Philtec Application Note

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Calibration of Fiber Optic Displacement Sensors

FORWARD

At the factory, Fiber Optic Displacement Sensors are calibrated using linear positioning stages. These can be ball bearing, crossed-roller bearing, or air bearing stages. The type of stage and maximum stage travel determines the overall size and cost. At Philtec, where there is the need to calibrate a very wide range of sensors and sensor targets, all three types are in use.

Air bearings provide the smoothest and best motion accuracy. Crossed-roller bearing stages have excellent motion specs for high resolution calibrations. The ball bearing stage is good for general purpose calibrations.

Philtec uses control programs to automate the stage motions and data collection process.

Customers may use single point-by-point steps for their calibrations. And customers may have to perform calibrations in situ using dial indicators, voltmeters, and/or other equipment.

Calibration Tips and Recommendations

A resolution of 10 microns can be easily achieved using a ball bearing staged equipped with a precision lead screw and a 0.1 micron encoder. Where applications require sensor accuracies of 1 micron or better, a crossed-roller bearing or air bearing stage used in a temperature controlled room should be provided.

Achieving sub-micron repeatability requires good temperature control, special handling of the parts and attention to details. It is more time consuming than calibrating to 10 micron accuracy.

General Guidelines for Conducting Good Calibrations

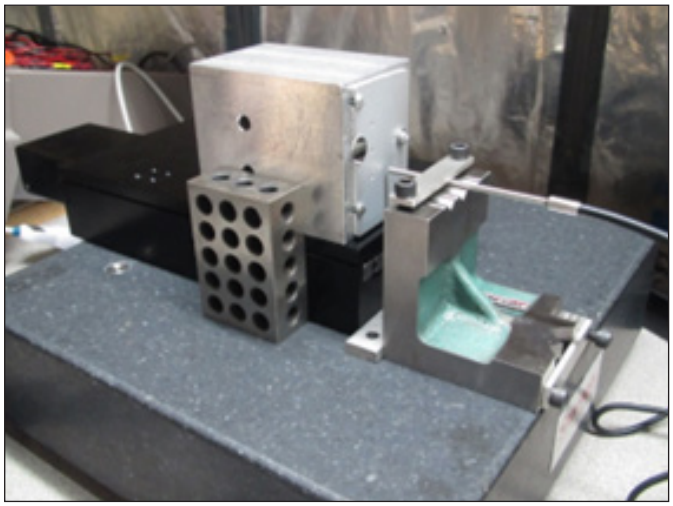
- Work in an air-conditioned constant temperature room.
- Clamp the probe in its holding fixture close to the sensing end of the probe.
- Support the weight of the fiberoptic cable so it does not put strain on the probe.
- Place the probe into light contact with the target at the start of calibration.
- Provide solid support for the calibration targets.
- The target must be clean: no fingerprints.
- The probe tips must be clean.
- Avoid prolonged contact with hands and the calibration hardware.
- Allow parts to stabilize to temperature in the calibration room prior to beginning the calibrations.

Calibration of Fiber Optic Displacement Sensors

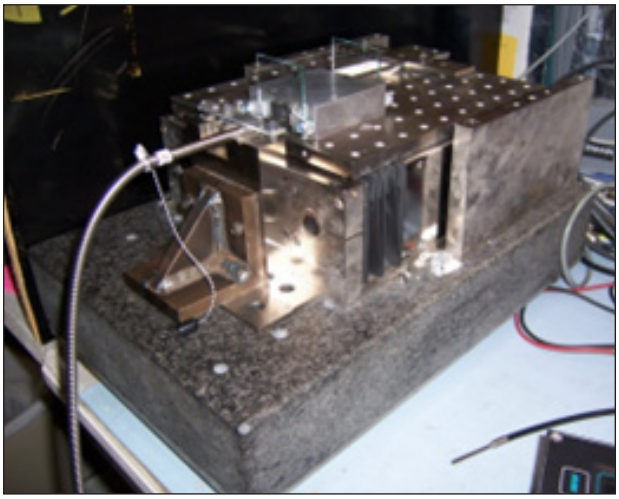
EQUIPMENT

Several elements are required to complete the calibration system:

- A granite surface plate
- A linear motion stage
- A programmable motion controller
- A motion interpolator (precision encoder)
- A data acquisition system (DAC)
- A sensor probe holding fixture
- Calibration Targets
- Assorted spacers and guides

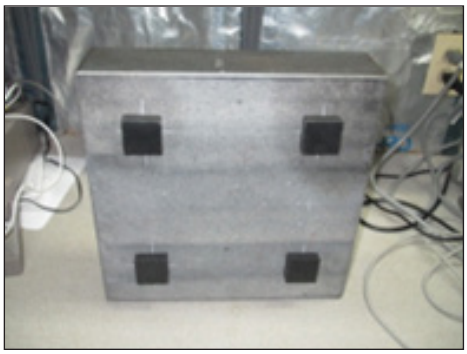


CROSSED-ROLLER BEARING STAGE



AIR BEARING STAGE

The linear stages are secured to a granite surface plate with rubber feet for vibration isolation.

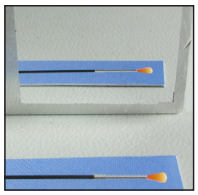
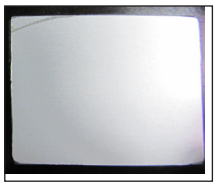
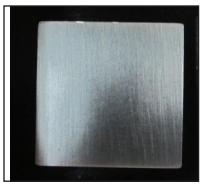
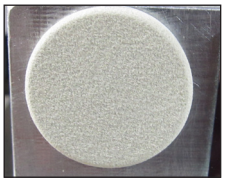


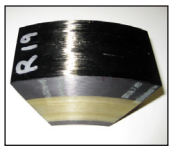
Calibration of Fiber Optic Displacement Sensors

CALIBRATION TARGETS

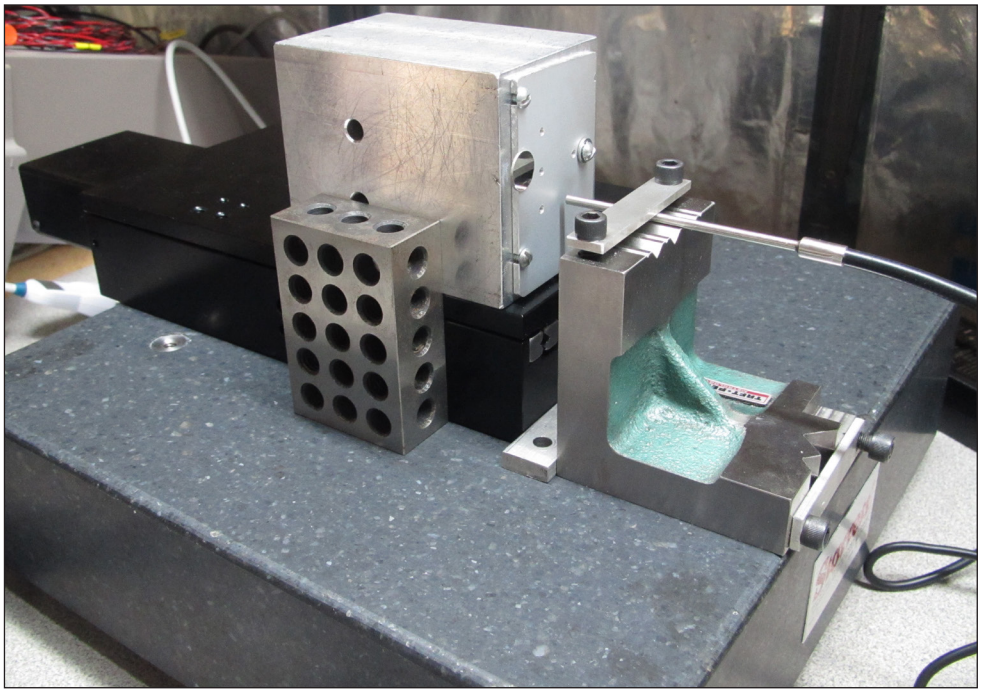
Standard targets include a specular mirror surface and a diffuse anodized surface. Custom targets may also be used when provided by customers.

