



# Instruction Manual—SM Series, Perfect Prox® and Standard Diffuse Reflective Photoelectric Sensors

The following models are covered in this manual:

## PERFECT PROX

### 50 mm Range Models

E65-SMPP050-GL	..... AC/DC	.... 3-Wire	.... Cable	..... Light Operate
E65-SMPP050-GD	..... AC/DC	.... 3-Wire	.... Cable	..... Dark Operate
E65-SMPP050-GLD	..... AC/DC	.... 3-Wire	.... Connector	..... Light Operate
E65-SMPP050-GDD	..... AC/DC	.... 3-Wire	.... Connector	..... Dark Operate
E65-SMPP050-HL	..... DC	.... 4-Wire	.... Cable	..... Light Operate
E65-SMPP050-HD	..... DC	.... 4-Wire	.... Cable	..... Dark Operate
E65-SMPP050-HLD	..... DC	.... 4-Wire	.... Connector	..... Light Operate
E65-SMPP050-HDD	..... DC	.... 4-Wire	.... Connector	..... Dark Operate

### 100 mm Range Models

E65-SMPP100-GL	..... AC/DC	.... 3-Wire	.... Cable	..... Light Operate
E65-SMPP100-GD	..... AC/DC	.... 3-Wire	.... Cable	..... Dark Operate
E65-SMPP100-GLD	..... AC/DC	.... 3-Wire	.... Connector	..... Light Operate
E65-SMPP100-GDD	..... AC/DC	.... 3-Wire	.... Connector	..... Dark Operate
E65-SMPP100-HL	..... DC	.... 4-Wire	.... Cable	..... Light Operate
E65-SMPP100-HD	..... DC	.... 4-Wire	.... Cable	..... Dark Operate
E65-SMPP100-HLD	..... DC	.... 4-Wire	.... Connector	..... Light Operate
E65-SMPP100-HDD	..... DC	.... 4-Wire	.... Connector	..... Dark Operate

## STANDARD DIFFUSE REFLECTIVE

### 200 mm Range Models

E65-SMSD200-GL	..... AC/DC	.... 3-Wire	.... Cable	..... Light Operate
E65-SMSD200-GD	..... AC/DC	.... 3-Wire	.... Cable	..... Dark Operate
E65-SMSD200-GLD	..... AC/DC	.... 3-Wire	.... Connector	..... Light Operate
E65-SMSD200-GDD	..... AC/DC	.... 3-Wire	.... Connector	..... Dark Operate
E65-SMSD200-HL	..... DC	.... 4-Wire	.... Cable	..... Light Operate
E65-SMSD200-HD	..... DC	.... 4-Wire	.... Cable	..... Dark Operate
E65-SMSD200-HLD	..... DC	.... 4-Wire	.... Connector	..... Light Operate
E65-SMSD200-HDD	..... DC	.... 4-Wire	.... Connector	..... Dark Operate



## WARNING

### IN ORDER TO AVOID ELECTRIC SHOCK OR OTHER POSSIBLE INJURY:

- Do not use this product for human safety applications. It was not designed, tested or recommended for this use.
- Do not use this product in hazardous locations (e.g. explosive atmospheres). It was not designed, tested or recommended for this use.
- Insure that the product is connected to the correct power supply for the application. Refer to the wiring diagrams in this manual.
- Do not use tools to apply force or torque directly to the sensor body. Align the sensor by hand before tightening the mounting hardware.
- Use #6 or smaller mounting hardware. Use of larger hardware can damage the sensor and possibly expose hazardous live voltages.
- AC/DC connector version sensors are equipped with an AC-type connector. The use of DC power with AC-type connectors may not conform with established standards.

## INTRODUCTION

The SM Series is a cost-effective photoelectric sensor family for use in a variety demanding industrial applications. They have high optical performance for reliable sensing, and their compact size allows use in tight spaces.

The sensors feature TargetLock™ for easy installation and set up. TargetLock™, a powerful alignment aid, tells you exactly when the sensors are on target for optimum performance. Sensor status is quickly available at a glance from the highly visible indicating LEDs.

