

OPERATING INSTRUCTIONS

FOR



FIBER OPTIC

DISPLACEMENT SENSORS

with Analog Output



TYPE D

REFLECTANCE DEPENDENT

Model No.

Serial No.



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 such as Philtec's Type D, 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 | % |
|----------------------------|---------|
| 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 |

CONTROLS

Gain controls are provided for adjusting the sensor output to various target surfaces. In-situ calibration is performed simply as follows:



- a) adjust the sensor-target gap to the peak output level
- b) Set the peak reading to full scale (5.000 volts)
- c) Reset the gap to a desired starting point on the Near Side or Far Side curve.

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 CALIBRATION

1) Mount the sensor so that it is perpendicular to the target surface, $\pm 0.5^\circ$ is best. 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 on specular targets.

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 until the output voltage reads **5.000 Volts**.



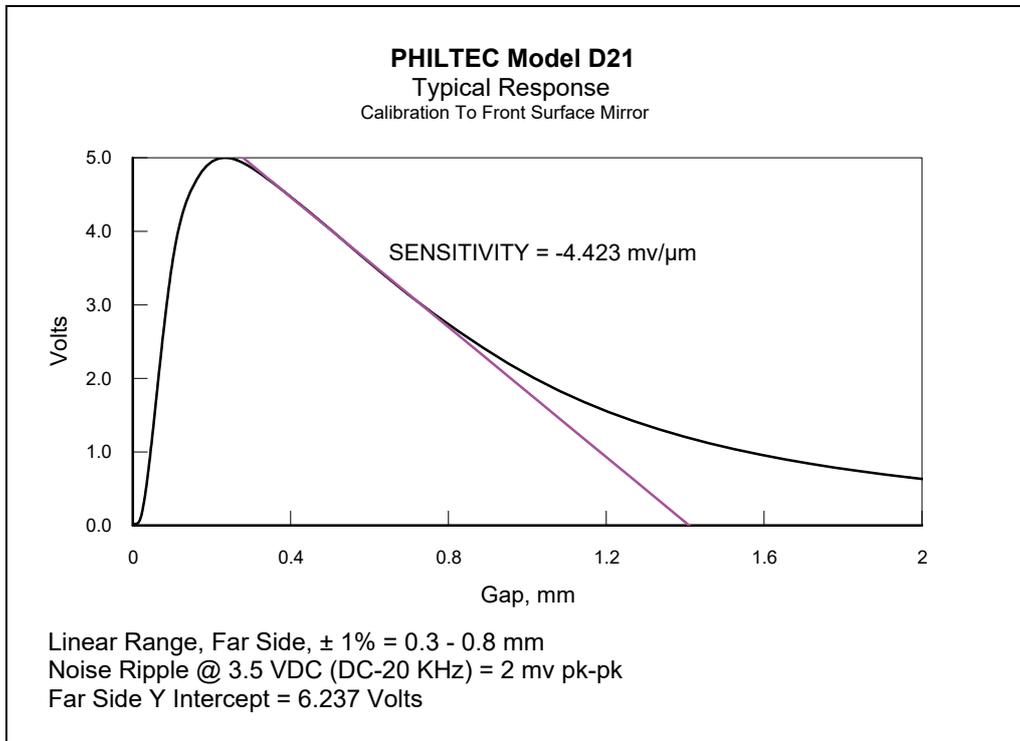
3) Reset the sensor gap to the desired starting point on either the NEAR SIDE or on the FAR SIDE (refer to the factory supplied calibration curves).

This calibration step scales the sensor's output to the reflectance of the target to be measured. With the sensor's peak output scaled to 5 volts, the factory supplied calibration can be applied to convert voltage to distance.

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 reflectance level.

RELATIVE DISTANCE. 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 pk-to-pk may be converted to microinches or microns pk-to-pk by dividing the measured change in voltage by the sensitivity given on the factory calibration chart::

$$\text{DISPLACEMENT (microinches or microns)} = \text{voltage change} \div \text{sensitivity}$$

NOTE: This conversion only applies when the optical peak has been set at precisely 5.000 volts.

ABSOLUTE DISTANCE. The factory calibration chart includes a best fit linear regression drawn through the data points. The bounds of a linear range are given on the calibration chart with a ±1% tolerance band. The Y-intercept of the regression line is included on the calibration chart. The equation of the regression line can be used to calculate absolute distance (within the linear range):

