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OPERATING INSTRUCTIONS

FOR

FIBER OPTIC

DISPLACEMENT SENSORS

with Analog Output

TYPE D

REFLECTANCE DEPENDENT

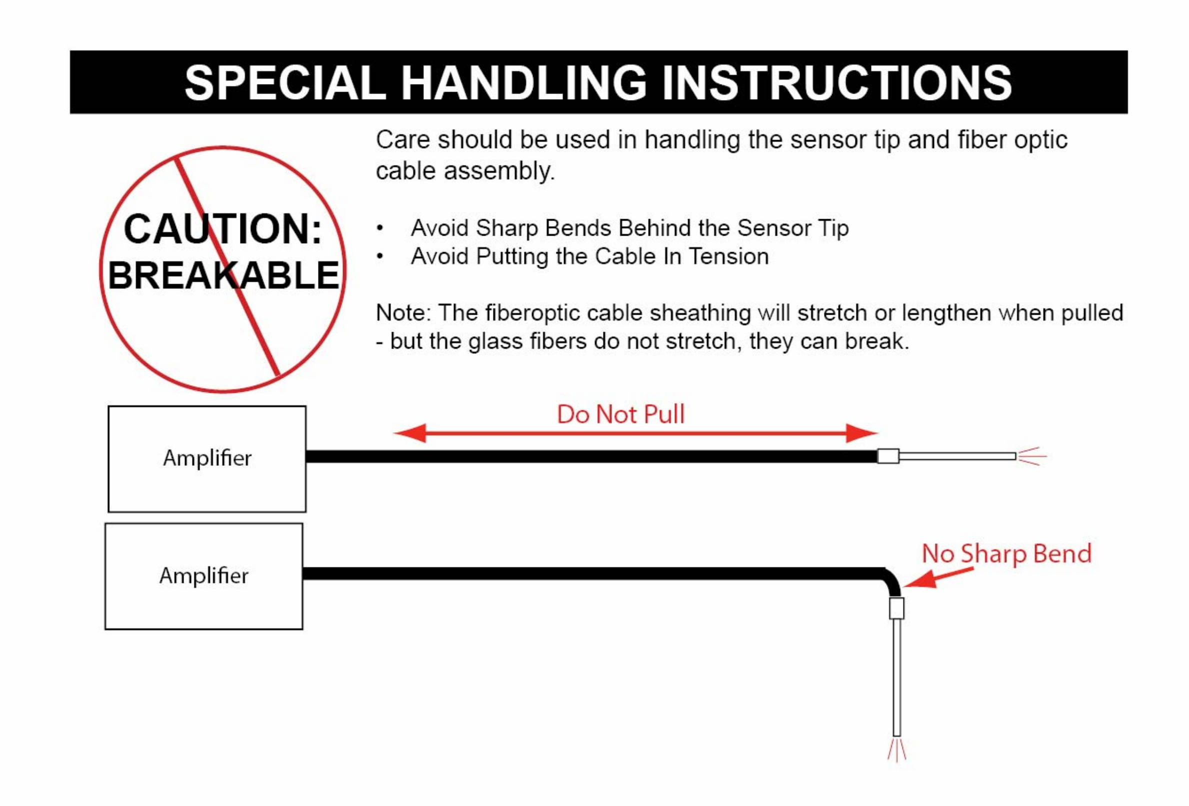
Model________________________________ Serial Nos.____________________________________

PHILTEC, INC. www.philtec.com
Precision Dynamic Measurements *410-757-4404*

CAUTIONS :

1. Sensor tips and fiber optic cables are provided in a variety of sizes and materials, some of which are extremely rugged and others which are very fragile. It is important to handle sensor tips and cables with care, as they are not subject to warranty replacement if broken.

2. Always ensure that the sensor tip, target area and optical path are clear and clean. Accurate motion amplitude measurements are dependent upon the precise reflection of rays of light from target surfaces. Dirt, debris and very rough surface textures can diffract and reflect light rays in unpredictable directions, thereby compromising the achievable accuracy of these devices. Sensor tips can be cleaned with alcohol and a soft cloth or tissue.



REFLECTANCE DEPENDANCE

With reflectance dependent sensors, the analog output voltage is proportional to the distance between the sensor tip and the target AS WELL AS the reflectivity of the target surface. The effect of changing target reflectance is to shift the output voltage higher or lower. The amplitude of the voltage shift is directly proportional to the change in target reflectance. The table here shows the relative reflectance of some common materials.