### Standard Diffuse Reflective Sensors

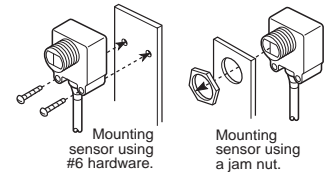
A diffuse reflective sensor operates by shining a beam of light out through the lens. An object that comes within the sensor's view reflects part of this beam of light back to the sensor causing the sensor to detect the object. The maximum range at which a given object can be detected depends on how well its surface reflects light—the less light it reflects back, the shorter the range. The ability of a surface to reflect light depends primarily upon its material of construction, color, and texture.

### Perfect Prox® Sensors

A Perfect Prox sensor is a special diffuse reflective sensor that includes precise background rejection. It has all of the sensing power of a standard diffuse reflective sensor, but ignores any object past a defined cutoff range. In addition to ignoring unwanted background objects, the Perfect Prox can sense objects of different color or reflectivity at virtually the same range. This makes the Perfect Prox one of the most reliable and simple sensors to set up and use.

## MOUNTING

The SM sensor features two mounting holes in the rectangular section of the body for mounting to a surface with #6 or smaller hardware. In addition, the threaded barrel and jam nut allow mounting into any 0.75 inch (19 mm) hole, or a selection of accessory mounting brackets.



## USING TARGETLOCK™

**Alignment:** The TargetLock LED provides a quick and easy way to set up the sensor for optimum operation. As you approach the best alignment and range, the LED changes from short flash, to long flash, to a solid ON condition. Refer to the set-up procedures in the next section.

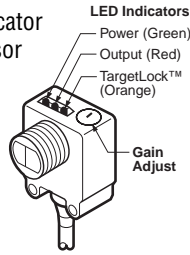
**Maintenance:** Another valuable feature of the TargetLock LED is to indicate the need for maintenance prior to loss of sensor operation. Observing a change from the normal operation of the LED when a target is present (for example, from solid ON to a long flash) indicates the gain has been reduced. This may be due to such things as sensor being bumped or vibrated out of alignment or contamination on the lens.

**INDICATIONS AND ADJUSTMENTS**

The SM Sensor features an advanced LED indicator display to provide information concerning sensor alignment and operating status.

**Gain Adjustment**

Diffuse reflective sensors include an adjustment control for optimizing the amount of gain for the application. The 270° pot provides a 10:1 adjustment of gain. A mechanical stop reduces the possibility of sensor damage due to over rotation.



LED	Function	State	Condition
Green	Power	ON	Power is applied to sensor
		OFF	No power
Red	Output	ON	Output is ON
		OFF	Output is OFF
		Flashing	Output is short circuited or overloaded
Orange	TargetLock™ Alignment Aid	ON	Target present—excellent gain, operating within optimum range
		Long Flash	Target present—good gain
		Short Flash	Target present—poor gain
		OFF	No target or sensor beyond range

**SENSOR LOCATION AND SET-UP**

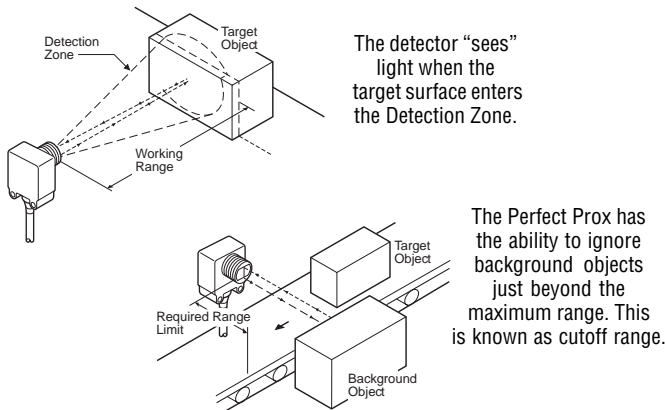
Select a mounting location with a clear view of the object to be detected. Mount the sensor so that the sensing beam is aimed at the most suitable part of the target object. The actual setup procedure varies slightly depending on your sensor type:

**Standard Diffuse Reflective**

Remove the target from the beam and apply power to the sensor. If the TargetLock LED is ON or flashing, then you are detecting a background object. Eliminate the object or reduce the gain using the gain adjustment on the sensor. Place the target in the sensing beam. The TargetLock LED should be on steady. If it is not, adjust the sensor alignment, the sensor gain, or move the sensor closer to the object until the LED lights steady. Remove the target and check for background detection again (hysteresis latch-up after sensing an object). Repeat procedure if necessary. If you are unable to avoid background detection, consider using a Perfect Prox. After setup, tighten all mounting hardware.

