

D1 DISPLACEMENT SENSOR

Keynotes and Installation Guide



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FBG Technology



Fiber Bragg grating (FBG) sensors are often used as sensing elements for displacement measurements, because they are resistant to electromagnetic interference, corrosion, on top of that, they are compact and they have high sensitivity.

FBG displacement sensors, unlike strain and temperature, can't measure quantity using only fiber optic sensors; it utilizes FBG response to its equivalent Bragg wavelength. Displacement sensor measures structural deformation estimation using the strain data.

D1 Sensor can be installed on the structure surface and measures the distance between two anchor points. It can be used in a combination with additional components to determine soil displacement. It can be used to monitor extension and compression displacement. Fiber optic displacement sensors are widely used to measure the gaps in bridges, buildings, roads, dams and other constructions. Fiber Bragg displacement sensors are more durable and provide long-term safety compared to any traditional sensors.

D1 Technical Parameters

This sensor is designed to measure displacements, cracks, and expansion joints over a 12 mm range. The sensor has a protective aluminum case. It can be mounted directly on concrete or metal surfaces.



Main technical parameters:

Measurement Range	0 – 12 mm
Resolution	< 0.02% FS
Linearity	0.026 mm (.22% F.S.) steady-state
Total accuracy	< 0.8% FS
Operating Temperature Range	From -40 to +80°C
Environmental Ingress	Suitable for wet, high humidity environments (IP67)
Dimensions	189 * 132 * 43 mm
Weight	954 g
Construction	Anodized Aluminum
Lead Cable Type	3 mm Tactical Buffered Cable
FBG Properties	
Reflective index	> 70%
FWHM (at the level of -3dB)	0.25 nm (\pm 0.05 nm)
Apodization	> 15 dB

D1 Key Features



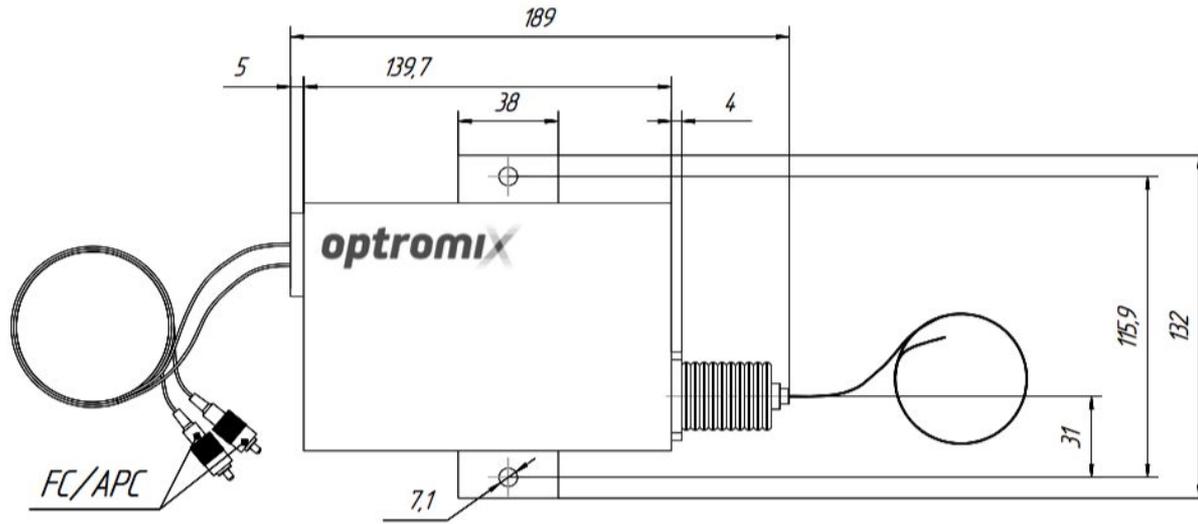
D1 displacement sensor is specifically designed to measure displacement between two gage points on a monitoring surface. The gage design is flexible enough to allow for easy attachment to various substrates, making measurements on metal, concrete and other surfaces straightforward. D1 gage is located within the rugged hard-coat anodized aluminum enclosure which shields them from the elements and allows for installations in harsh environments.