TARGET	% REFLECTANCE
Gold Mirror	100
Mirror Polished Aluminum	85 - 90
Mirror Polished Stls Steel	60 - 70
Brushed Aluminum	40 - 50
Copper Clad PC Board	45
Matte Finish Aluminum	30 - 35
Anodized Aluminum	20 - 25
Silver Paint, Glossy	15 - 20
Photo Paper, High Gloss	15
Photo Paper, Soft Gloss	12
Inkjet Paper, Bright White	8
Fiberglass, Glossy	7
Black Plastic, Glossy	6
Black Matte Finish	3
Flat Black Rubber	1

INPUT/OUTPUT CONNECTIONS

A. Connect a positive voltage DC power source (+12 to +24 Volts) with at least 150 ma capacity to the amplifier terminal strip contacts marked +DC and GND (Ground).

B. Connect any suitable voltage readout device to the terminal strip contacts marked OUT (Output) and GND.

Standard units provide 0 - 5 volt output with DC - 20 KHz bandwidth.

SET-UP AND OPERATION

1) Mount the sensor so that it is perpendicular to the target surface. Perpendicularity can be established by holding the sensor against the target surface while adjusting its contact angle until a minimum voltage reading is obtained. The output voltage should read close to zero. Generally, at best perpendicularity, the output should read less than 250 millivolts.

2) While maintaining perpendicularity, move the sensor away from the target until the maximum output level is attained. At that position, adjust the **GAIN** controls (coarse and fine) until the output voltage reads **5.000 Volts**.

3) Reposition the sensor gap to the desired operational set point on either the near side or on the far side (refer to the factory supplied calibration curves).

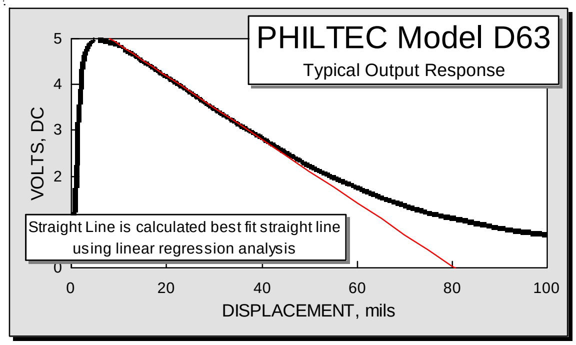
THE SENSOR IS NOW SET UP FOR OPERATION

NOTES

The above described procedure calibrates the sensor output for the spot on the target directly beneath the sensor tip. If either the sensor or the target moves such that a different area of the target falls under the sensor tip, or if the target surface reflectivity changes, step 2 should be repeated to recalibrate the sensor for the new reflectivity.

SENSITIVITY. Factory supplied calibration curves give sensitivity values (slopes) of the linear ranges of the near side and far sides. When sensor operation falls within the bounds of a near or far side linear range, the readings in millivolts peak-to-peak may be converted to microinches peak-to-peak by dividing measured change in voltage by the sensitivity millivolt/microinch given on the factory calibration chart:

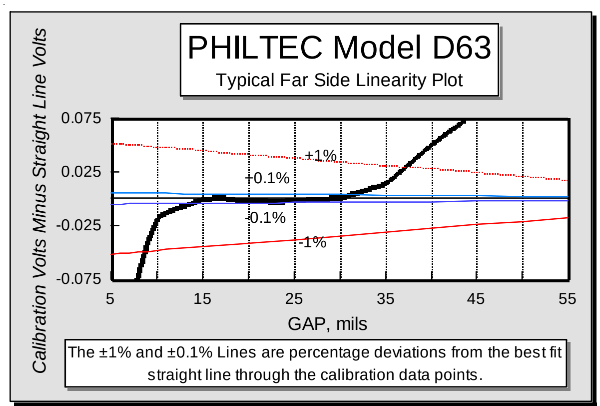
✓ microinch = voltage change / sensitivity



<u>This conversion only applies when the calibration procedure has been carefully followed and the optical peak has been set at precisely 5.000 volts.</u>

LINEARITY. 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 graph is included here which shows a typical far side linearity plot for a D type sensor. **It can be seen that there is a tighter tolerance band at ±0.1% that can be drawn about a linear range that is <u>at least one half as long as the ±1% tolerance band.</u>**



In the example shown here, the bounds of the linear range at ±1% extend from 8 to 37 mils, and at ±0.1% from 14 to 31 mils.

REFLECTIVITY MEASUREMENTS. The sensor is totally insensitive to target motions when it is set at the optical peak where the slope of the output function is horizontal. Measurements of relative surface conditions (changes in surface finish or reflectivity) with excellent signal-to-noise can be made when a target passes under the sensor while the target-to-sensor gap is maintained within the bounds of the optical peak.

