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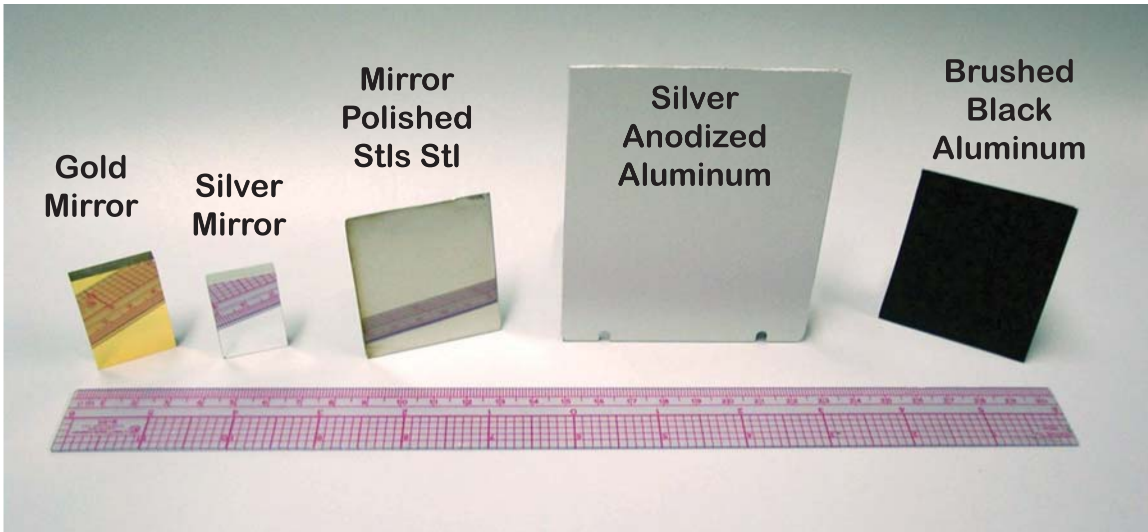
Reflectance Compensated (RC) Sensors



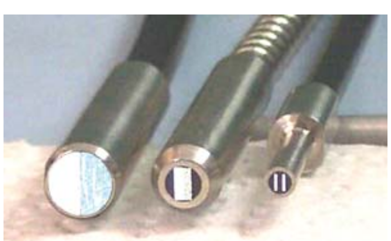
The Problem

The output signal from an intensity-based reflective optical displacement sensor (*Philtec D Type*) varies proportionately with the reflectivity of the target surface as well as with distance: i.e., the shinier the target, the higher the signal. This limits successful distance measuring applications to targets having a single axis reciprocating or vibratory motion (reflectivity is unchanging).

The Solution

PHILTEC developed the ***Reflectance Compensated*** fiberoptic sensor to overcome those limitations of reflectance dependent sensors, by providing a sensor whose output signal is blind to reflectance variations. The RC type sensor is a more general purpose optical sensor that can make accurate distance measurements to rotating or translating targets as well as measure part-to-part size variations in production parts.

RC Sensors



Light is transmitted to the target thru one side of adjacent fiberoptic bundles. The reflected light is captured in two separate fiber bundles which follow independent paths back to the electronics. A ratiometric calculation provides the distance measurement which is independent of target reflectivity variations; i.e., **reflectance compensated.**

