OPERATING INSTRUCTIONS

FOR

FIBEROPTIC

DISPLACEMENT SENSOR

with Analog Output

TYPE RC

REFLECTANCE COMPENSATED

Model______________________________ Serial Nos.___________________________

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

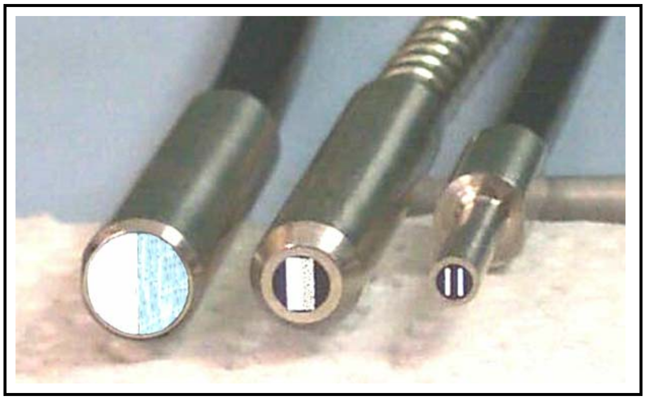
CAUTIONS :

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 broke.

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. Lint, 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 COMPENSATION

Reflectance Compensated Fiberoptics *eliminate sensitivity to target reflectance variations.*



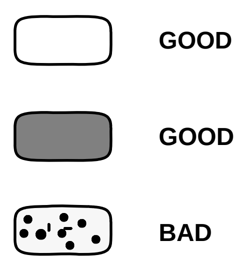
There are many applications where distance to a target has to be measured in the presence of changing reflectivity. For example:

- Shaft runout
- In-process dimensional control
- Z coordinate measurement with X & Y travel
- Part-to-part inspection

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 amplifier. A ratiometric calculation provides the distance measurement which is independent of target reflectivity variations; i.e., **reflectance compensated.**

RC sensors perform static as well as dynamic measurements with equally excellent results. Transverse motion is *not required* for reflectance compensation to work.

The RC sensor works very accurately with target surfaces that appear uniformly reflective to the unaided eye, which means the reflectance variations under the small area covered by the fiber optic sensor are negligible. The target could be very shiny, or it could be all dark, and that is OK. It is not so good when the area is a mix of light and dark spots or highlights. If reflective highlights and less reflective areas within the small spot size of the sensor can be observed with the naked eye, the sensor's performance will be effected by them.



INPUT/OUTPUT CONNECTIONS

1) Connect a positive voltage DC power source +12 Volts with at least 150 ma capacity to the contacts marked +DC and GND (Ground).
2) Connect any suitable voltage readout device to the terminal marked OUT.
   Standard units provide 0 - 5 volt output with DC - 20 KHz bandwidth.

THE SENSOR IS NOW READY FOR OPERATION

SENSOR OPERATING PROCEDURE

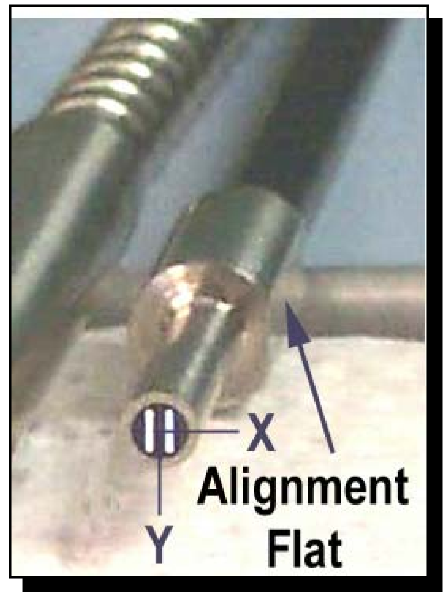
A new measurement application requires the consideration of

- **Sensor tip fixturing**
- **Sensor electronics adjustments**

SENSOR TIP FIXTURING and ALIGNMENT

1) ALIGN THE SENSOR TIP

RC sensors have adjacent fiber bundles in the face of the sensor. Note there is an alignment flat on the casing to aid with alignment. The flat is ground parallel to the split between the adjacent fiberoptic bundles. Depending upon the application, there may be a preferred orientation for best performance. For example:



- If the target is cylindrical, it is usually best to mount the sensor with the X axis parallel to the cylindrical axis
- If there is lateral motion, it may be preferrable for the direction of motion to be parallel to the x axis
- the sensor is 10 times more sensitive to tilt about the Y axis than the X axis. If tilt is directional, orient the sensor so that the target pivots about the sensor's X axis.
- If targets are discontinuous, voltage spiking at the leading and trailing edges of the parts will occur when the direction of travel is parallel to the X axis. The voltage spiking is eliminated when the direction of parts travel is parallel to the Y axis.
- For smooth and continuous flat surfaces, sensor tip orientation is not critical.

2) MOUNT THE SENSOR, so that it is perpendicular to the target surface.

SENSOR ELECTRONICS ADJUSTMENTS

A new measurement application requires the consideration of

- **Sensor Signal-to-Noise Ratio (SNR)**
- **The reflective nature of the target surface**

HOW TO CHECK SNR

SNR should be checked and optimized each time the sensor is being set up for a new measurement application.

How To Properly Set The SNR Level

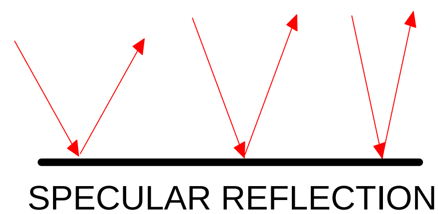
1. SNR is a measure of the analog signal strength passing thru the amplifier.
2. To check the SNR level, hold the sensor perpendicular to a target and move it thru the sensor's range of operation while noting the highest voltage level measured on the SNR output.
3. With the sensor gap held at the position where the highest SNR level is reached, adjust the SNR control until the SNR voltage reads about 3.5 volts.

NOTES

- SNR should be set between the values 2 and 5 volts to achieve the best resolution and accuracy.
- SNR levels above 5.0 volts should be avoided to prevent clipping of the signal.
- SNR levels below 0.3 volts must be avoided. A minimum level of 0.3 is required for reflectance compensation to work.
- SNR is optimized at the factory for highly reflective targets such as front surface mirrors.
- SNR amplitude is proportional to the reflectivity of the target surface.

REFLECTIVE NATURE OF THE TARGET SURFACE

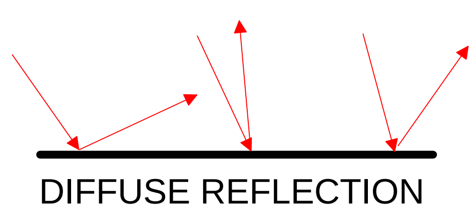
TARGET	% REFLECTANCE
Gold Mirror	100
Mirror Polished Aluminum	85 - 90
Mirror Polished Stls Steel	60 - 70
Brushed Aluminum	40 - 50
Copper Clad PC Board	45
Matte Finish Aluminum	30 - 35
Anodized Aluminum	20 - 25
Silver Paint, Glossy	15 - 20
Photo Paper, High Gloss	15
Photo Paper, Soft Gloss	12
Inkjet Paper,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



1. Specular Targets...*A mirror surface calibration should be used when making measurements to mirrored surfaces*.

A factory supplied calibration chart shows the sensor's voltage relationship with distance to the target surface, where the target surface is a front surface aluminized mirror. The RC sensor as delivered from the factory can be used - without adjustment - for any target surface is very smooth, highly polished, mirrored, glossy or very shiny; i.e., specular.

2. Diffuse Targets... *A diffuse surface calibration should be used when making measurements to diffuse surfaces.* A diffuse surface looks dull rather than shiny.



With diffuse surfaces, reflected light rays travel randomly varying path lengths back into the sensor tip. Reflectance compensation can not correct for this random scattering of light rays. The response of an RC sensor to a diffuse reflector can be as much as 15% in error unless it is recalibrated or reset to the diffuse reflector. See Philtec Application Note "Reflectance Compensated (RC) Sensors" of July 2004.

