The EZ-Pro™ Smarteye® sensor is a high performance, automatic photoelectric sensor that can be adjusted by a single push of a button. As a result, there is no guess work on the part of the operator. Now you can throw away the screwdriver and the manual!

The EZ-Pro™ AUTOSET™ ADJUSTMENT PROCEDURE is as simple as it gets...

1. Establish one of the following conditions:
   - Proximity . . . . . . . . . .Reflect light off object.
   - Beam Break . . . . . . . . . .Remove object from light beam path.
2. Depress either yellow or blue button for three (3) seconds.

**NOTE:**
- Yellow button AUTOSET™ provides light “ON” output.
- Blue button AUTOSET™ provides dark “ON” output.

That’s all there is to it! From that point on, the sensor will automatically maintain a perfect setting, thanks to the dynamic Automatic Contrast Tracking System (ACT™). The EZ-Pro™ AUTOSET™ routine can also be implemented from a momentary remote switch. (I.E. pushbutton or touch screen). The EZ-Pro™ is equipped with a Contrast Indicator™ as well as an Action Alert diagnostic indicator that allows the operator to visually substantiate performance. When the lock feature is enabled (see advanced features), the EZ-Pro™ sensor is tamper proof. Now, the sensor will provide you with automatic, hassle-free performance that you expect from a Smarteye®.
**OPTION 1**

Preferred
Retroreflective beam break sensing mode is the preferred choice for detecting opaque objects.

**Sensing Range**

**Fiber Optic:** Fiber Tip to Reflector...Up to 2 ft.

**Lens:** Lens to Reflector...Up to 12 ft.

**AUTOSET™ INSTRUCTIONS**

1. Remove opaque object from light beam path.
2. Depress the **BLUE** button for 3 seconds.

**OPTION 2**

Alternate
Reflective/Proximity beam make mode is an excellent alternative choice when the sensing site precludes using the retroreflective mode.

**Sensing Range**  Dependent on size, shape, color and surface reflectivity.

**Fiber Optic:** Fiber Tip to Object...Up to 6 in.

**Lens:** Lens to Object...Up to 3 ft.

**AUTOSET™ INSTRUCTIONS**

1. Place object in the light beam path at it’s Maximum sensing range.
2. Position object with Darkest area facing light beam path.
3. Depress the **YELLOW** button for 3 seconds.
**OPTION 1**

Full or Empty Containers  
Proximity, beam make sensing mode is one method for detecting translucent or transparent objects.

**Sensing Range**  
Dependent on size, shape, color, and surface reflectivity.

**Fiber Optic:** Fiber Tip to Reflector...Up to 6 in.

**Lens:** Lens to Reflector...Up to 3 ft.

**AUTOSET™ INSTRUCTIONS**  
1. Place translucent/transparent object in the middle of the light beam path at its most distant location.
2. Depress the **YELLOW** button for 3 seconds.

**OPTION 2**

Empty Containers  
Retroreflective, beam break sensing mode is the preferred choice for detecting empty translucent or transparent objects.

**Sensing Range**  
Fiber Optic: Fiber Tip to Reflector...Up to 18 in.

**AUTOSET™ INSTRUCTIONS**  
1. Remove opaque object from light beam path.
2. Depress the **BLUE** button for 3 seconds.

**IMPORTANT NOTE:**

The AutoSet™ instructions as shown above, result in the triggering on the arrival of the leading edge of the object at the sensing site. To trigger on the departure of the trailing edge of the object from the sensing site, depress the opposite color AutoSet™ button for 3 seconds.
**DIAGNOSTICS**

The Smarteye® pro sensor is equipped with two important and useful diagnostic features. The first one is the 5 LED **Contrast Indicator**, which provides “at-a-glance” analysis of the sensor’s response to the light state vs. the dark state sensing conditions. This device is not only useful in static conditions for alignment purposes, but is also functional during dynamic conditions when input events are ongoing. The second important feature is the **Action Alert™** bright yellow indicator. This indicator will turn “on” whenever the highest “light state” reading, or the lowest “dark state” reading (as viewed on the contrast indicator) fails to exceed preset levels.

