Technology Offer

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Beam Angle Interferometer (BAI)

Ref.-No.: MI 0105-5623-FG

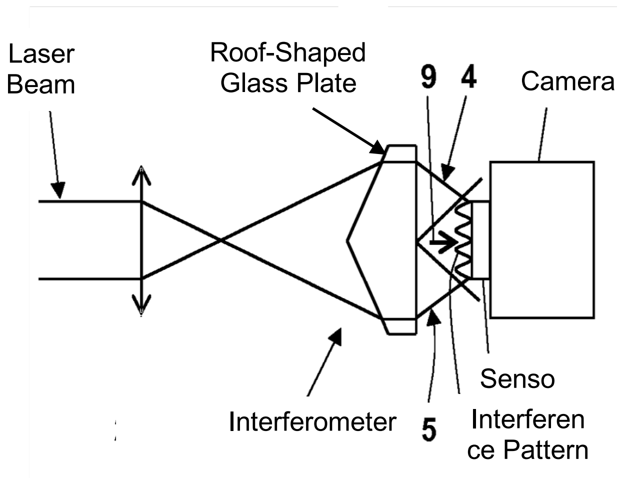
The patented highly sensitive interferometric method detects minute angular changes of a coherent laser beam. Unlike conventional beam position sensors, the beam direction is determined by tracking the collective displacement of an interference pattern generated by two or more coherent partial beams. By evaluating the average displacement of many interference fringes simultaneously, the method substantially improves angular measurement accuracy while remaining largely insensitive to beam position fluctuations. The technology is particularly suitable for laser beam stabilization, precision metrology, laser scanning microscopy, semiconductor manufacturing, and optical instrumentation.

Background

Many modern optical systems – including laser-scanning microscopes, semiconductor inspection systems, lithography equipment and precision metrology instruments – require extremely stable laser beam pointing. Angular beam drifts of only a few microradians or even nanoradians can significantly degrade positioning accuracy, imaging quality and measurement precision.

Existing beam angle sensors typically employ quadrant photodiodes or position-sensitive detectors. Their performance is often affected by laser intensity fluctuations, beam profile variations and detector calibration. Other interferometric methods generally monitor the motion of a single interference feature or require complex optical arrangements.

Technology



4, 5 - Partial Beams
9 - Mean Propagation

The patented technology introduces a fundamentally different approach for beam angle measurement. The incoming coherent laser beam is split into two or more coherent partial beams using an interferometer. After recombination, the beams generate a high-contrast interference pattern consisting of many intensity maxima and minima recorded by a camera.Instead of tracking a single interference fringe, the system determines the average displacement of a large number of interference maxima simultaneously. This statistical evaluation improves angular measurement sensitivity approximately with the square root of the number of detected fringes while maintaining excellent robustness against noise.

A focusing optic positioned before or within the interferometer makes the interference pattern sensitive primarily to angular changes of the incident beam while substantially suppressing sensitivity to lateral beam translations. As a result, the system directly measures beam pointing rather than beam position.

Advantages

- **Exceptional angular sensitivity** reaching nanoradian-level beam pointing detection
- **Higher accuracy** through evaluation of numerous interference periods
- **Robust operation** against intensity and beam profile variations
- **Simple optical implementation** using commercially available components
- **Flexible system design** with several interferometer configurations
- **High-speed real-time operation**
- **Easy integration** into existing laser systems
- **Scalable architecture** for laboratory and industrial environments.

Potential Applications

- Laser beam stabilization systems
- Laser-scanning microscopes
- Semiconductor lithography
- Wafer inspection
- Coordinate measuring systems
- Optical metrology
- Industrial laser processing
- Precision alignment systems
- Free-space optical communication
- Scientific laser instrumentation
- Aerospace optical systems
- Precision manufacturing

Patent Information

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