CALIBRATE OR ADJUST THE AMPLIFIER FOR DIFFUSE TARGETS

For diffuse target surfaces, which include anything with a dull, flat or matte finish, as well as those with machined or ground finishes:

A) calibrate the sensor to the diffuse target material

or

B) apply an adjustment to the mirror surface calibration for the diffuse surface

ADJUSTING THE AMPLIFIER FOR DIFFUSE TARGETS

A control labelled **CAL 1** is located on the side of the amplifier. The **CAL 1** control is used to set the DC voltage output to full scale (5.000 volts) when the sensor gap (mils) is set to full scale. Full scale set points for RC sensors are given here. This control is set during factory calibration with a specular target surface such that the sensor output reads precisely 5.000 volts at the maximum gap for the sensor. The operating maximum gap for each RC model is given in the following table.

Maximum Operating Gaps For RC Sensors

MODEL	RC12	RC25	RC20	RC60	RC62	RC63	RC94	RC100	RC140	RC90	RC171	RC190
GAP, mils	20	30	50	125	80	160	200	200	300	350	500	800
GAP, mm	0.51	0.76	1.27	3.2	2.03	4.06	5.08	5.08	7.62	8.89	12.7	20.3

1) SET THE SENSOR GAP... With a diffuse target surface, while maintaining perpendicularity to the target, set the maximum sensor gap for your model according to the table above.

2) RESET THE CAL 1 CONTROL... Remove the black cover from the Cal 1 control and adjust the **Cal 1** control until the DC output volts reads precisely 5.000 volts at that maximum gap.

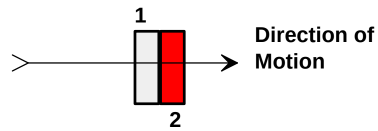
Note: Adjusting this control voids the factory calibration setting.

THE SENSOR IS NOW RESET FOR MEASUREMENTS TO DULL TARGETS

NOTES ON SENSOR TIP ORIENTATION

Uniformly Reflective Targets

The sensor should be oriented as shown here, where the target motion crosses the short side of the fiber bundle. With this orientation, the same area of the target that passes across sensing channel 1 also passes across sensing channel 2, and reflectance compensation is most accurate. However, the passage of part edges will cause voltage spikes on the output signal as the leading and trailing edges of the part passes thru the sensing area. Those spikes can be minimized or eliminated by turning the sensor tip 90° so the motion is parallel to the sensor's long axis.