- The “light state” reading must exceed “4”
- The “dark state” reading must fail below “2”

Whenever the lightest or darkest light levels are unacceptable, the bright yellow LED indicator will be turned “on” when the light level passes through the sensor’s switch point of 3 on the contrast indicator. Both the contrast indicator and the Action Alert™ indicator can be viewed simultaneously during dynamic conditions when input events are ongoing.

**OUTPUT INDICATOR**

Red LED illuminates when output transistor is in the “on” state.

**ADVANCED OPTIONS**

See additional data sheet for details on how and when to use advanced options.
The EZ-Pro gives you a choice of 12 Interchangeable Optical Blocks.

**Quick Reference Guidelines**

<table>
<thead>
<tr>
<th>OPTICAL BLOCKS</th>
<th>IR</th>
<th>RED</th>
<th>BLUE</th>
<th>WHITE</th>
<th>OPTICAL BLOCKS</th>
<th>IR</th>
<th>RED</th>
<th>BLUE</th>
<th>WHITE</th>
<th>OPTICAL BLOCKS</th>
<th>RED</th>
<th>WHITE</th>
</tr>
</thead>
<tbody>
<tr>
<td>V4</td>
<td>1 IN</td>
<td>1 IN</td>
<td>1 IN</td>
<td>1 IN</td>
<td>F4</td>
<td>3 FT</td>
<td>1 FT</td>
<td>8 IN</td>
<td>5 IN</td>
<td>F6</td>
<td>9 IN</td>
<td>2 IN</td>
</tr>
<tr>
<td>V6</td>
<td>1.5 IN</td>
<td>1.5 IN</td>
<td>1.5 IN</td>
<td>1.5 IN</td>
<td>F4 w/lens</td>
<td>20+ FT</td>
<td>20+ FT</td>
<td>12 FT</td>
<td>9 FT</td>
<td>F6 w/lens</td>
<td>6 FT</td>
<td>2 FT</td>
</tr>
<tr>
<td>V8</td>
<td>0.5 IN</td>
<td>0.5 IN</td>
<td>0.5 IN</td>
<td>0.5 IN</td>
<td>F4 w/lens</td>
<td>20+ FT</td>
<td>20+ FT</td>
<td>12 FT</td>
<td>9 FT</td>
<td>F6 w/lens</td>
<td>6 FT</td>
<td>2 FT</td>
</tr>
<tr>
<td>O4</td>
<td>18 IN</td>
<td>11 IN</td>
<td>4 IN</td>
<td>3 IN</td>
<td>F6 w/right angle lens</td>
<td>3 FT</td>
<td>1 FT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O5</td>
<td>4 FT</td>
<td>3 FT</td>
<td>1.5 FT</td>
<td>12 IN</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>20+ FT</td>
<td>18+ FT</td>
<td>6 FT</td>
<td>5 FT</td>
<td>F4 w/lens</td>
<td>1 FT</td>
<td>1 FT</td>
<td>N/A</td>
<td>6 IN</td>
<td>F6 w/lens</td>
<td>1 FT</td>
<td>1 FT</td>
</tr>
<tr>
<td>R5</td>
<td>N/A</td>
<td>7 FT</td>
<td>4 FT</td>
<td>3 FT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:** Proximity test utilized a 90% reflective white target. Retroreflective tests utilized a 3in. dia. round reflector, Model AR-3

**NOTE:** Range tests utilized a .125in. dia. fiber bundle

**NOTE:** Range tests utilized a .040in. dia. fiber

**OPTICAL BLOCKS / ACCESSORIES**

O4 and O5 - Proximity Sensing
V4, V6, and V8 - Convergent Sensing
R4 and R5 - Retroreflective Sensing
F4 and F6 - Fiber Optic Sensing
Gap Probe - Slot or Thru-Beam Sensing

