interior of the concrete, reinforced concrete or composite materials. Its rugged design ensure long term monitoring.

Embedded FBG Strain Sensor
• Center Wavelength: any wavelength between 1510 to 1590nm
• Strain Range: +/-3000µε (+/-5000µε as option)
• Resolution: 1µε
• Installation: Embedded
• Dimension: 35x60mm (or 35x100mm)
• Operating Temperature Range: -30 to 80 degC
• Option: with temperature compensation
  (i.e. built-in 2 fbg inside, one for strain measurement, another for temperature compensation)
• Dimension: 35x130mm

Typical Calibration Curve

Ordering Code

FBG-Embedded

- wavelength
- left pigtail
- right pigtail
- fiber length (m)
- cable type:
  A=armor cable
  J=3mm jumper cable
- connection:
  N=no connector
  A=FC/APC
  B=FC/PC
- connector: N=no connector
  A=FC/APC
  B=FC/PC
- fiber length (m)
Temperature FBG (Temperature Fiber Bragg Grating Sensor)

Application: Temperature measurement

The temperature FBG is designed to measure the exterior and interior temperatures of various structures, which can be embedded into the interior or stick on the surface of the measured object. We can follow customer requirement to make any shape of temperature FBG.

Temperature FBG (Standard)
- Wavelength: any wavelength between 1510 to 1590nm
- Temperature Range: -20 to 85 degC
  (Option1: -20 to 150degC)
  (Option2: -50 to 85degC)
- Resolution: 0.1degC
- Accuracy: 1degC
- Fiber: SMF-28 or compatible
- Dimension: Φ8x100mm

Temperature FBG (Ceramic Type)
- Temperature Range: -20 to 85degC (-20 to 150degC as option)
- Resolution: 0.1degC
- Accuracy: 1degC
- Fiber: SMF-28 or compatible
- Dimension: 40x10x5mm

Temperature FBG (Bare Type)
- Temperature Range: -20 to 250degC
- Resolution: 0.1degC
- Accuracy: 1degC
- Fiber: SMF-28 or compatible

Ordering Code

- FBG-Temperature
- Wavelength
- Fiber length (m)
- Cable type: A=armor cable J=3mm jumper cable
- Connection: N=no connector A=FC/APC B=FC/PC
- Connector: N=no connector A=FC/APC B=FC/PC
- Cable type: A=armor cable J=3mm jumper cable
- Fiber length (m)
Fiber Reinforced Polymer FBG (FRP FBG)
The FRP FBG is designed for displacement measurement

- Glass FRP
- Carbon FRP

FRP-FBG Strain Sensor
- Wavelength: any wavelength between 1525 to 1565nm
- Sensing Length: 12mm
- Strain Range: > 5000µε
- Accuracy: <0.1% (about 2-3µε)
- Resolution: 1µε
- Repeatability: <0.5%
- Linearity: <0.5%
- Reflectivity: > 90%
- Side Lobe Isolation: >15dB
- Length: 50mm to 2m (or >2m), please specify when ordering
- Material: Glass or Carbon Fiber Reinforced Polymer
- Type: Embedded Type or Weldable Type

Typical Calibration Curve

Ordering Code

- g: glass
- c: carbon
- wavelength
- fiber length (m)
- cable type: A=armor cable, J=3mm jumper cable
- connection: N=no connector, A=FC/APC, B=FC/PC

connector: N=no connector
A=FC/APC
B=FC/PC

cable type: A=armor cable
J=3mm jumper cable
fiber length (m)
PRESSURE FBG (Pressure Fiber Bragg Grating Sensor)

Fiber Reinforced Polymer FBG (FRP FBG)
The Pressure FBG is designed for water level monitoring

Pressure FBG
- Pressure FBG Sensor
- Range: 0.35, 0.7, 1, 2, 3, 5, 7 or 10 Mpa
- Dimension: 26x164mm (option: 12mmx164mm)
- Accuracy: 0.3% F.S.
- Resolution: 0.05% F.S.
- Wavelength: 1510 to 1590nm
- Working Temperature: -30 to 70degC (option: up to 150C)
- Temperature Compensated pressure measurement. (i.e. one wavelength for pressure fbg)

Option:
- Dual wavelength output: one for temperature, one for pressure

Ordering Code

- FBG - Pressure
- Wavelength
- S = Standard
- H = High Temperature
- Fiber length (m)
- Cable type:
  - A = armor cable
- Connection:
  - N = no connector
  - A = FC/APC
  - B = FC/PC
Displacement FBG (Displacement Fiber Bragg Grating Sensor)
The displacement FBG is designed for displacement measurement.