**Perfect Prox**

Remove the target from the beam and apply power to the sensor. If the TargetLock LED is ON or flashing, then you are detecting a background object. Eliminate the object or move the sensor farther from the object. Place the target in the sensing beam. The TargetLock LED should be on steady. If it is not, move the sensor closer or farther away until you find the range where the LED lights steady. Position the sensor in the center of this range. Remove the target and check for background detection again (hysteresis latch-up after sensing an object). Repeat procedure if necessary. After setup, tighten all mounting hardware.



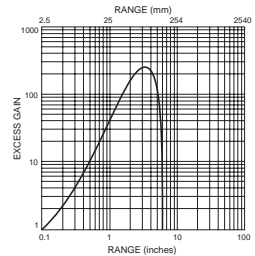
**PERFECT PROX APPLICATION HINTS**

Perfect Prox sensors combine high excess gain with a sharp cut-off. The optics that provide this performance can also make it possible to misapply the sensor, giving the appearance of a malfunction. Simple adjustments alleviate these application problems. Following is a simplified description of how the Perfect Prox works, and tips on adjusting the sensor for proper performance.

**WHY MAKE A PERFECT PROX?**

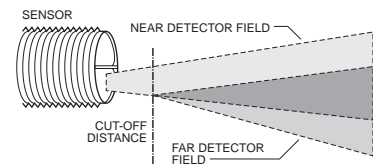
Diffuse reflective mode photoelectric sensors use high excess gain to reliably detect targets with low reflectance (dark color, rough texture, etc.). Since higher reflectance objects reflect more light, they will be detected at a much greater distance. When sensing a target against a background with higher reflectance, reliability problems can occur.

We developed Perfect Prox to have the high gain needed to detect low reflectance targets, but with a sharp cut-off to reject backgrounds. The excess gain graph clearly shows this gain cut-off.



**HOW A PERFECT PROX WORKS**

To get high gain and the sharp cut-off, the sensor has 2 different detectors. The first is the near detector. It has a range (for the 2-inch model) of 0 to 24 inches. The second is the far detector with a range of 2 to 24 inches. Objects closer than 2 inches are detected by only the near detector. Objects farther than 2 inches will be detected by both detectors. If the near signal is stronger than the far signal, the sensor output is "on". If the far signal is stronger than or equal to the near signal, the output is "off." The result is a sensor with high excess gain for 2 inches followed by a sharp cutoff.



**APPLICATION DIFFICULTIES?**

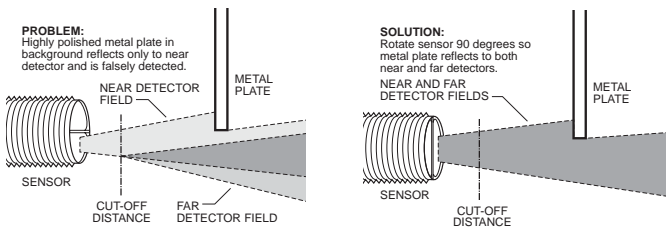
As you can see, the sensor lens is divided in half. When the sensor is oriented so that one half is above the other, the two detection fields are stacked one on top of the other (see previous illustration). Application difficulties with Perfect Prox usually come from targets or backgrounds that reflect unequally to these two detectors. Fortunately, these problems are easily remedied by slight readjustment of the sensor's mounting. NOTE: Backgrounds that cause specular reflections, such as mirror-like surfaces, can occasionally reflect more light to the near detector than to the far detector. This will cause detection at distances greater than the sensor's cutoff range, resulting in a false "ON" condition. To avoid this, dull the surface to a matte finish, or angle the sensor or background to eliminate direct reflections.

The following examples are simple solutions to three specific problems that can occur when installing the Perfect Prox sensor. All drawings exaggerate field placement for purposes of illustration.

**BACKGROUND OBJECTS CAUSING UNEQUAL REFLECTIONS**

Any background object that reflects light to only one detector can cause problems. Reflections to only the near detector can cause a false "on" condition. (These reflections can come from objects up to 2 feet away for diffuse objects, or 10 feet away for retroreflectors and mirrors.) If the background object reflects only to the far detector, it may provide enough signal that the sensor cannot detect a near object. If the background object does not reflect enough light to be detected, it may reflect enough that the sensor will lock up and not turn "off" after a near target has left the sensor's field of view.