**ACCESSORIES**
- Mounting Bracket
  - P/N SEB-3
- Power Cables
  - Standard
    - GSEC-6 (6 ft. Cable)
    - GSEC-15 (15 ft. Cable)
    - GSEC-25 (25 ft. Cable)
  - Right Angle
    - GRSEC-6 (6 ft. Cable)
    - GRSEC-15 (15 ft. Cable)
    - GRSEC-25 (25 ft. Cable)
**SPECIFICATIONS**

**SUPPLY VOLTAGE**
- 10 to 30 VDC
- Polarity Protected

**CURRENT REQUIREMENTS**
- 45 milliamps (exclusive of load)

**OUTPUT TRANSISTORS**
- (1) NPN and (1) PNP sensor output transistors
- Sensor outputs can sink or source up to 150 milliamps (current limited)
- All outputs are continuously short circuit protected
- Action Alert PNP transistor source up to 75 milliamps

**REMOTE AUTO-SET INPUT**
- Opto isolated momentary sinking input (10 milliamps)

**RESPONSE TIME**
- Light state response = 300 microseconds
- Dark state response = 300 microseconds

**LED LIGHT SOURCE**
- Infrared = 880 NM, Red = 660 NM, Blue = 480 NM, White = Broadband Color Spectrum
- Pulse modulated

**PUSH BUTTON CONTROL**
- Automatic set-up routines, i.e., QuickSet™/AutoSet™
- Manual Adjustments
- Set status of 5 options: 5) Lock, 4) AutoTrac™, 3) 10ms, 2) 25ms, and 1) 50ms (Options 1-3 are Timer Functions)

**HYSTERESIS**
- Set for high resolution … less than one bar on the contrast indicator

**LIGHT IMMUNITY**
- Responds to sensor’s pulsed modulated light source … immune to most ambient light, including indirect sunlight

**INDICATORS**
- 5-LED Bargraph functions in one of two modes:
  1. Contrast Indicator … Displays scaled reading of sensor’s response to contrasting light levels (light to dark)
  2. Status Indicator … Displays status of 5 selectable options
  - Red LED output indicator … Illuminates when the sensor’s output transistors are "on"
  - Amber LED … Illuminates when in the options select mode
  - Yellow LED … Illuminates when action alert is activated
  Also indicates when ACT™ adjusts sensor

**AMBIENT TEMPERATURE**
- –40°C to 70°C (-40°F to 158°F)

**RUGGED CONSTRUCTION**
- Chemical resistant high impact polycarbonate housing
- Waterproof, ratings: NEMA 4X, 6P and IP67
- Conforms to heavy industry grade CE requirements

Product subject to change without notice.

**DIMENSIONS**

**WIRING DIAGRAM**

**MOUNTING OPTIONS**

P/N SEB-3
Optional Mounting Bracket With Hardware

Proudly made in the U.S.A. by Tri-Tronics®

P.O. Box 25135, Tampa, FL 33622-5135
TEL: (813) 886-4000 / TOLL FREE: (800) 237-0946
FAX: (813) 884-8818 / TOLL FREE: (800) 375-8861
http://www.ttco.com / E-MAIL: info@ttco.com

070-0127
**Advanced Options**

The SmartEye® EZ-PRO™ is equipped with the following 3 optional features that can help to adapt the sensor to specific application requirements.

**Lock**  
When this feature is enabled the sensor becomes tamper proof.

**ACT™** (Automatic Contrast Tracking) - When this feature is enabled the sensor will automatically track with a variety of changing conditions by adjusting itself during normal operation.

**Timer**  
When this “off” delay timer is enabled, the output duration is extended by 10, 25, or 50 miliseconds. This timing function helps to prevent erratic triggering of the printer.

---

### DISPLAY STATUS OF SELECTABLE OPTIONS

Press and hold both Blue and Yellow buttons simultaneously for 3 seconds. The 5-LED bargraph will go into a flashing routine. When completed, the 5-LED bargraph will switch from functioning as a contrast indicator to a status indicator. Now the status of the selectable options will be displayed and the amber LED option status indicator will be lit.

