

Fiber optic sensing technology for distance measurement



Overview

The fiber-optic sensor measures distance, position and changes of position with an accuracy of just a few nanometers.

Key Takeaways

Fiber optic sensors measure distance by detecting changes in light intensity, phase, or interference patterns caused by the position of a target relative to the sensor probe. Principles of Distance Measurement

Fiber optic distance sensors operate by transmitting light through an optical fiber to a target and analyzing the light that is reflected or modulated by the target. The amount of reflected light, its phase, or interference pattern changes depending on the distance between the sensor probe and the target surface, allowing precise measurement of displacement or position .

Intensity-Based Measurement

In extrinsic fiber optic sensors, a light beam is sent through the fiber to a target. The reflected light is collected by receiving fibers, and the intensity of the received light varies with distance. When the target is close, less light reaches the receiving fibers; as the target moves away, more light is captured until saturation occurs. The sensor converts this intensity change into an electrical signal proportional to distance .

Interferometric Measurement

High-precision fiber optic sensors, such as those in the FDM series, use white light interferometry. Light from the fiber is split into reference and measurement paths. When the light reflects from the target and recombines with the reference beam, it creates an interference pattern. The pattern shifts as the distance changes, allowing nanometer-level resolution and absolute distance measurement. This method is particularly useful in precision manufacturing and environments requiring extreme accuracy .

Fiber Optic Lever Principle

Some sensors, like the Fotonic Sensor, use the fiber optics lever principle, where the reflected light distribution across multiple receiving fibers changes with target displacement. The sensor detects these changes and converts them into a voltage signal, which is then used to calculate distance, vibration, or surface condition .

Advantages of Fiber Optic Distance Sensors

- High sensitivity and resolution: Capable of detecting nanometer-scale changes .
- Non-contact measurement: Ideal for delicate or moving surfaces .
- Electromagnetic immunity: Light-based signals are unaffected by electrical noise .
- Remote sensing capability: Probes can be placed far from the evaluation unit via fiber-optic cables .
- Miniaturization: Probes can be as small as 50 μm in diameter, allowing measurements in tight spaces .

Applications

Fiber optic distance sensors are widely used in precision manufacturing, component alignment, vibration monitoring, and quality control. They are also suitable for harsh environments where traditional electrical sensors may fail due to electromagnetic interference or extreme temperatures . In summary, fiber optic sensors measure distance by analyzing how light is affected by the target's position, using intensity modulation, interferometry, or fiber lever principles, providing highly accurate, non-contact, and flexible measurement solutions.

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Distributed Optical Fiber Sensing (DFOS) transforms standard fiber optic cables into powerful sensors capable of detecting

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