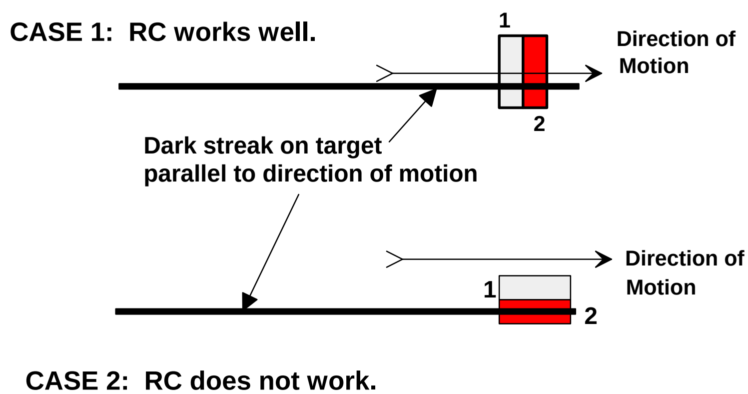


CORRECT ORIENTATION

Target Streaks

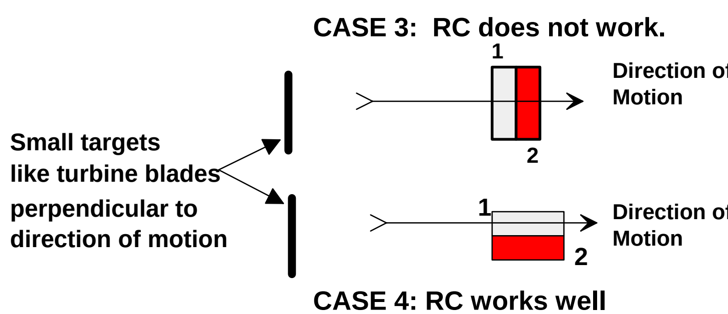
a) Parallel To The Direction of Motion

A wear score, streak or band on the target that is of a different reflectance than the rest of the surface will not have a major effect on sensor performance if it is *parallel to the direction of target motion,* as we show in Case 1. Reflectance compensation will still work rather well in this case, because sensor section 1 and sensor section 2 will cover identical areas of the target. If the sensor is oriented as shown in Case 2, sensor section 1 "sees" a different part of the target than sensor section 2, and reflectance compensation does not work accurately.

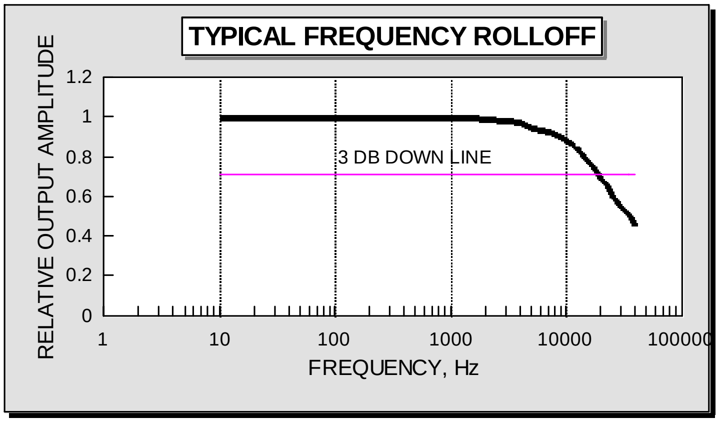


b) Perpendicular To The Direction of Motion

The passage of small discontinuous targets like turbine blade tips, streaks, sharp contrast changes, or the edge of a part perpendicular to the direction of motion will create voltage spiking on the output when the sensor is oriented as shown in Case 3. Voltage spikes can be avoided by orienting the sensor as shown in Case 4, where the part edge is perpendicular to the direction of motion.



FREQUENCY RESPONSE



The amplitude response of a standard Type RC sensor will have a frequency rolloff characteristic that approximates a single 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 2 KHz.

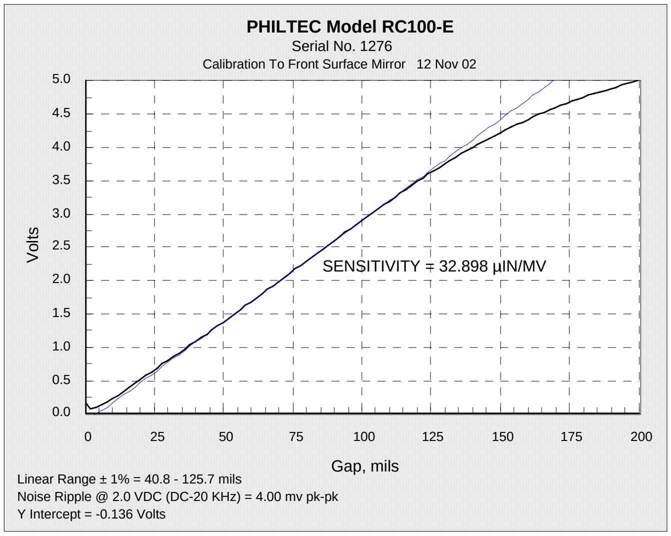
- With a high frequency amplifier, the 3 db down point is set at 200 KHz.
- With a low frequency amplifier, the 3 db down point is set at 100 Hz

FACTORY CALIBRATION

The factory supplied calibration chart provides:

- Sensor model & serial number
- Date of calibration
- The linear sensing range
- The slope sensitivity
- The y intercept of the linear range
- The AC noise ripple

The XY calibration data points are made available upon request.



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.