### SELECT OPTION TO BE ALTERED

Step to the desired function to be toggled to the opposite state by “tapping” the Blue button. The first “tap” will step to the “lock” select function. To indicate the “lock” function has been selected, the #5 LED will blink. The next “tap” will step the blinking of the indicator to the #4 LED. Another “tap” of the Blue button will step the blinking of the indicator to the #3 LED. Another “tap” to the #2 LED and, finally, the fifth “tap” will select the #1 LED. Once the blinking LED is next to the option to be changed, depress the Yellow button to enter your choice into memory. The sensor will then display the choice briefly before returning to normal operation. **This sequence must be repeated for each function to be altered.** If there is no change in the status of any of the control functions, tap the Blue button a sixth time or wait 5 seconds and allow the sensor to automatically return to normal operation.

---

<table>
<thead>
<tr>
<th>LED</th>
<th>FEATURE</th>
<th>On/Off</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5 LED</td>
<td>Lock</td>
<td>On</td>
<td>The manual up/down and Auto-Set™ adjustments are disabled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off</td>
<td>Manual adjustments are enabled.</td>
</tr>
<tr>
<td>#4 LED</td>
<td>ACT™</td>
<td>On</td>
<td>ACT™ is enabled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off</td>
<td>ACT™ is disabled.</td>
</tr>
<tr>
<td>#3 LED</td>
<td>10ms Timer</td>
<td>On</td>
<td>10ms Timer/Pulse Stretcher is enabled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off</td>
<td>10ms Timer/Pulse Stretcher is disabled.</td>
</tr>
<tr>
<td>#2 LED</td>
<td>25ms Timer</td>
<td>On</td>
<td>25ms Timer/Pulse Stretcher is enabled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off</td>
<td>25ms Timer/Pulse Stretcher is disabled.</td>
</tr>
<tr>
<td>#1 LED</td>
<td>50ms Timer</td>
<td>On</td>
<td>50ms Timer/Pulse Stretcher is enabled.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Off</td>
<td>50ms Timer/Pulse Stretcher is disabled.</td>
</tr>
</tbody>
</table>
FACTORY PRESET OPTION MENU

<table>
<thead>
<tr>
<th>LED</th>
<th>FEATURE</th>
<th>On/Off</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>#5</td>
<td>Lock</td>
<td>Off</td>
<td>Lock disabled, Manual and Auto-Set™ adjustments are enabled.</td>
</tr>
<tr>
<td>#4</td>
<td>ACT™</td>
<td>Off</td>
<td>ACT™ is disabled.</td>
</tr>
<tr>
<td>#3</td>
<td>10ms Timer</td>
<td>Off</td>
<td>10ms Timer/Pulse Stretcher is disabled.</td>
</tr>
<tr>
<td>#2</td>
<td>25ms Timer</td>
<td>Off</td>
<td>25ms Timer/Pulse Stretcher is disabled.</td>
</tr>
<tr>
<td>#1</td>
<td>50ms Timer</td>
<td>Off</td>
<td>50ms Timer/Pulse Stretcher is disabled.</td>
</tr>
</tbody>
</table>

LOCK FUNCTION

When enabled (#5 LED lit), the Blue (down) and Yellow (up), manual and Auto-Set™ commands will be disabled. This will provide tamper-proof operation. To toggle the lock function to the opposite state, hold in the both buttons for 3 seconds. Then, tap the Blue button once. The #5 LED should be blinking. Now, push and hold the Yellow button for one second.

ACT™ (AUTOMATIC CONTRAST TRACKING)

When enabled (#4 LED lit), the sensor will automatically track with a variety of changing conditions by adjusting itself during normal operation. For example, the sensor will continue to maintain the proper setting to compensate for changing detrimental conditions:

1. Lens or reflector contamination.
2. Scratched or damaged lens.
4. LED light source or thermal drift.
5. Target variations such as position, orientation or color.
6. Diminishing contrast deviation/shift caused by high speed events, particularly when input duty cycles are severely offset.

