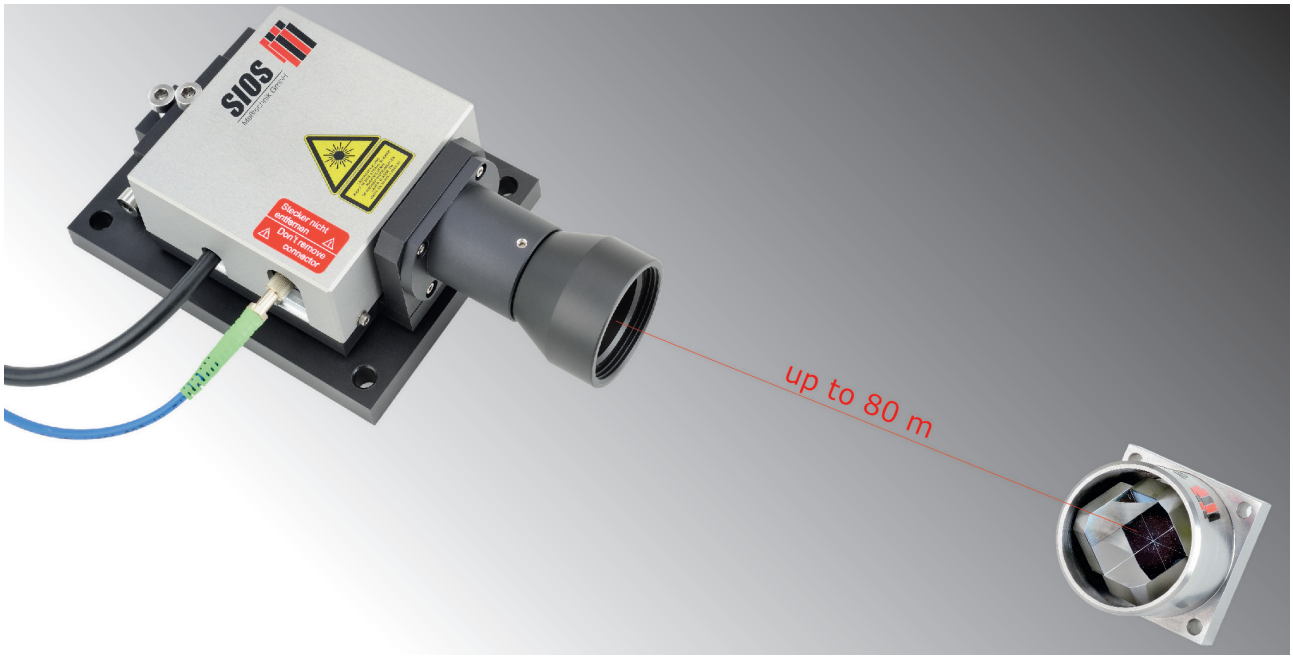

SIMULTANEOUS DISTANCE AND ANGLE MEASUREMENT UP TO 80 METERS

Precise and reliable

The increasing accuracies with which tool and coordinate measuring machines with ranges of motion exceeding several meters have to be calibrated place great demands on the measuring system. The SIOS Meßtechnik company, located in Ilmenau, provides a solution for combined distance and angle measurement based on the single-beam concept of the miniature interferometer. These systems can be traced back to national standards, and enable high-precision measurements to be made over long distances with simultaneous tilt angle measurement.

The series SP-LR long-range interferometer made by SIOS Meßtechnik, Ilmenau, is based on the design of the miniature interferometer with a plane mirror reflector. These interferometers are characterized by the use of only one beam for interferometric length measurement. The beam is reflected back into itself by the measuring reflector. This gives a defined scanning point on the object measured. This makes it possible to arrange the measuring set-up so that the laser beam is precisely aligned with the measuring axis, which enables the abbe error, a typical source of error in length measurements, to be minimized. With the environmentally corrected light wavelength of a stabilized He-Ne laser as a natural, highly stable, dimensional standard, according to the manufacturer these sensors have nanometer accuracy and outstanding linearity. The light is supplied via a fiber-optic cable. This means that the sensor head can be very compact, as its size is determined solely by the optical element.

