Fiber optic sensor for distance measurement



Overview

A fiber optic displacement sensor uses reflected light to measure changes in distance or position without physical contact.

Key Takeaways

Fiber optic sensors measure distance with high precision using light transmitted through optical fibers, offering nanometer-level accuracy and flexibility in confined or harsh environments.

Working Principle

Fiber optic distance sensors operate by transmitting light through optical fibers and detecting changes in the reflected or interfered light to determine distance, position, or displacement. Advanced systems, such as those using white light interferometry, provide absolute distance measurements that are not lost if the measurement process is interrupted, unlike traditional laser interferometers. Detection methods include through-beam, reflective, retro-reflective, and definite-reflective configurations, each suited for different target types and distances.

Accuracy and Measurement RangeHigh-precision fiber optic sensors, like the FDM series, achieve nanometer-level resolution. For example, the FDM-1 and FDM-2 systems offer accuracies from 3 nm over ranges up to 1 mm, while the FDM-3 laser interferometer can measure up to 1 m with sub-nanometer resolution. These sensors can detect minute changes in position, expansion, drift, or vibrations, making them ideal for precision manufacturing and component alignment.

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Miniaturization and Integration

Fiber optic probes can be miniaturized to diameters as small as 50–80 µm, allowing measurements in tight or hard-to-reach spaces, such as microbores, narrow cavities, or microsystems where tactile sensors are impractical. The modular design allows the probe and evaluation unit to be positioned independently, facilitating integration into automated production lines and inline measurement systems.

Advantages

Electromagnetic immunity: Optical signals are unaffected by electromagnetic interference. Long-distance transmission: Minimal signal attenuation allows probes to be placed far from the evaluation unit. Chemical and environmental resistance: Suitable for harsh industrial or biomedical environments.

Non-contact measurement: Prevents damage to delicate components. High-speed and multipoint measurement: Enables real-time monitoring in production processes.

Applications

Fiber optic distance sensors are used in a wide range of fields: Industrial precision manufacturing: Component positioning, alignment, and vibration monitoring. Microsystems and microgear inspection: Measuring shapes and tolerances in confined spaces. Biomedical diagnostics: Endoscopic and minimally invasive measurements, including spectroscopy and tissue morphology.

Structural monitoring: Continuous measurement of highly stressed components. Fiber optic sensors combine high accuracy, miniaturization, and environmental robustness, making them a versatile solution for both industrial and biomedical distance measurement tasks.

Article Content

Development of fiber optic sensor technology

One approach to taking measurements in confined spaces is to use fiber optic distance sensors. The sensors offer great flexibility and are easy to integrate into

Optical distance sensors | Leuze

To meet these diverse needs, the operating principles of triangulation, propagation time measurement and phase measurement in different sensor sizes and

Fiber Optic Displacement Sensors | MTI

A fiber optic displacement sensor uses reflected light to measure changes in distance or position without physical contact. It is ideal for precision measurement in environments with vibration, high

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Fiber Optic Sensors | KEYENCE America

Learn all about various sensors—including fiber optic sensors, photoelectric sensors, laser sensors, and contact sensors—with detailed information on

An optical fiber high-precision absolute distance measurement ...

An optical fiber high-precision absolute distance measurement technology that incorporates white-light interferometry and single-wavelength interferometry is presented, which is

FIBER-OPTIC SENSORS

Sensor type Size Sensing distance (in mm)*1 *1Sensing distance measured in Standard Mode Order code Standard fiber High-flex fiber Standard fiber High-flex fiber E3X-HD E3NX-FA E3X-HD E3NX

fiber optic distance sensor

At their core, fiber optic distance sensors operate on a brilliantly simple principle: sending pulses or modulated beams of light down a hair-thin glass or plastic fiber and precisely measuring

High-Performance Optical Fiber Displacement Sensor with Extended

Optical Fiber Displacement Sensors (OFDSs) provide several advantages over conventional sensors, including their compact size, flexibility, and immunity to electromagnetic

Optical Fibre-Based Sensors—An Assessment of Current Innovations

Optical fibre sensors are an essential subset of optical fibre technology, designed specifically for sensing and measuring several physical parameters. These sensors offer unique advantages over traditional

4 Types of Distance Sensors and How to Choose the

Many different types of distance measurement sensors exist. Of course, not all sensors are the same; different sensor types have their own unique advantages

Optical Fiber Proximity Sensor for Micro Distance Measurement

This paper demonstrates an optical fiber proximity sensor for micro distance measurement. The optical fiber was used to detect a silver plate which acted as an obstacle. A flat

Fiber Optic Sensor Principles | How Fotonic Sensors Work | MTI

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The Fotonic Sensor™ is a non-contact instrument, which uses the fiber optics lever principle to perform displacement measurement, vibration analysis and surface-condition measurements. The Fotonic

Fiber Optic Sensors: Principles, Characteristics, and

Summary Fiber optic sensors have become an essential tool in modern sensing technology due to their high precision, anti-interference

Introduction to Fiber Optic Sensors and their Types

Article provides diffrent types of FIber optic sensors andvapplications is a sensor that uses optical fibers for sensing the elemnet (remote sensing).

Fiber Optic Sensor : Types, Working, Interfacing & Its Applications

Fiber optic sensor is a new branch in fiber optics in competition with the existing communication system. This is a very interesting and also well-known topic in the research field.

Optical methods for distance and displacement measurements

Illustration of a fiber optic intensity sensor for distance measurements. (a) Two-fiber sensor, showing the object and the operational principle (b) Various geometries for fiber bundle sensor heads, copied with

Fiber Optic Sensors: Fundamentals and Applications

While Brillouin scattering is an excellent strain sensor technology, the response time is about 1 second; and therefore, is not suitable for vibration measurements.

Optical Fiber Sensors and Sensing Networks: Overview of the Main ...

In oil wells, intrinsic optical fiber sensors are used for measuring temperature and pressure with precision.Simultaneous temperature and strain sensing over large distances is also possible

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