The dynamic adjustments of the sensor maintains excess gain and contrast deviation. As automatic adjustments occur, there will be an occasional flash of the bright yellow action alert indicator.

Note: On rare occasions (usually associated with low contrast sensing or product inspection applications) the ACT™ self-adjusting may have to be disabled.

TIMER FUNCTION

The optional “Pulse Stretcher” timer can be activated to help prevent false triggering of the printer in difficult sensing applications. The timer will extend the sensors output duration by either 10, 25, or 50 milliseconds. (not additive) Therefore the time duration of the gap between objects must be less than the timers duration. There are 3 selectable time durations which can be enabled only one at a time. They can be activated by toggling LED #3, #4, or #5. (Note selectable options as listed above)

Important: When triggering off trailing edge of object, the timer must be disabled.
**FUNDAMENTALS OF PHOTOELECTRIC SENSING**

**Introduction**

Today's photoelectric sensor is one of the most versatile non-contact sensing devices known to man. The reliability of photoelectric “eyes” or “sensors” took a giant leap forward in the early 1970s when the light emitting diode (LED) replaced the fragile incandescent light source.

This solid-state light source also enables the designer to eliminate most problems previously caused by ambient room light. Modern pulse modulated photoelectric sensors respond only to the light emitted by their own light source. This capability allows the sensor to be very sensitive and responsive to small light changes that occur to the light beam path between the light source lens and the receiving lens.

For an object to be detected, it must affect the intensity of the light beam reaching the sensor’s light detector in one of two ways.

- The object must break or diminish an existing light beam path between the light source lens and receiver lens (beam break mode).
- The object itself must diffuse or reflect the light beam to the receiving lens (beam make mode).

One sure way to simplify the selection of a photoelectric sensor to fit your application is to remember that you only have two choices ... beam make or beam break.

---

**Contrasting Light Levels**

The sensing task of any digital switching photoelectric sensor is to respond to and resolve the difference between the contrasting light levels and switch its output accordingly.

When operating in the beam break mode, the intensity of the light beam reaching the receiving lens is in its brightest or lightest state condition before an object is introduced into the light beam path. Introducing an object into the light beam path will block out, or diminish, the intensity of the received light beam, resulting in the darkest state condition.

In the beam make mode, the darkest state condition is before an object is placed in the light beam path. The lightest state condition is when an object is introduced into the light beam path so as to bounce, or reflect the light beam to the receiving lens.

The amount of difference or deviation of the intensity of the light beam in its lightest state condition vs. the intensity of the received light beam in the darkest state is called “contrast.”

These contrasting light levels define the degree of difficulty of the sensing task. In real estate, it is well known that the three most important considerations are location, location, location. In photoelectric sensing, the three most important considerations are contrast, contrast, contrast.

---

**Beam Break Mode**

**Beam Make Mode**
Beam Break Sensing

Opposed Mode

In this mode of sensing, two separate devices are utilized. • One unit is the light beam source. • The other is the light beam receiving device.

In this mode, the light source lens focuses a beam of light across the detection path to the lens of the receiving unit. Detection occurs when an object interrupts, or sufficiently diminishes, the intensity of the received light beam. Unfortunately, this mode of sensing is often overlooked as a result of the initial cost of purchasing and installing two separate units and the sometimes tedious task of alignment. However, the opposed mode of sensing has distinct advantages when detecting opaque products. It provides the most reliable sensing method under very adverse conditions, such as dusty, dirty and moisture-laden environments.

Remember . . . when opaque, go beam break.

Typical Applications

1. Detection of very small objects.

2. Detection of an object’s precise location.

3. Detection of fill levels in containers.

4. Detection of opaque objects.

5. Detection of splices or overlapped materials.

6. High power light source/receiver detect container contents.
The retroreflective sensor contains both the light source and receiving device in one housing. A unique dual lens system establishes the transmitted light beam path and the returned light beam path on the same axis. When a retroreflective sensor is pointed or aimed at a reflector, the light beam is reflected back to the receiving lens. Sensor alignment with a prismatic reflector can be skewed by 10 to 15 degrees and, still a strong light beam will return to the receiving lens on exactly the same axis as the original transmitted light beam.