Relative reflectivity measurements can also be made at the sensor's maximum gap capability, where the slope of the output function is approaching horizontal. In the maximum gap region of operation, the sensor output is highly sensitive to reflectance and only slightly sensitive to displacement. The sensor signal-to-noise is not exceptional at that location, but can be adequate for some reflectivity measurements.

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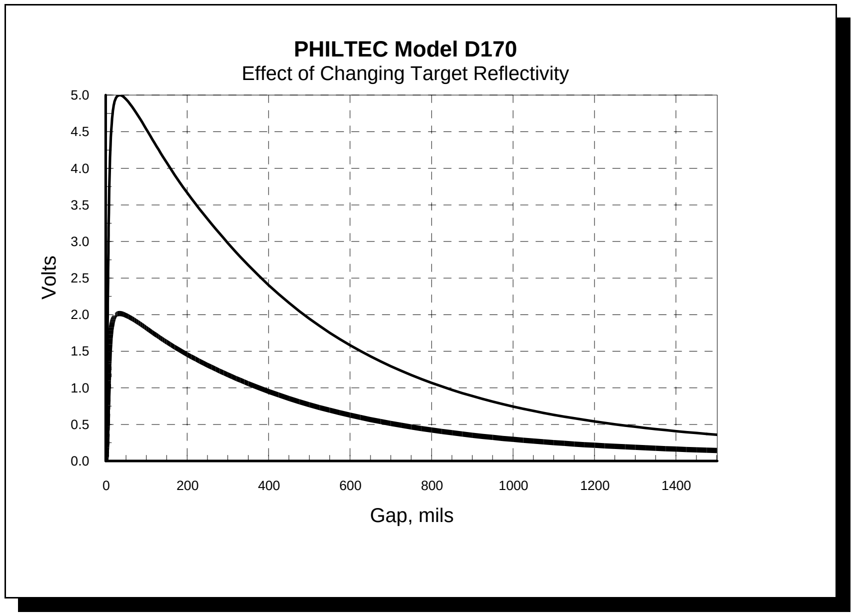
TARGET REFLECTIVITY CHANGES.
The voltage output from D model sensors is proportional to:
a) distance to a target surface, and b) reflectance of the target surface.

The chart shows two data series: one where the optical peak was set to 5 volts for a target (using the sensor gain controls); another to show the resulting output when the sensor is moved over a much less reflective target without resetting the gain control.



The change in target reflectivity rescales the Y-axis. Every data point is multiplied by the same scaling factor. It does <u>not provide</u> a parallel shift of the calibration which would be equivalent to a fixed amount of DC voltage offset.

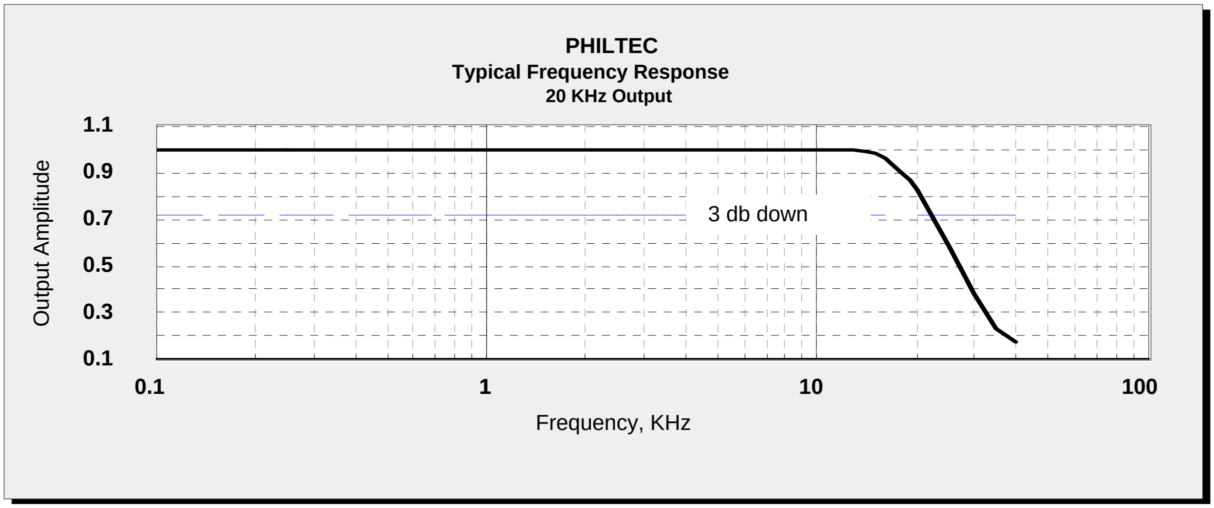
How can you account for changing target reflectivity without resorting to recalibration?