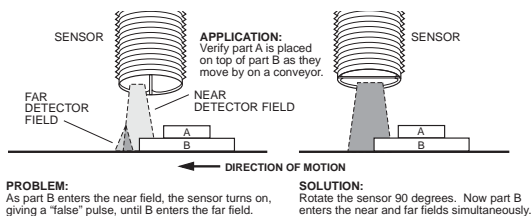
To solve these problems, rotate the sensor 90° to direct reflections to both detectors. Aiming the sensor at an angle to the background may also bring the background into the field of view of both detectors.



**DETECTING TARGETS MOVING PARALLEL TO SENSOR'S LENS SURFACE**

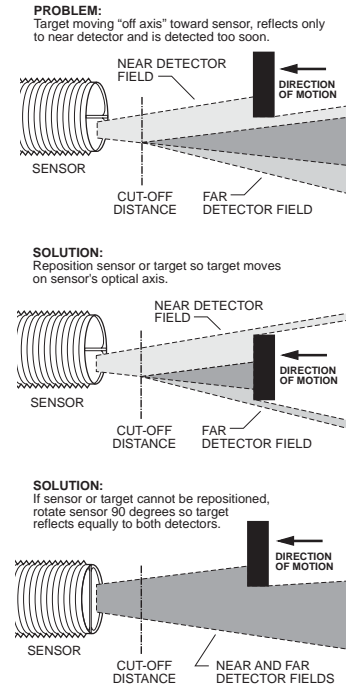
When one object is to be detected as it moves on a second "background" object, the background may cause a "false" pulse if the sensor is not oriented properly.

To avoid these pulses, the target must enter and leave both fields simultaneously. This is easily done by having the object approach the sensor as shown in the illustration.



**DETECTING TARGETS MOVING HEAD-ON TOWARDS THE SENSOR**

Sometimes you need to detect an object as it approaches the sensor head on. If the object is not centered on the sensor's optical axis, it may reflect into just one of the detectors. The result is that the Perfect Prox will either not sense at all, or will act as a regular diffuse reflective sensor and detect the object at too great a distance. Repositioning the sensor or the object so that the object travels on the sensor's optical axis will solve the problem. You may also relocate the sensor so that the object moves in a plane parallel to the sensor's lens surface.



**WIRING DIAGRAMS**

Pin numbers are for reference only, rely on pin location when wiring.

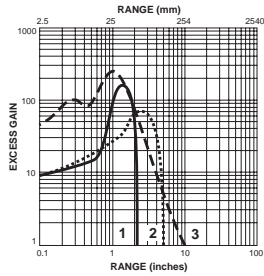
Mode	Cable Models	Micro-Connector Models*
<b>3-Wire AC/DC Models (18-264 VAC, 50/60 Hz or 18-50 VDC)</b>		
All Sensors		
<b>4-Wire DC Models (10-30 VDC)</b>		
All Sensors		