To detect presence or absence of objects, the light beam path is directed across the detection path so that passing opaque objects interrupt the light beam. When the light beam is broken, or when the intensity of the received light beam is reduced below a threshold level, the sensor responds by switching its output.

The effective beam width is controlled largely by the diameter of the reflector and, therefore, retroreflective sensing is not recommended for small parts detection. The retroreflective sensor is generally low in cost and easy to install.

However, care must be taken to ensure that shiny objects passing near the sensor do not reflect a light beam off the surface of the object strong enough to accidentally switch the sensor’s output. This undesirable characteristic of the retroreflective sensor is referred to as proxing. To prevent proxing, the sensor’s light beam can be aligned on an angle of incidence that reflects the light beam away from the receiving lens. Another way to reduce proxing is to polarize the light beam. Polarized light helps to ensure that only the light beam reflected off the prismatic reflector reaches the sensor’s receiver. While reducing the response to light reflected off the surface of the sensed object, polarizing reduces sensing range.

In the past, the retroreflective sensor has been the most cost-effective sensor used to detect opaque objects. However, recently things have changed! Now, thanks to the SMART EYES®, equipped with a unique high intensity blue LED light source, totally transparent plastic or glass containers can also be detected. The retroreflective beam break sensing mode has now been transformed into one of the most versatile methods of noncontact sensing.

**Typical Applications**

1. Detection of large objects.

5. Detection of reflective tape moving at high rapidity.

4. Use high performance retroreflective sensor for sensing a transparent glass or plastic product, from leading edge to trailing edge.

2. Use high performance retroreflective sensor for sensing a transparent glass or plastic product, from leading edge to trailing edge.

5. Fiber optic retroreflective detection of moving objects.

3. Detection of objects moving at high velocity.

6. Beam break detection of objects at sensing sites where mounting space is limited.
Optical proximity sensors contain both the light beam source and the light beam receiving device in one common housing. The light source lens shapes the light beam into a diverging column of light that, with distance, increases in width and decreases in intensity. A wide angle receiving lens is used to collect the reflected light beam off the surface of the object to be detected.

It is often difficult, if not impossible, to access both sides of the detection path of objects moving past the sensing site. When this circumstance occurs, the beam make mode of sensing is the only choice. For example, when attempting to detect each item in a row of objects resting on a common conveyor belt, the proximity sensor is recommended. In this situation, the proximity sensor must resolve the difference between the contrasting light levels reflecting off the object vs. light reflecting off the conveyor belt.

The suppression of light reflecting off shiny objects in the background can be enhanced by proper positioning of the sensor. If the angle of incidence to the reflected light beam is adjusted so that the light beam path does not return to the receiving lens, the proximity sensor will only respond to the light diffusing, or reflecting off the object itself.

Unfortunately, there are many situations when the intensity of the light reflected off the object is not much different from the intensity of light reflected off background objects. In applications when the differential between these contrasting light levels are minimal, a high performance sensor, equipped with high gain amplifiers and the contrast indicator are recommended. As a result of the diverging light beam, it is sometimes necessary for small objects to be as near as a few inches to the receiving lens to be detected. Larger objects can be detected at a distance of up to 6 feet or more in this mode.

Typical Applications

1. Detection of multiple objects on common conveyor systems.

2. Detection of web of material.

3. Detection of translucent objects.

4. Detection of identifying features of object for orientation.

5. Detection of the fill level of the contents of a container.

6. Detection of unwanted condition for product inspection task.
Beam Make Sensing
Convergent (“V” Axis) Mode

The convergent mode of beam make sensing is very similar to the proximity mode. The convergent beam sensor, like the proximity sensor, responds to a light beam path that reflects off the surface of the object. However, the lensing system of a convergent (also referred to as “V”axis) sensor converges the light beam into a small spot of light at a distance of a few inches, precisely at the receiving lens focal point. Using this technique provides an effective method of enhancing background light suppression, while directing, by reflection, a very strong light beam on a direct path to the receiving lens. In addition to improving background light suppression, convergent sensing is very useful for small parts detection and for detection of printed identification data.