Philtec's reflectance compensated sensors were developed as the elegant solution to the problem of dynamically variable reflectance . However, using D model sensors, the problem can be solved this way. Start with test surface #1.

1. Calibrate the sensor to that surface by setting the optical peak to 5 volts.
2. Open the gap to any conveniently reproducible fixed reference position, for example, 1". Record the voltage output V1 at that location.
3. Install sensor over test surface #2.
4. Move to the 1" reference position and record the voltage output V2.
5. Calculate the ratio V1/V2.
6. Record test data for surface number two and multiply the data points by the ratio V1/V2.

This procedure will correct the readings for the change in target surface reflectance, and it will be accurate provided (a) you can accurately return to the reference location and (b) the target moves only parallel to the axis of the sensor tip with no lateral (sideways) motion.

There may be instances where it is inconvenient to adjust the optical peak to 5.000 volts and other instances with non-reflective targets where it is impossible to obtain 5 volts output, even with the gain full on. In those cases, precise amplitude measurements can still be made, provided the optical peak value is recorded and the correspondingly appropriate sensitivity conversion factors are applied. For example, if the optical peak reads 4 volts, then the near and far side slope sensitivities have been decreased to 80% (4/5) of their 5 volt values, and the conversion from millivolts to microinches should account for that change proportionately. Alternatively, it is possible to achieve 5 volts output by attaching a small reflective target such as aluminum foil, any polished metal, or applying a spot of glossy paint to the specimen being measured.

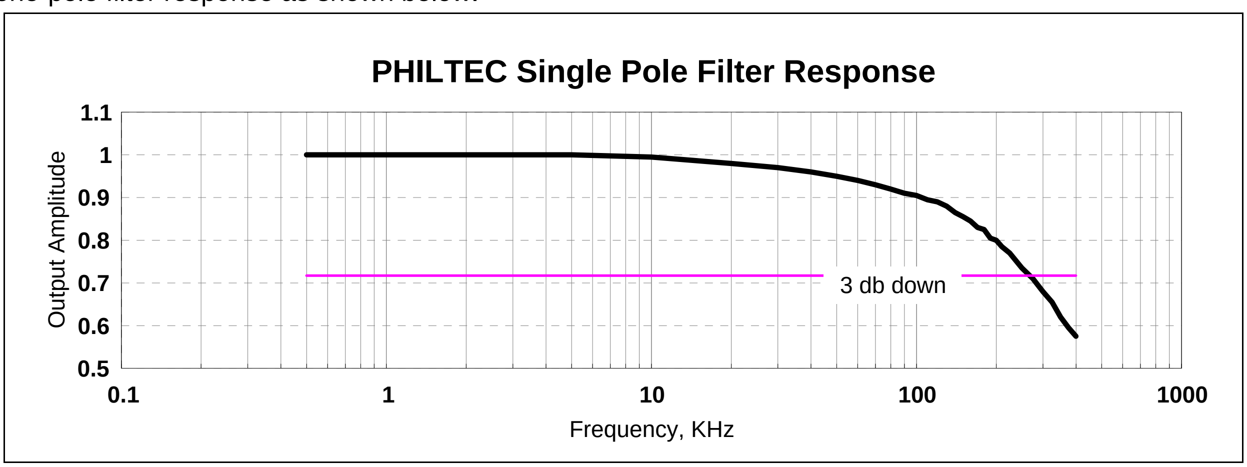


The amplitude response of a <u>standard</u> Type D sensor will have a frequency rolloff characteristic that approximates a 3 pole filter response. The chart above shows that typical response. With the 3 db down point set at 20 KHz, the output is flat out to approximately 15 KHz.

- With a low frequency amplifier, the 3 db down point is set at 100 Hz
- With a high frequency amplifier, the 3 db down point is set at 200 Khz (flat to 100 KHz)

The typical phase shift from input to output is 45 degrees at the 3db down frequency.

NOTE: Any high frequency amplifier exceeding 200 KHz as well as the Options +H and +L will have a one-pole filter response as shown below.



WARRANTY

Fiber Optic Displacement Sensors are warranted by Philtec, Inc. against defects in material and workmanship for 12 months from the date of shipment from the factory.
<u>NOTE</u>: Damage to the fiber bundle or sensor tip from rough handling is not covered under this warranty.

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