**SPECIFICATIONS**

	AC/DC Models (AC Operation)	AC/DC Models (DC Operation)	DC Models
<b>Input Voltage</b>	18-264 VAC, 50/60 Hz	18-50 VDC	10-30 VDC
<b>Power Dissipation</b>	4 VA maximum	4 VA maximum	2 W maximum
<b>Output Type</b>	VMOS (bi-directional)	NPN (Sink)	NPN and PNP (dual outputs)
<b>Current Switching</b>	200 mA maximum	200 mA maximum	100 mA maximum
<b>Voltage Switching</b>	264 VAC	50 VDC	30 VDC maximum
<b>Off-State Leakage</b>	500 µA maximum	500 µA maximum	10 µA maximum
<b>Surge Current</b>	2 A maximum	2 A maximum	1 A maximum
<b>On-State Voltage Drop</b>	3.5 V maximum	3.5 V maximum	2.5 V maximum
<b>Response Time</b>	16 mS	1.5 mS	1 mS
<b>Short Circuit Protection</b>	Auto reset short circuit and overload protection (Output Indicator LED will flash); IMPORTANT: During installation, correct power connections must be made first to ensure fail-safe short circuit protection of the outputs.		
<b>Light/Dark Operation</b>	By model		
<b>Temperature Range</b>	Operating: -13° to +131° F (-25° to +55° C); Storage: -13° to +158° F (-25° to +70° C)		
<b>Material of Construction</b>	Lens: Polycarbonate; Cable jacket: PVC; Body: Cyclopol		
<b>Cable/Connector</b>	6.5 foot (2m) 4-wire cable; or 4-pin, micro connector (AC-key on AC/DC models; DC-key on DC models)		
<b>Vibration and Shock</b>	Vibration: 30 g over 10 Hz to 2 kHz; Shock: 50 g for 10 mS 1/2 sinewave pulse		
<b>Indicator LEDs</b>	Green LED: Power; Red LED: Output; Orange LED: TargetLock™		
<b>Source Light</b>	Visible Red, 660 nm		
<b>Gain Adjustment</b>	3/4-turn pot, 10:1 adjustment of gain (provided on thru-beam and diffuse reflective sensors only)		
<b>Sunlight Immunity</b>	Perfect Prox: 5,000 footcandles; All others: 10,000 foot-candles		
<b>Enclosure Ratings</b>	NEMA 1, 3, 4, 4X, 6, 6P, 12, and 13; IP 68 (Our products conform to NEMA tests as indicated, however, some severe washdown applications can exceed these NEMA test specifications. If you have questions about a specific application, contact our Applications Department.)		
<b>Approvals</b>	CE Compliant; Contact factory for the latest list of approvals		

**OPTICAL PERFORMANCE**

All optical specifications are guaranteed to be the minimum performance under clean conditions of any product delivered from stock. Typical performance may be higher. Dirt in the environment will affect optical performance by reducing the amount of light the control receives. For best results, sensors should be used at distances where excess gain is higher than 1.5 (1.5 times the amount of sensing power required to detect an object under ideal conditions). Higher excess gain will allow the sensor to overcome higher levels of contamination on the lens.

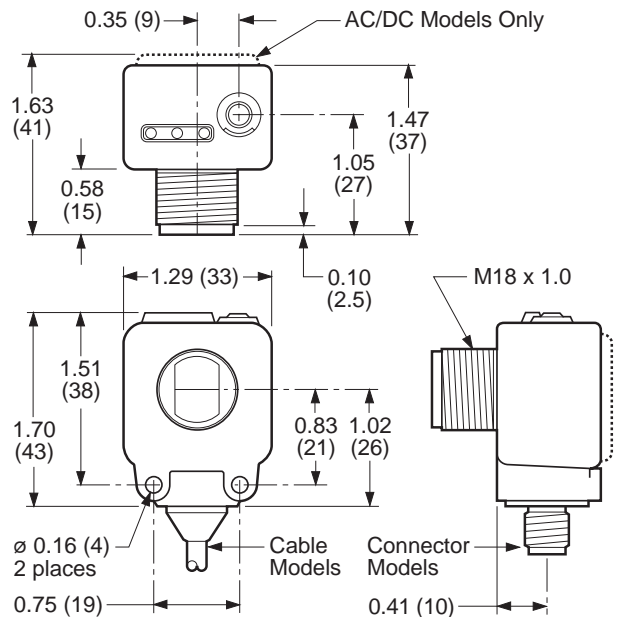


1. 50 mm Perfect Prox
2. 100 mm Perfect Prox
3. Diffuse Reflective (based on a 90% reflectance white card)

	50 mm Perfect Prox	100 mm Perfect Prox	Diffuse Reflective
<b>Maximum Range</b>	2 inches (50 mm)*	4 inches (100 mm)*	8 inches (200 mm)
<b>Optimum Range</b>	0.4 to 1.8 inches (10 to 45 mm)	0.5 to 3 inches (13 to 76 mm)	0.25 to 5 inches (6 to 127 mm)
<b>Cutoff Range</b>	2.3 inches (58 mm) & beyond	5 inches (127 mm) & beyond	---
<b>Field of View</b>	0.25 inch (6 mm) diameter at 2.25 inches (57 mm)	0.35 inch (9 mm) diameter at 5 inches (127 mm)	2 inch (50 mm) diameter at 5 inches (125 mm)

\* Nominal Range

**APPROXIMATE DIMENSIONS**



**Still Need Help?**  
 Contact the  
 Cutler-Hammer Sensor  
 Application Engineers  
**1-800-426-9184**  
 Fax: 425-513-5356

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