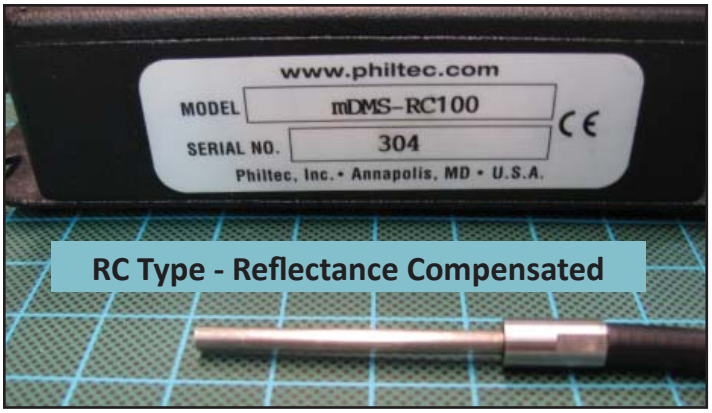
Philtec

23 March 2011

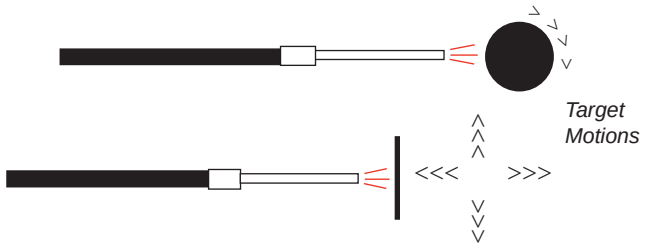
APPLICATION NOTE

WHY USE AN RC SENSOR?



The RC Sensor was developed at Philtec to overcome the limitations of reflectance dependent D Type sensors. The D Type fiber optic displacement transducer is a single channel light intensity based measuring device. Its output will change when the reflectivity of its target changes or when the distance to the target changes.

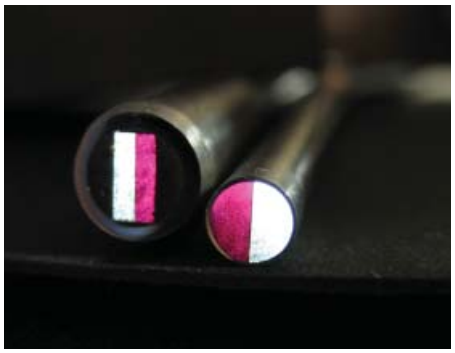
If the gap AND reflectivity of a target are both changing simultaneously, then an RC type sensor is required to make accurate gap measurements.



There are many examples of distance measurements with variable target reflectivity, such as:

- Bearing/Rotor Dynamics
- In-process Dimensional Control
- Part-to-Part Measurements
- Z Axis Distance with X and Y Travel
- Dynamic Thickness Measurements
- Shaft Runout and Orbit
- Parts Moving Past The Sensor
- Turbine Blade Clearance

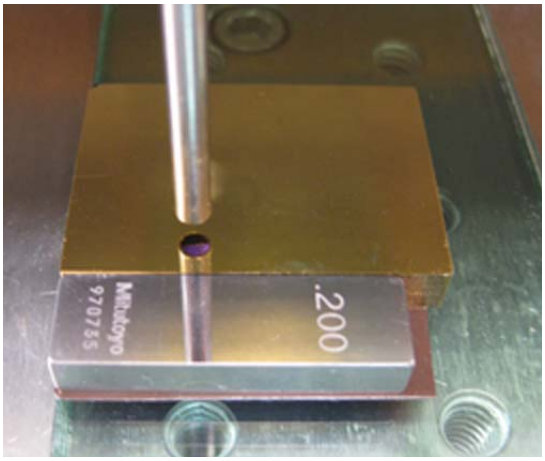
RC sensors are dual channel light intensity based measuring devices where *Reflectance Compensation* is derived from a ratiometric processing of two detector signals.



Two fiber bundles are arranged side-by-side in the probe tips. Light is emitted from one side only. Emitted light rays reflect off the target surface and are captured by detector fibers in both sides of the probes.

