QC-500 One-day Quick Check Laser Calibration System For CNC Machining Centers

I. What is the problem?

For quality assurance, higher productivity and performance, it is important to calibrate the machine performance **volumetrically** and **dynamically**. The ASME B5.54 standard recommended a sets of comprehensive measurements including linear displacement accuracy, bi-directional repeatability, volumetric performance and contouring performance.

II. What is QC-500?

The QC-500 Laser Calibration System is designed for a quick check of the machine's performance based on the ASME B5.54 standard's one-day test. It can perform a complete calibration on **volumetric** positioning accuracy and circular **contouring** performance in less than one day. Furthermore, the measured 3 displacement errors, 6 straightness errors and 3 squareness errors can be used to generate the volumetric compensation file to achieve higher volumetric positioning accuracy. The laser/ballbar can measure circular contours at any radii. The true **radius,** the **feed rate** and the **acceleration/deceleration** can all be measured.

III. Why QC-500 is different?

Conventional laser interferometers are based on the Michaelson interferometer. There are two laser beams, the output beam and the return beam, which are parallel but displaced about 1", as shown in the figure below. Hence, large optics are required. Also, the alignment is critical, 3 elements have to be aligned co-axially. The laser head is large and heavy, and a heavy tripod is needed to support the laser head.

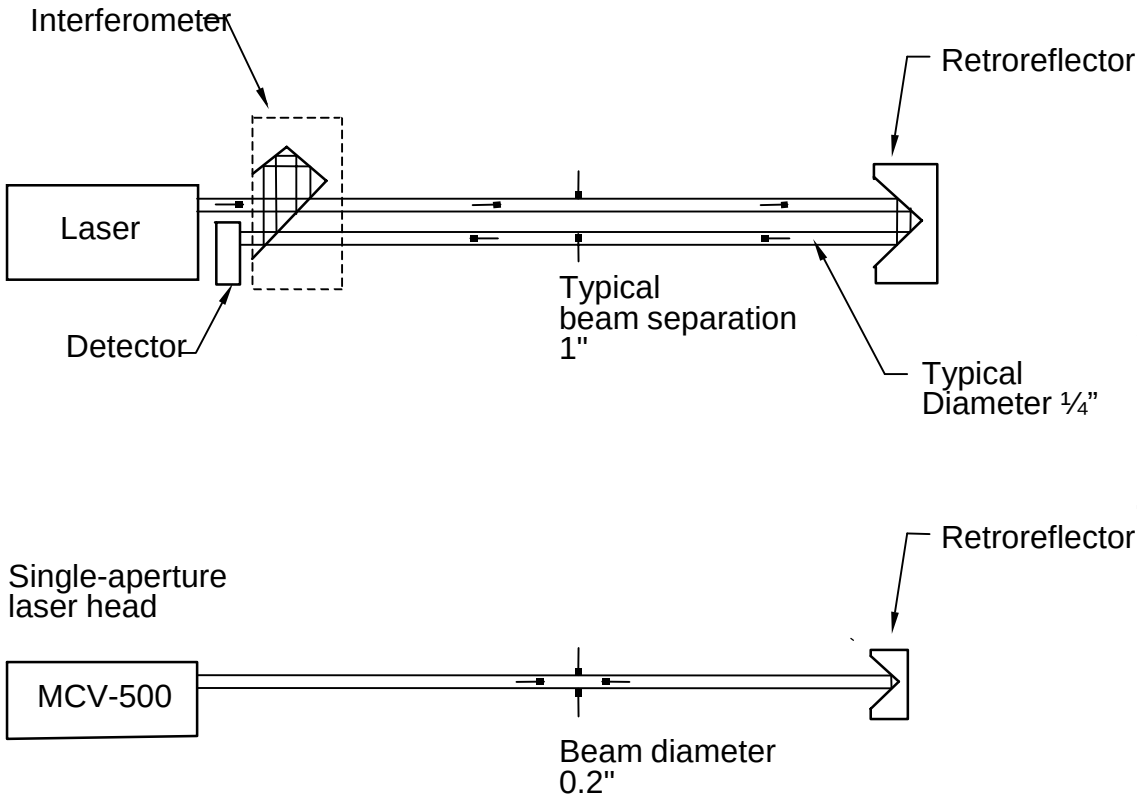

Fig1 A comparison of a laser interferometer and a single-aperture Laser Doppler system

The single-aperture QC-500 laser system is based on laser Dopplermetry. The laser head is very compact (2" x 2" x 8.5") and is completed with stabilization circuits, electro-optics, and photo-detectors. As shown in the figure, the output beam and the return beam share the same aperture. Hence large optics are not required. Since there are only two elements to be aligned, the alignment is not as difficult.

The compact size and lightweight of the laser head and optics allows the operator to mount the components to the machine directly with magnetic bases without the use of a tripod. Also, there is no need to dismantle the protective machine enclosure.

IV. System description

All the components of the QC-500 are compact and small; they can easily be mounted directly on the machine reducing overall setup and calibration time. The Windows™ based data collection and analysis software is simple to operate. Hence any machine tool operator can use the QC-500 to calibrate the machine with minimum training.

The QC-500 is a complete calibration system with air temperature, barometric pressure, and material temperature sensors to compensate any environmental and temperature changes. The laser stability is 0.1 PPM and the system accuracy is 1 PPM. It is calibrated and traceable to NIST. The range of the measurement is very large, up to 330 ft. (100m) and the maximum speed is up to 200 ips (300 m/minutes), for use with high-speed machines. For circular contouring measurement, the QC-500 laser calibration system is noncontact and the radius can be varied continuously down to less than a fraction of an inch. There is no limit on the feed rate and the true radius, feed rate, acceleration and deceleration can all be measured.

V. Major benefits

Using the QC-500 system will reduce expensive machine downtime and improve the machine performance. The same laser can be used for both the volumetric positioning and the dynamic circular contouring measurement. Hence, the system is more compact, less equipment is needed and offer savings on the capital and shipping cost.

The QC-500 is based on Optodyne's Laser Doppler Displacement Meter (LDDM) technology. Furthermore, both the vector measurement and laser/ballbar technique are invented by Optodyne and patent pending.

In summary, the QC-500 is **easy to setup** and **operate**, **compact** and **affordable**. It is also very **flexible** and **versatile**.

VI. Supporting material (Available in www.optodyne.com)

[1] C.Wang, "Laser Vector Measurement Technique for the Determination and Compensation of Volumetric Position Errors, Part I: Basic Theory," Rev. Sci. Instrum. Vol. 71, pp. 3933-3937 (October 2000).

[2] “Methods for Performance Evaluation of Computer Numerically Controlled Machining Centers”, An American National Standard, ASME B5.54-1992 by the American Society of Mechanical Engineers, P69, 1992.