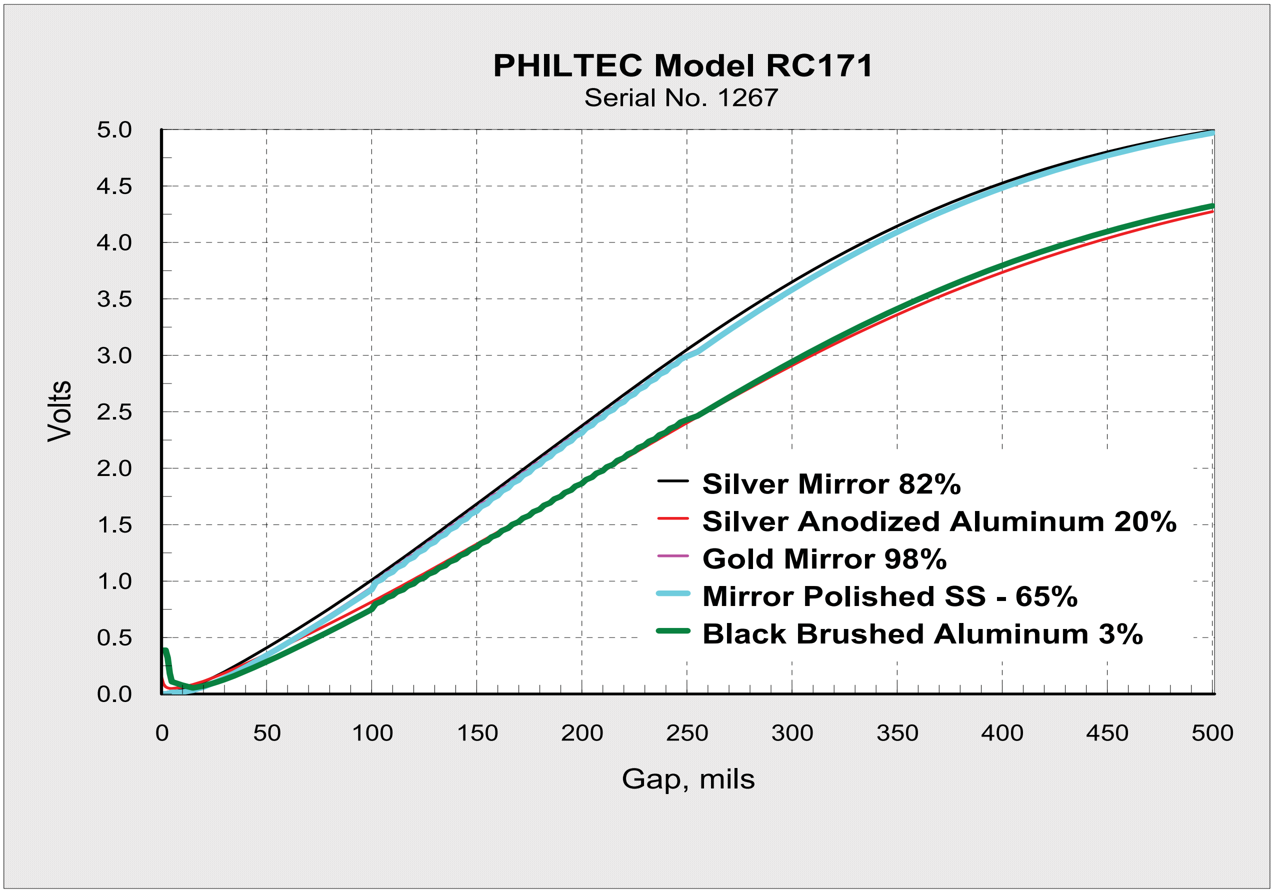
MIRROR vs. DULL SURFACE RESPONSES

Specular (Mirrored) Targets

All targets with mirror smooth surface finish generate identical output responses. This is illustrated in the chart below where the gold, silver and stainless steel mirrors generate identical outputs even though their surface reflectances vary from 65 to 98%.

Diffuse (Dull) Targets

Dull or matte finish targets will generate output curves less steep than specular targets. While being different than the mirror targets, they are essentially identical between them. This is illustrated in the chart below where the silver anodized aluminum and black brushed aluminum generate identical outputs even though their surfaces vary from 20% to 3% reflectance.