EXAMPLE

We use a steel gage block and a gold mirror to demonstrate the effectiveness of the RC sensor. These two targets were placed on a linear air bearing stage. A shim was placed under the gage block to bring the top surface to the same height as the top surface of the mirror.



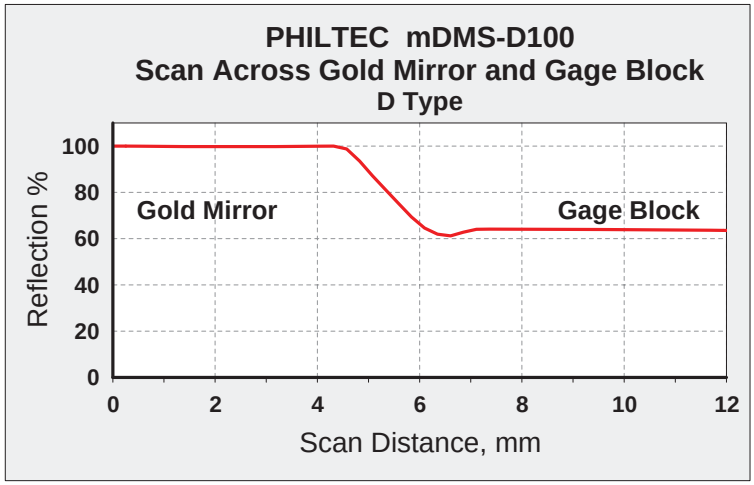
The D Type sensor was used first.

- A calibration to the gold mirror was made and stored in the sensor.
- The probe was positioned over the gold mirror and the gap set to 2.5 mm.
- After the sensor temperature stabilized, data was recorded as the stage moved across the objects for 12 mm in 50 steps.

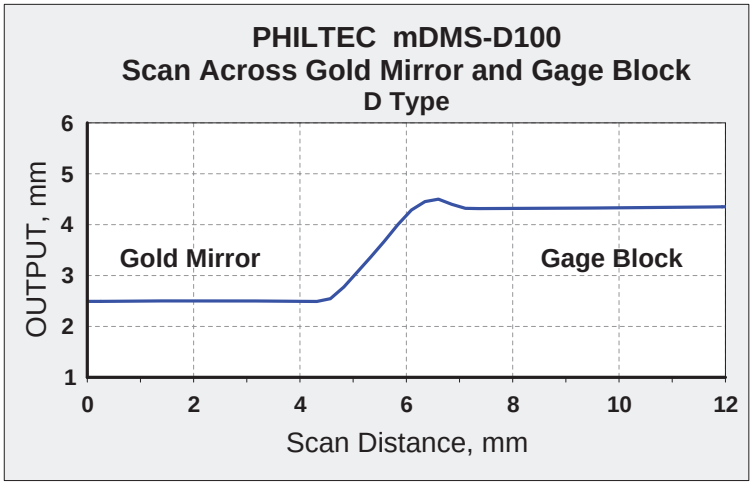
D SENSOR RESULTS

Reflectance and Gap measures were monitored with Philtec's DMS Control Software. The measurements show:

- The gage block is less reflective than the mirror: the block reflection is 64% of the gold mirror reflection.



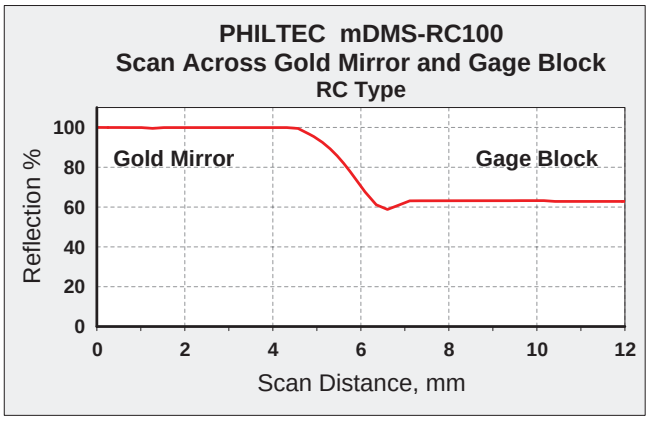
- The distance measure increases from 2.6 to 4.3 mm from gold to steel: ***a 65% error, proportional to the measured difference of reflectance.***