SPECULAR | DIFFUSE | MACHINED METAL | TBC THERMAL BARRIER | CLEAR GLASS | TINTED GLASS | FIBERGLASS ROTOR

Sensor probes should be solidly mounted on the granite base and perpendicular to the target surface. Precision 90° blocks with V-grooves for various size probes are used for this purpose.



Calibration of Fiber Optic Displacement Sensors

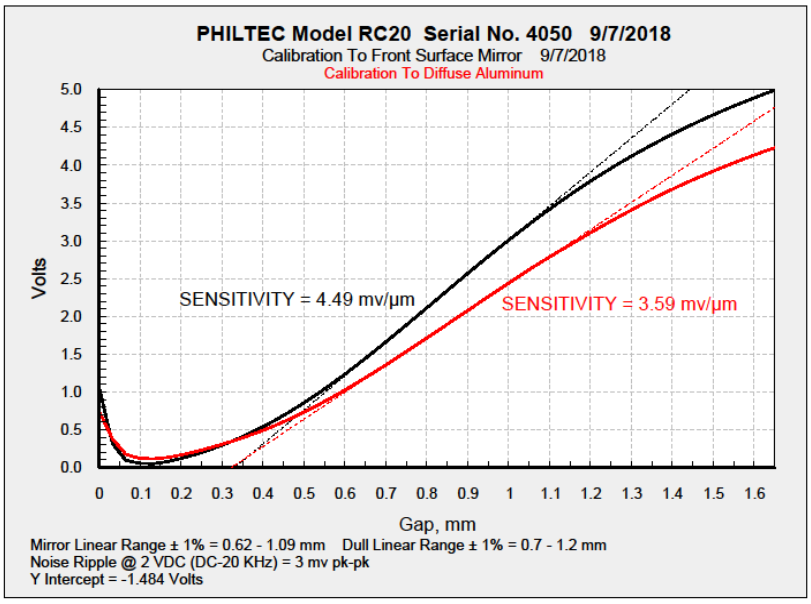
CALIBRATION PROCEDURE – SENSORS WITH ANALOG OUTPUT

1. Mount a target squarely on the stage table.
2. On the surface plate, mount the sensor in a separate holding fixture.
   This probe holder will securely clamp the sensor tip perpendicular to the target.
   - The stage table with target moves during calibration.
   - The sensor is stationary.
3. Begin with the sensor making light contact with the target.
4. Move the stage with target away from the sensor in discrete steps covering the total range of the sensor. 51 steps are normally used for RC type sensors; 91 steps for D Models (Near & Far Sides). *Customers may choose a much smaller point set for their calibrations.*
5. After each step:
   a) the stage position is read from the stage encoder and
   b) the sensor voltage output is read using a data acquisition system

6. The stored data is copied to a spreadsheet program where a linear regression analysis is made and a calibration chart prepared.

Factory Calibration Charts

The factory calibration chart includes a best fit regression line drawn through the data points. The bounds of a linear range are given on the calibration chart with a ±1% tolerance band.



A typical factory calibration chart provides:

- Sensor Model & Serial Number
- Date of Calibration
- The Linear Sensing Range
- The Max. Slope Sensitivity
- The Y Intercept of the Linear Range
- The AC Noise Ripple

The XY calibration data points are made available upon request

Calibration Procedure – Sensors with Digital Output

Fixture a target and probe in the same manner as for the analog output sensor.

Use Philtec's DMS Control Software at the 'New Calibrations' tab to conduct the calibration and store the data into the sensor memory.

Follow the 'Calibration Instructions' at that tab.