Typical Applications

1. Detection of small parts.
2. Detection of fill level in container.
3. Detection of object when background light suppression is required.
4. Detection of printed registration marks.
5. Detection of condition for product inspection task.
6. Detection of object moving at high speed.
Fiber Optic Light Guides

“The guiding light of photoelectric sensing.”

Shine a flashlight into one end of either a flexible plastic or glass fiber optic light guide, and you will see light coming out the other end. This ability to guide light from one place to another provides many advantages when applied to industrial photoelectric sensing.

The light guides are flexible and small enough to fit into difficult sensing sites. They are resistant to high temperatures, vibration, condensation and corrosion. They allow the sensor to be located at a remote, convenient location... out of harm's way.

One of the main advantages of glass fiber optic light guides is that they can be sized and shaped to provide optical advantages. When fiber optic light guides are utilized, they become the optics of the sensing system.

At the sensing site, the size and shape of the fiber optic bundle carrying the light controls the size and shape of the transmitted light beam. The size and shape of the fiber optic bundle receiving the light beam controls the effective viewing area of the sensing system. Optional lenses are available to provide additional control of the transmitted and received light beams. All modes of both beam make and beam break sensing are adaptable to fiber optic sensing.
Another very important factor in the selection of a photoelectric sensor is the sensor's ability to resolve input events occurring at rapid rates. Unfortunately, response time specifications provided by most photoelectric sensor manufacturers are sometimes vague or, at best, difficult to interpret. It should be noted that there is a difference between response time and operating speed.

**Response time** is the length of time it takes for the output of the sensor to switch when a change from the lightest state to the darkest state (or vice versa) occurs. This can be important when attempting to locate the exact position of an object moving at a high velocity.

**Operating speed** is the maximum output switching rate the sensor can achieve. This rating is usually expressed by the maximum rate of input events that can be resolved under set conditions.

These conditions generally involve input events that are equally spaced apart, i.e., the length of time the sensor will be in the dark state condition is equal to the length of time in the light state condition. This is referred to as a 50-50 duty cycle. If the duty cycle of the input events is other than 50-50, attention should focus on the minimum duration of time the input event will spend in either the light state or the dark state condition.

The shortest duration of time spent in either state should then be compared with the minimum light state/dark state response times as stipulated in the sensor's specifications.

A word to the wise: Beware, you cannot expect the sensor to achieve the specified minimum response time or maximum operating speeds under all sensing conditions without making some adjustments to either the gain or offset settings.

### Speed Conversion Table

<table>
<thead>
<tr>
<th>Ft/Min</th>
<th>In/Min</th>
<th>In/Sec</th>
<th>Sec/In</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12</td>
<td>.2</td>
<td>5.000</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>.4</td>
<td>2.500</td>
</tr>
<tr>
<td>3</td>
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**EXAMPLE:** Determine the time a .25-inch registration mark remains totally in view of a sensor when traveling at 300 feet/min. and the sensor’s effective beam width is .062 inch.

**ANSWER:** .25-inch mark width - .062-inch beam width = .188-inch travel distance.
Using above table, a 1-inch travel distance at 300 feet/min. = .0167 sec/in. .188 inch x .0167 sec/in. = 3 milliseconds.
Range

The sensing range specification provided by sensor manufacturers is typically the maximum absolute sensing range under ideal circumstances.

In the opposed mode of sensing, maximum range is defined as the absolute maximum distance allowable between the light source and the receiver.

In the retroreflective mode of sensing, it is the absolute maximum distance between the sensor and the prismatic reflector.

In the proximity mode of sensing, the maximum range is the absolute maximum distance between the sensor and the sensed object.