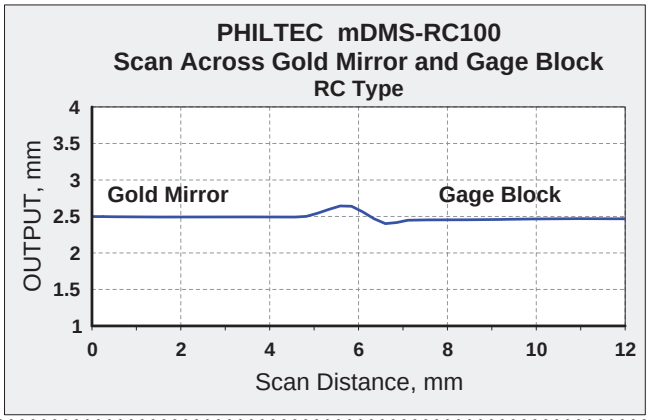


RC SENSOR RESULTS

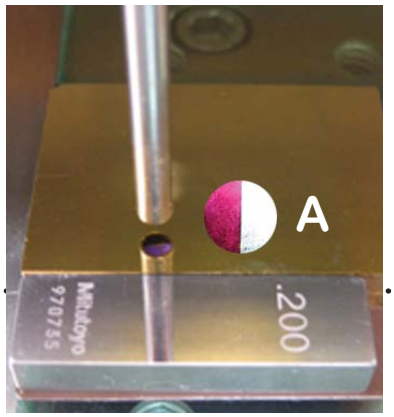
The RC Type sensor was used next. The measurements show:

- Same as with the D Type sensor, the gage block is 64% less reflective than the gold mirror.
- The distance measured to the gold mirror and silver block are the same: **there is little or no error.**

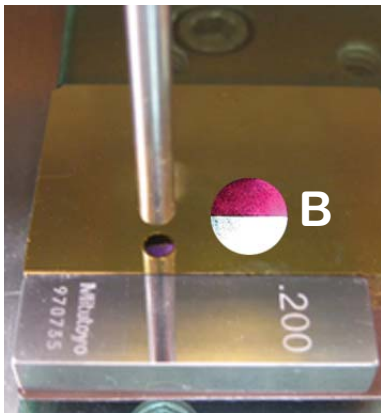


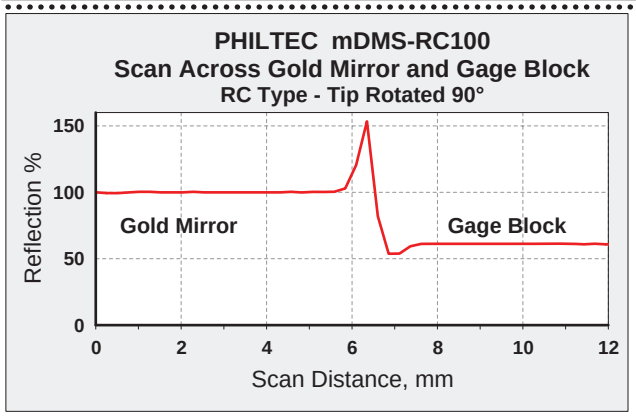


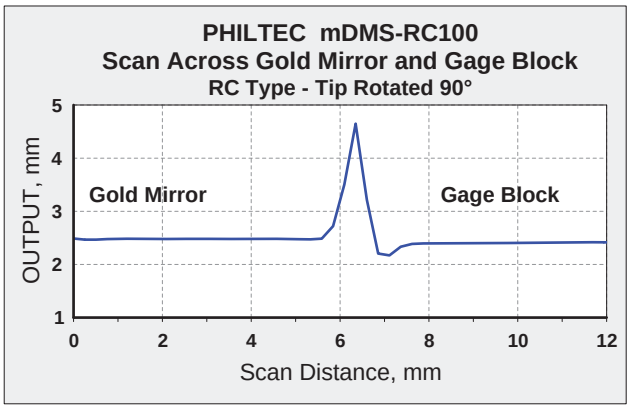
Fiber optic orientation **A** was used for the first RC scan.



