

Error of fiber optic sensor



Overview

Ma et al. have presented an error analysis of temperature-compensated white-light interferometric fiber-optic strain sensor.

Key Takeaways

Fiber optic sensors can experience errors due to installation issues, environmental factors, connector contamination, bending, and aging of optical components. Common Sources of Errors



1. **Installation and Connector Errors** Errors often arise from improper installation, such as poor connector cleaning, misalignment, or air gaps, which lead to high insertion loss and signal attenuation. Scratches, defects, or contamination on connector end faces—caused by dust, fingerprints, or oils—are among the leading causes of performance degradation and sometimes permanent damage to the fiber optic system . Poor field termination or faulty fusion splices can also introduce errors.

2. **Bending and Mechanical Stress** Microbends and macrobends in the fiber can cause light leakage, resulting in signal loss and measurement inaccuracies. Maintaining the minimum bending radius is critical; for example, DIN EN 50174-2 recommends a radius of at least 10 times the cable diameter without tensile load . Excessive strain or improper cable routing can exacerbate these errors.

3. **Environmental Influences** Fiber optic sensors are sensitive to temperature variations, humidity, and chemical exposure. Changes in temperature can alter the refractive index of the fiber or cause expansion/contraction, affecting sensor accuracy. Harsh environments may accelerate aging of optical components, leading to drift in sensor readings over time .

4. **Signal and Optical Losses** Insertion loss (IL) and optical return loss (ORL) are critical parameters. IL exceeding 1.5 dB or ORL below 30 dB can compromise sensor performance. Excessive connections, long multimode fiber runs, or violations of distance limitations can increase modal dispersion and reduce signal quality .

5. **Calibration and Aging Errors** Over time, fiber optic sensors may drift due to aging of the optical components or changes in the sensing medium. Regular calibration is necessary to maintain accuracy, especially in precision applications like structural health monitoring or medical diagnostics .

Mitigation Strategies

- **Proper Cleaning and Handling:** Use lint-free cloths, cleaning fluids, and specialized tools to prevent contamination.
- **Correct Installation:** Ensure proper alignment, avoid tight bends, and follow manufacturer guidelines for cable routing.
- **Environmental Protection:** Use protective housings and coatings for sensors deployed in extreme conditions.
- **Regular Calibration:** Schedule periodic calibration to correct for drift and maintain measurement accuracy.
- **Quality Components:** Use high-quality connectors, splices, and fiber to minimize intrinsic losses and defects. By addressing these factors, the reliability and accuracy of fiber optic sensors can be significantly improved, ensuring optimal performance in demanding applications .

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