$$\text{DISTANCE} = (\text{VOLTS} - \text{Yintercept}) \div \text{SENSITIVITY}$$

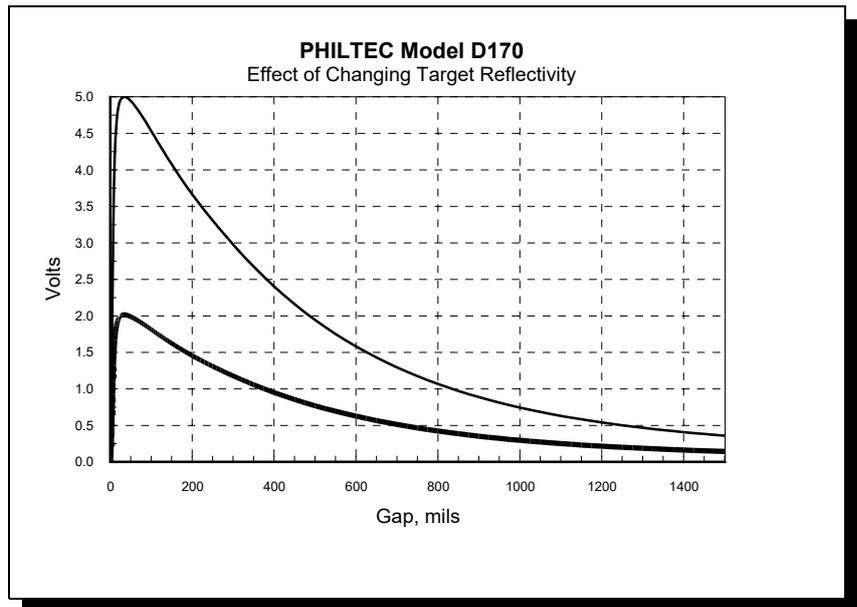
TARGET REFLECTANCE CHANGES.

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 sets: 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.



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

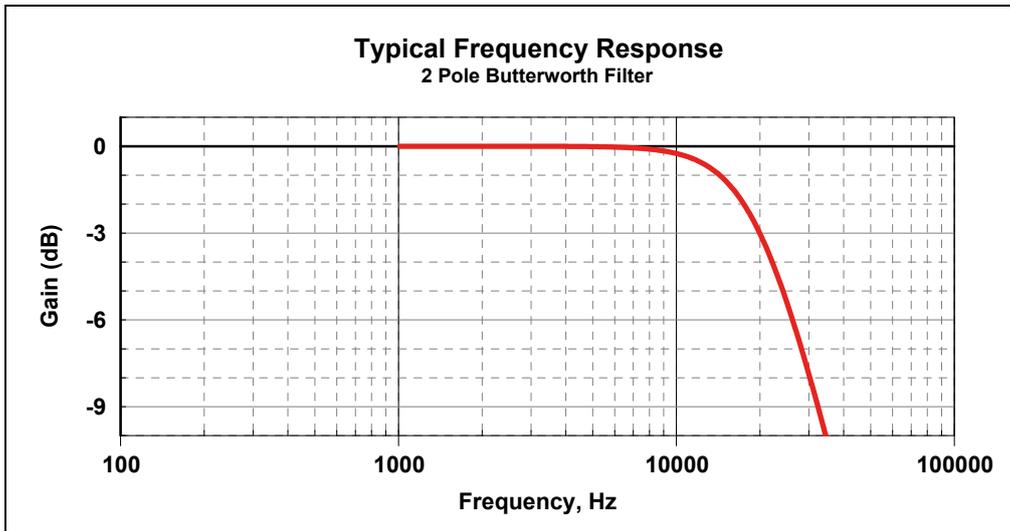
Start with test surface #1.

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. Record the voltage output V1 at that location.
3. Install sensor over test surface #2.
4. Move to the reference gap 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 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.

FREQUENCY RESPONSE

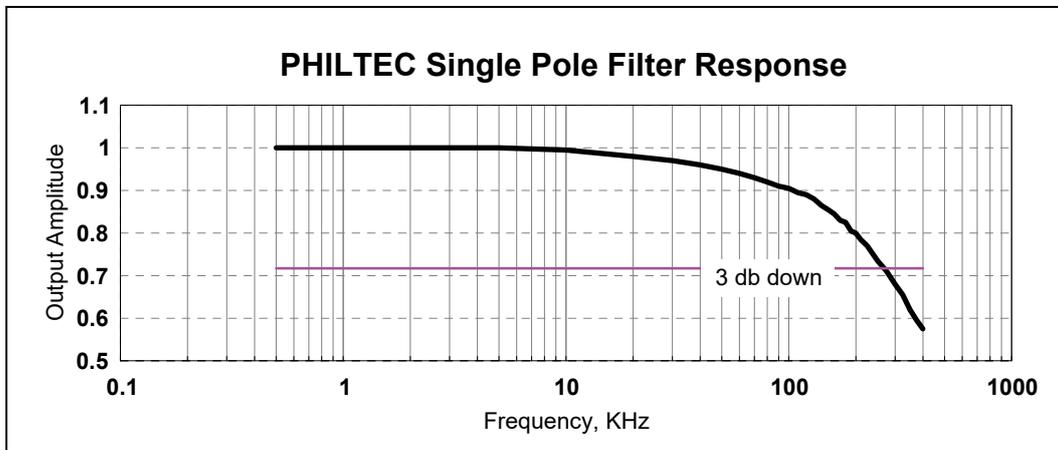


The amplitude response of a standard D sensor has a frequency rolloff characteristic that approximates a 2 pole filter response. The chart above shows that typical response. With the 3 db down point set at 20 KHz, the output is flat out to approximately ~6 KHz.

- 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 ~25 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 here:



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.

NOTE: Damage to the fiber bundle or sensor tip from rough handling is not covered under this warranty.