Fiber optic orientation **B** was used for the second RC scan







Note: The orientation of the fiber optics can be set to a favorable position depending upon the application. Note that with orientation A, there is a smoother transition from the gold to the steel surfaces. With orientation B sharp spikes occur at the transition from gold to silver. The sharp spikes can be used to precisely mark or time the passage of the intersection between the gold and silver targets.

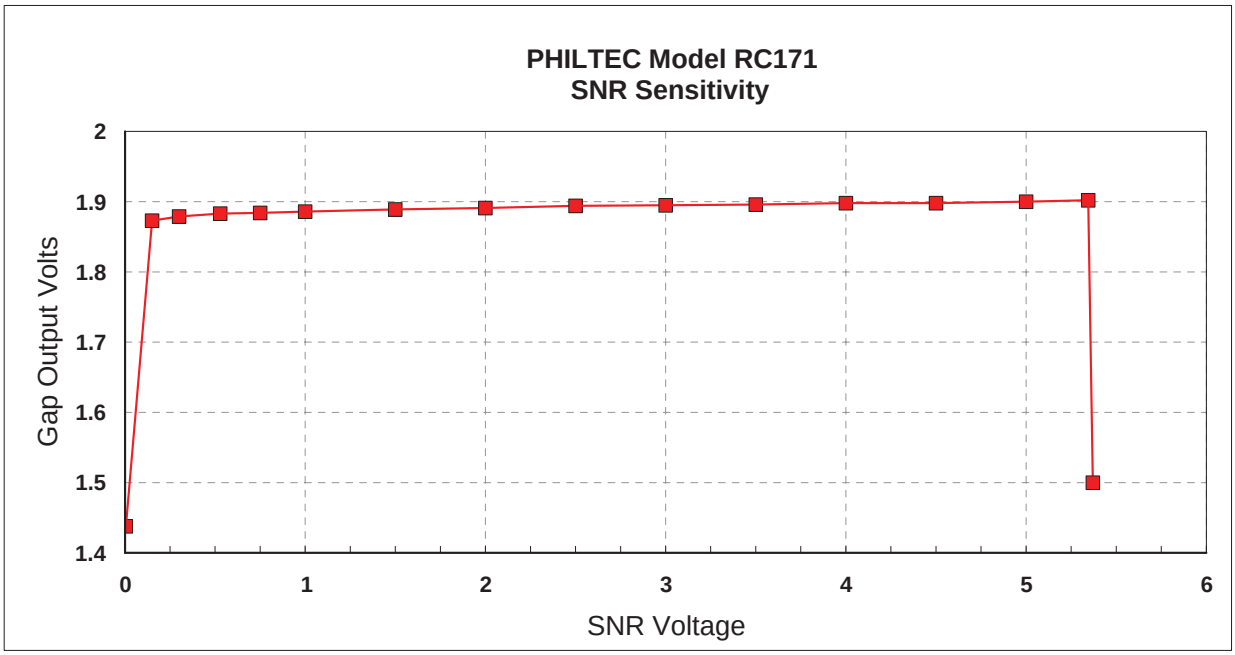
SNR SENSITIVITY

RC sensors have an SNR control for optimizing the analog signal strength passing thru the sensor. RC operating instructions recommend setting the peak SNR voltage between 2 and 5 volts for the best accuracy and resolution. SNR levels above 5.0 volts should be avoided to prevent clipping of the signal. A minimum level of 0.3 is required for reflectance compensation.

How sensitive is the gap measurement to the SNR amplitude?

- A model RC171 sensor was fixtured to a metal target and the gap set into the linear range at 1.9 volts
- The SNR control was varied from maximum to minimum and data recorded.

Between 0.15 and 5.3 SNR volts, the Gap voltage varied by 1.4%.
Between 1 and 5 SNR volts, the Gap voltage varied by 0.75%.
Between 3 and 5 SNR volts, the Gap voltage varied by 0.25%.



SNR SENSITIVITY

Returning to the gold mirror and silver gage block results, we see that there was only a 1% change in the Gap voltage with a 31% change in the SNR voltage.