The long-range interferometer can be used with various optical reflectors. A hollow reflector is used for standard measurements over longer lengths. This consists of the three mirrors aligned with one another at angles of precisely 90°. This means that there is no additional falsification of the measured values caused by the transition of the measuring beam between air and the reflector medium. According to company information, the maximum tilt of the reflector is ± 22.5° when the tilt point is in the center of the reflector.
Almost tilt invariant reflectors are used to simplify the adjustment and set up of the interferometer. According to the manufacturer, the permissible lateral offset of the hollow reflector is ± 1.5 mm. A higher tilt invariance can be achieved with a cat-eye reflector. In which case, it must be ensured that the measuring and guidance lines are precisely aligned, because lateral displacement of the reflector will cause variation of the length measurement.
The measurement and calibration procedure with a long-range interferometer can be synchronized with the position control of the system. The many possible ways of electrically isolating the triggering of the system, such as start/stop triggering, triggering of the individual measured values, and substitution of the scanning frequency, enable the measurement recording to be controlled. This means that measurements can be made „on-the-fly“ over longer distances and save time. The measured values are transferred to a laptop or computer via

Fig. 1. Long-range single-beam interferometer

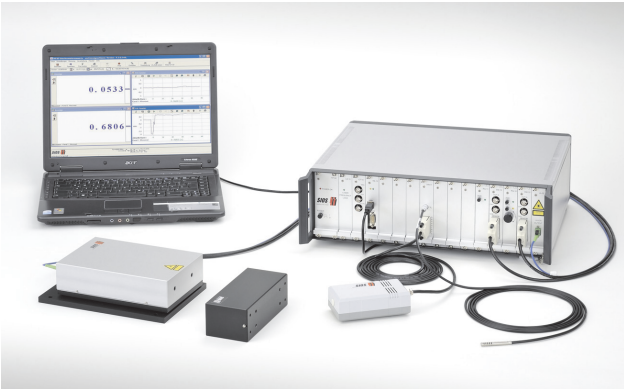

Fig. 2. Long-range two-beam interferometer

a USB interface.
Another important aspect of length measurement tasks in which the highest accuracy cannot be disregarded is the tilting of the measured object and/or the positioning unit. The measurements must be made so that the abbe error is minimized or can be corrected. The angle of tilt of the measured object and the scanning position of the measuring system play a crucial role here. Conventionally, the measuring tasks of position finding and angle measurement are dealt with separately. Simultaneous, multi-channel position and angle measurement is required in order to avoid measurement errors occurring.

Distance and angle can be precisely determined

Two-beam interferometers are measuring instruments supplied by a laser, and which evaluate two separate interferometer channels. Great importance is placed on a completely symmetrical optical set up. Two length values can be measured simultaneously with nanometer resolution. The relevant angle can be precisely determined from the difference between two length values Δs and the associated beam spacing. All systems transfer the data of all measuring channels synchronously.
Long-range, two-beam interferometers for the precise measurement of lengths and angles can be adapted to various measuring tasks on account of their compact construction. The beam spacing in the measuring system shown is 65 mm. According to the manufacturer‘s information, this gives a theoretical angular resolution of 0.03 arcsec at a distance resolution of 10 nm. The actual system resolution of the interferometer is < 0.1 nm. This distance resolution can only be achieved under stable ambient conditions. It is seldom achieved during practical use of the interferometer because of air movements.
The measuring reflector is based on a combination of hollow reflectors. In this case, the maximum angle of tilt of the reflectors is ± 15° if the center of rotation is in the center of the reflector.

Fields of application of the long-range two-beam interferometer are laserinterferometric measurements of guides, the calibration of high-precision axes on measuring and machine tools, and coordinate measuring instruments, and the high-precision measurement and correction of angles in the case of two or multicoordinate measurements.
When the interferometer electronics are connected to a positioning control system, the position and angle deviations can be determined in a single run by fast data recording.

For large measuring ranges

Laser interferometers with one and two measuring beams designed for measuring lengths of up to 80 meters are used for accurate, non-contact length and angle measurements. The systems are characterized by high precision and resolution as well as high immunity to interference.
The optical-fiber coupling for transmitting the laser light avoids heat sources in the sensor head, and enables it to be positioned freely in space, and quickly and easily adjusted. A high tilt invariance and low sensitivity to lateral offset of the measuring reflector make these interferometers a tool suitable for the commissioning, adjustment and calibration of precision guides, coordinate measuring instruments and machine tools. These laser interferometer systems have many possible applications and can be adapted to various measuring tasks.

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