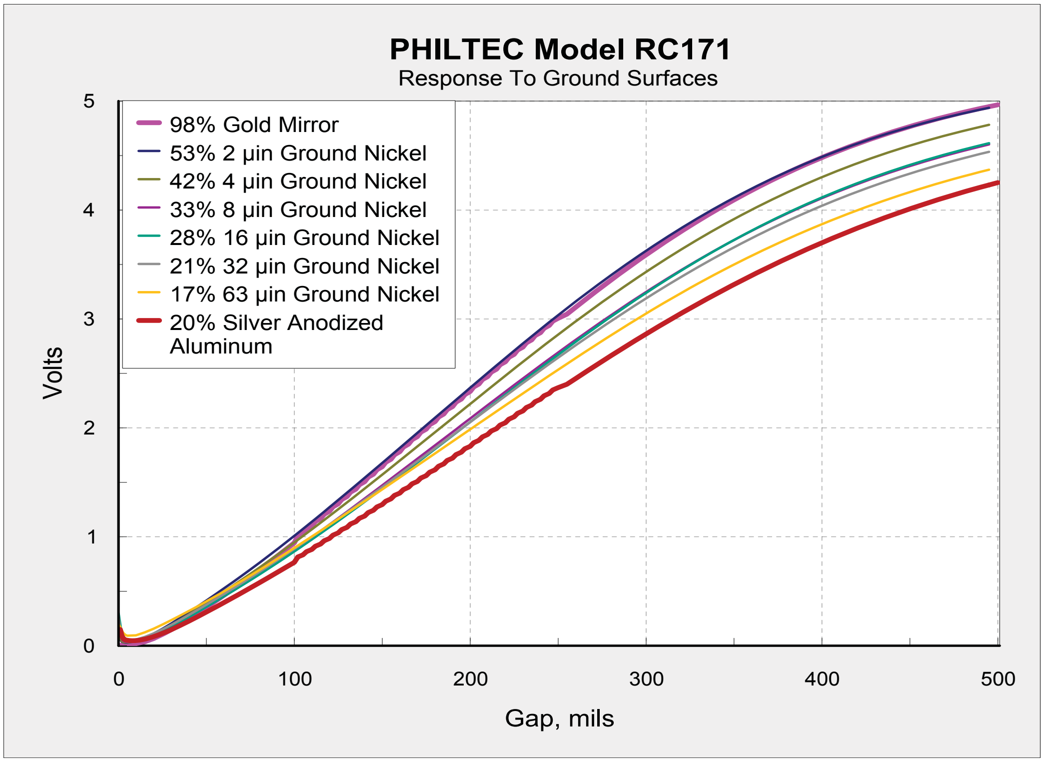


This chart illustrates that reflectance compensation works over a very wide range of target reflectances, nearly 100::1. These data also demonstrate that reflectance compensation does not correct for the differences between specular and diffuse reflectors. Specular (smooth and shiny) targets generate about 15% higher sensitivity than diffuse reflective targets...and therefore, different calibrations are required for different surface roughnesses (but not for different materials).

Machined Surfaces

Machined surfaces span the range from diffuse to specular. Rough machined surfaces are diffuse reflectors. Ground finishes can be in between totally diffuse and specular. This is illustrated in the chart here: a 2 microinch ground finish acts essentially as a mirrored surface; a 63 microinch ground surface is essentially a diffuse reflector. For best results, it is always good practice to calibrate a sensor to the same ground surface to be measured.

The reflectivity of the ground surfaces are provided in the chart legend. *The differences between the ground surfaces are proportional to the surface roughness, not to the reflectivity of those surfaces.*



Calibrations

The factory supplies a calibration to a mirrored target with analog model sensors. To make accurate measurements to non-mirrored targets:

a) calibrate the sensor to the target material, or
b) rescale the sensor output to the target material.