D1 sensor provides you with the following features:

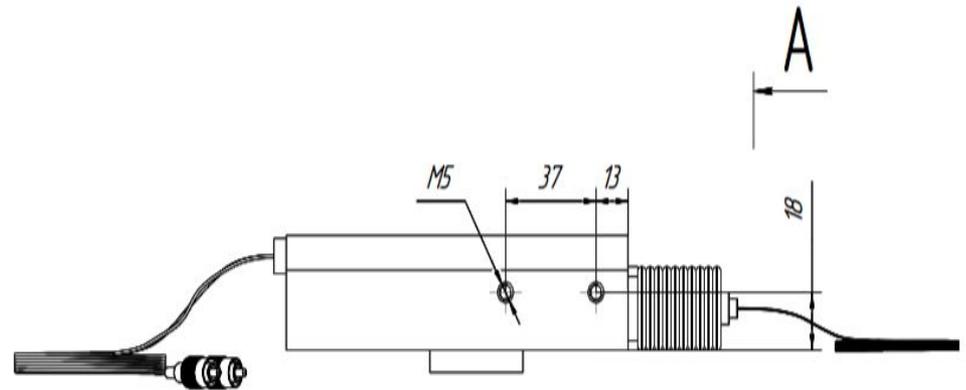
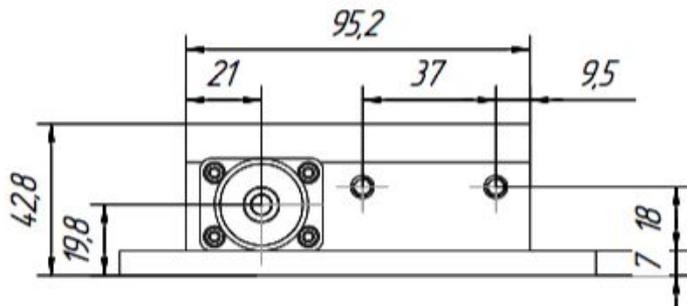
- Up to 12 mm measurement range using 1 mm stainless steel cable
- Rugged aluminum enclosure suitable for outdoor installations, IP67 rating
- Qualified to same rigorous standards used for comparable electronic gages
- Internal protection of connectors/splices
- Supports multiplexing of multiple gages on one fiber
- Fully temperature compensated over entire operating range
- Fast response time, stable measurements, high resolution
- Designed for simple installation in a variety of applications

D1 Drawing

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A-A



Installation Guide



Surface Preparation

The surface must be properly prepared prior to mounting the gage. The surface should be clean and flat where the gage is to be attached. The moving section that is to be monitored should move in a direction near perpendicular to the face of the gage where the wire rope exits through bellows.

Installation Guide



D1 comes standard with a mounting strap attached to the bottom of the gage. This allows the gage to be easily mounted on a surface with two 1/4 inch or 7mm screws. The gage can also be mounted by removing this strap and utilizing any of the 1/4-20 UNC mounting holes provided on the gage. Typical strap mounting is described below:

- a. Position the gage on the stationary surface to monitor such that the wire rope exit is aligned with the direction of movement;
- b. Mark the hole locations for the gage then remove the gage and drill two holes. The gage mount will accept 1/4 inch or M6 screws;
- c. Secure the gage in place. Tighten to substrate securely to prevent any movement;
- d. Determine the range of displacement to be measured and the current relative position of the two parts. The midpoint of the measurement range should coincide with the midpoint of the travel of the moving part as much as possible. The D1 has limited range of 12mm.
- e. Attach the wire rope to the moving substrate. It is recommended to clamp it to the substrate. If a loop is placed on the end of the wire rope, it should be a tight fit over the post (hook) since the loop will have flex in it and cause error in the measurements. To maximize accuracy, strip the FEP jacket off of the wire rope and clamp directly on the stainless steel wire.

Installation Guide. Calibration



For many installations mechanical protection will be needed to protect the gage from the environment. The gage is rated for IP67 protection. Protection for the wire rope may be needed in harsh environments to protect from ice, snow and animals to insure the best measurement accuracy possible. Suggestions include feeding a portion of the wire rope through a pipe or protect it with a shroud appropriate for the installation conditions.

D1 sensor is a pass through design that allows multiple gages to be installed in series. The gage is available either unterminated (UT) or with FC/APC connectors.

D1 displacement sensor has been calibrated over the entire range at room temperature. The nominal wavelengths indicated in calibration sheet are with the gage fully retracted.

The spectrum width required for each gage can be determined by subtracting 3nm from the wavelength of FBG1 and adding 3nm to FBG2.

If operating over a limited temperature range or displacement range, one can reduce the spectrum width required.

Equation and coefficients



Calculation formulas:

The D1 sensor is calibrated on full operation range and supplied with calculation formula and individual calibration coefficients.

To measure displacement value check two wavelengths with interrogation devices and put them to the following equation of real displacement in millimeters:

$$D = c_3 * \Delta\lambda^3 + c_2 * \Delta\lambda^2 + c_1 * \Delta\lambda + c_0$$

where

$$\Delta\lambda = (\lambda_2 - \lambda_1)$$

λ_1 and λ_2 - wavelengths of 1st and 2nd FBGs (should be interrogated);

c_0, c_1, c_2, c_3 - calibration coefficients (provided with a calibration sheet).

To provide maximum performance operate D1 sensor together with a high-accuracy interrogating device. It is recommended to use Interrogators with wavelength' measurement accuracy of +/- 2 pm or better.

The accuracy of the Interrogators directly affects the total accuracy of the entire system.



Thank You!

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