**Displacement FBG**
- Wavelength: any wavelength between 1510 to 1590nm
- Standard Range: 100mm
- Accuracy: 1mm
- Reflectivity: >90%
- Working Temperature: -30 to 80degC

**Typical Calibration Curve**

![Typical Calibration Curve](image)

\[ x = -6.10998 + 0.08121(\Delta\lambda/\lambda_1 - \Delta\lambda/\lambda_2) \]
\[ \beta = 0.99969 \]

**Ordering Code**

- **FBG-Displacement**
- **wavelength**
- **fiber length (m)**
- **connection**: N=no connector, A=FC/APC, B=FC/PC
- **cable type**: A=armor cable
- **S=Standard**
- **H=High Temperature**
ACCELERATION FBG

Acceleration FBG (Acceleration Fiber Bragg Grating Sensor)

Suitable for vibration, security sensing
Application: bridge monitoring, pipeline security monitoring

Acceleration FBG Sensor

**Type 1:**
- Range: 5g
- Frequency Range: 0-40Hz
- Dimension: 72x54x37.5mm

**Type 2:**
- Range: 0.5g
- Frequency Range: > 100Hz
- Dimension: 54x48x24.5mm
  - Wavelength: 1525 to 1565nm
  - Working Temperature: -30 to 70degC

Ordering Code

**FBG-Acceleration**
- Wavelength
- Fiber length (m)
- Cable type:
  - A=armor cable
  - J=3mm jumper cable
- Connection:
  - N=no connector
    - A=FC/APC
    - B=FC/PC
- Range
  - A=0.5g, B=5g
- Connector:
  - N=no connector
    - A=FC/APC
    - B=FC/PC
- Left pigtail
- Right pigtail
- Cable type:
  - A=armor cable
  - J=3mm jumper cable
  - Fiber length (m)
Earth Pressure FBG (Earth Pressure Fiber Bragg Grating Sensor)
The Earth Pressure FBG is designed for earth pressure measurement.

Earth Pressure FBG Sensor
- Dimension: 160mm dia, 25mm thickness
- Wavelength Range: any wavelength between 1510 to 1590nm
- Measure range: 0.6MPa
- Accuracy: 3%
- Resolution: 0.66%
- Repeatability: <1.32%
- Linearity: <0.66%
- Reflectivity: >90%

Calibration Curve

![Calibration Curve](image)

\[ \Delta \lambda / \lambda = -3.35206E-8 + 1.64635E-4 \times P \]

R = 0.99986

Ordering Code

**FBG-Earth Pressure**
- Wavelength
- Fiber length (m)
- Cable type: A=armor cable
- Connection: N=no connector, A=FC/APC, B=FC/PC
Rebar FBG (Rebar Fiber Bragg Grating Sensor)
The Rebar FBG is designed for measuring strains in foundations, slurry walls, precast piles, caissons, bridge abutments, tunnel liners, etc.

Rebar FBG Sensor
- Range: 200 MPa
- Accuracy: <=1%
- Resolution: <=0.1%FS.
- Wavelength: 1525 to 1565nm
- Working Temperature: -30 to 70degC
- Rebar Diameter: 12mm or 25mm

Wavelength VS Temperature Curve

\[ y = 0.021075 x + 1549.231700 \]
\[ R^2 = 0.999628 \]

Ordering Code
- Wavelength
- Left pigtail
- Right pigtail
- Connector: N=no connector
  - A=FC/APC
  - B=FC/PC
- Cable type:
  - A=armor cable
  - J=3mm jumper cable
- Connection: N=no connector
  - A=FC/APC
  - B=FC/PC
- Fiber length (m)
Load FBG (Load Fiber Bragg Grating Sensor)
The Load FBG is designed for measuring load, maximum up to 1000ton is available

Load FBG Sensor
- Range: 100, 300, 500, 700, 1000, 2000, 3000ton
- Wavelength: 1525 to 1565nm
- Accuracy: 0.3%FS.
- Sensitivity: 0.05-0.1%FS.
- Reflectivity: > 85%
- Working Temperature: -30 to 70degC

Ordering Code

fiber length (m)  cable type:
A=armor cable
J=3mm jumper cable

connection: N=no connector
A=FC/APC
B=FC/PC

Range
A=100ton  B=200ton  C=500ton
D=700ton  E=1000ton  F=2000ton
The tilt FBG is designed for tilt measurement.

**Tilt FBG Sensor**
- Range: +/-5deg
- Dimension: 90x70x27cm
- With temperature compensation
- Wavelength: 1525 to 1565nm
- Resolution: 0.01%FS.
- Accuracy: 1%FS.
- Working Temperature: -25 to 80degC

**Ordering Code**
- Wavelength (nm)
- Fiber length (m)
- Cable type: A=armor cable
- Connector: N=no connector, A=FC/APC, B=FC/PC

**A Wavelength**
- Linear equation: \( y = -0.06522x + 1561.80310 \)
- \( R^2 = 0.99997 \)

**B Wavelength**
- Linear equation: \( y = -0.06564x + 1563.66910 \)
- \( R^2 = 0.99997 \)