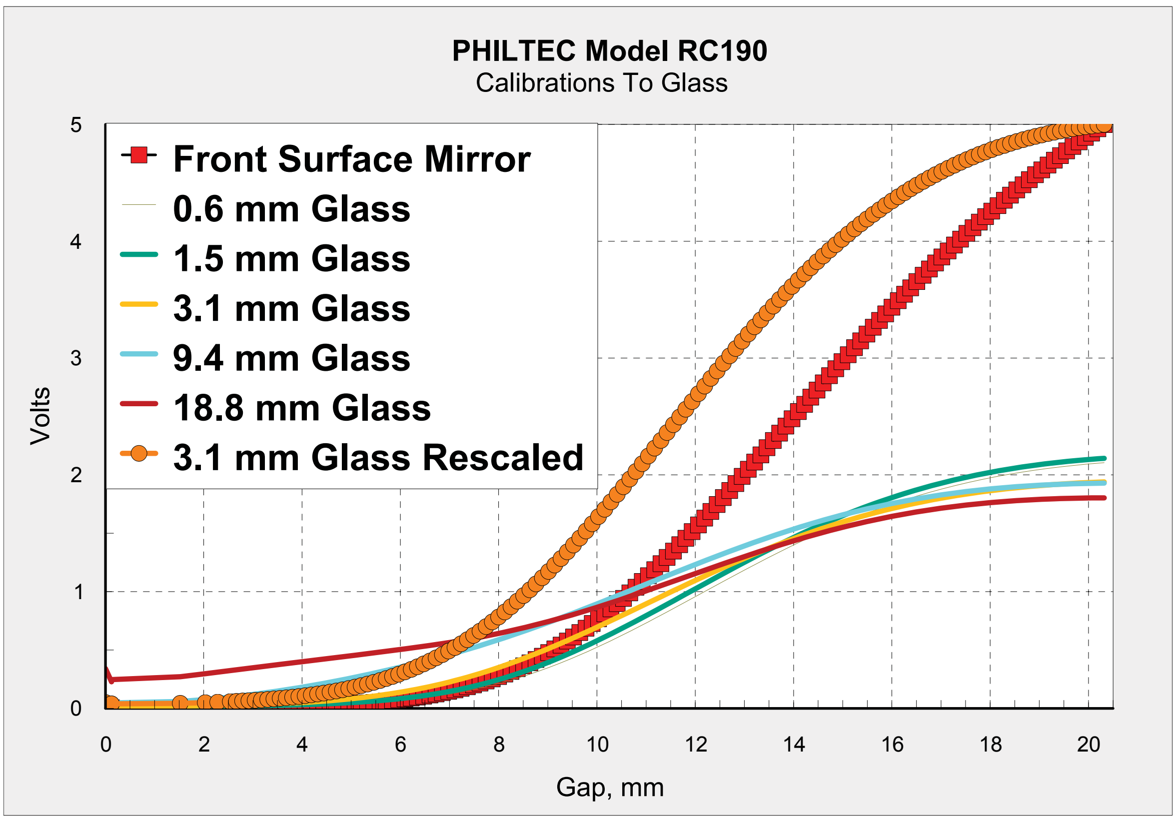
A Gain Control is provided for rescaling the sensor output. The procedure is simple. Gap the sensor to full scale, such as 500 mils for the model RC171 shown above. Using the Gain Control, bring the output voltage to read precisely 5.0 volts.

DMS units have 24 storage registers for calibration data. The factory supplies new DMS units with a mirror surface calibration in register #1 and a diffuse target calibration in register #2.

Transparent Materials

Transparent materials require calibrations to the material with the same thickness, as some light will reflect off the front surface and some light will reflect off the back surface and return to the sensor. In the examples shown below, a model RC190 was first set up and calibrated to a front surface mirror. Then, it was used without adjustments, and calibrated to 5 different thicknesses of glass. The output voltage reached only 2 volts at 20 mm with glass.

Finally, a repeat calibration was performed using the 3.1 mm thick glass, whereby the sensor was rescaled to 5 volts using the Gain Control. The resulting slope sensitivity of the sensor was equal to that using a front surface mirror.



APPLICATIONS FOR RC SENSORS

Automated Parts Inspection Bearing/Rotor Dynamics Commutator Profile Hard Drive Assembly Deformation Studies	Distance To Glass Distance To Paper Dynamic Expansion Hard Disc Thickness Precision Grinding	Process Control Rotor Runout Shaft Orbits Structural Deformation Surface Finish	Turbine Blade Growth Ultrasonic Vibration Ultra-High Vacuum Vibration Studies