However, these maximum sensing range specifications are for reference only. That is because these range specifications are taken under ideal conditions, with clean lenses and in very clean environments. These conditions are not found in the vast majority of industrial applications.

Many manufacturers supply “excess gain” charts that plot range vs. signal strength obtained above the necessary level to trip the output of the sensor. These charts are plotted with the gain adjustments at maximum.

In the beam break mode, the simulated target, or object, is larger than the effective light beam and is always opaque.

When operating in the retroreflective mode, there is no way to obtain the effect of light reflecting off the sensed object.

In the beam make mode, the object is larger than the effective light beam, perfectly flat and has a 90% reflective white surface. In addition, in the beam make mode, there is no way to obtain the effect of light reflecting off background objects from excess gain charts.

In summary, excess gain charts totally ignore signal strength generated by the dark state condition.
TRI-TRONICS’ unique CONTRAST INDICATOR provides actual signal strength indications that provide for perfect alignment by ascertaining actual response to the intensity of the received light. TRI-TRONICS sensors equipped with CONTRAST INDICATORS provide an instantaneous real time indication of the received light intensity at any range.

Contrast signal deviation charts are available on all sensors equipped with the CONTRAST INDICATOR. These charts are extremely helpful in determining if the sensor you have selected will adequately perform your particular sensing task at the desired range. Simply reference the amount of contrast deviation required to perform the sensing task in your environment, and compare it to the performance chart of the sensor you have selected to determine if the sensing range is adequate.

For TRI-TRONICS sensors not equipped with CONTRAST INDICATORS, range guidelines charts are available that indicate recommended maximum sensing ranges. To estimate useful range in your environment, simply decrease the specified maximum range by the percentage indicated in the following table.

### Environmental Considerations:
Sensing site environmental conditions should always be considered when selecting the appropriate TRI-TRONICS sensor to fit your application. All TRI-TRONICS products are designed into enclosures or housings that provide varying degrees of protection against special environmental conditions. The accompanying table lists the NEMA and IEC/IP Standards that apply to the TRI-TRONICS sensor and control enclosures.

#### NEMA TYPE 1
Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling dirt.

#### NEMA TYPE 2
Enclosures are intended for indoor use primarily to provide a degree of protection against limited amounts of falling water and dirt.

#### NEMA TYPE 4
Enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against wind-blown dust and rain, splashing water, and hose-directed water; and damage from external ice formation.

#### NEMA4X
Same as type 4 except includes protection against corrosion.

#### IEC/IP66
Enclosures are dust tight and protected against powerful water jets.

#### IEC/IP67
Enclosures are dust tight and protected against the effects of temporary immersion in water.

### Guidelines for Determining Useful Range

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<td>Dirty</td>
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<tr>
<td>Very Dirty</td>
<td>-40%</td>
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**Example: Model MDIR4 (Retroreflective)**

If the maximum range of a retroreflective sensor is rated at 20 feet and your sensing site environment is dirty, the specified maximum range would decrease by 30%, to a useful range of 14 feet.
The pulse modulated photoelectric sensor is designed to respond only to its own light source while ignoring ambient light. Preferred color perception of the sensor is controlled by the color of the LED light source.

Solid state light emitting diodes are available in several different colors, such as white, red, green, blue and infrared. Variable “shades” of colored visible light emitting diodes (LEDs) provide an extended choice for the light source of a pulsed photoelectric sensor. Selecting a color for the LED light source provides the same advantage as choosing a very selective colored filter for narrowing the response of the photoelectric sensor to a specific color. Narrowing the response of a photoelectric sensor to a specific color provides obvious advantages when color perception is required.

White Light SMARTYE® COLORMARK™II

The White LED Light Source in our Model CMSWL SMARTYE® is the best choice for detecting the widest variety of colored registration marks on today’s packing material. White Light enhances performance when detecting dark-colored registration marks on dark-colored webs of materials. In addition, there are COLORMARK sensors equipped with RED, GREEN, or BLUE LED light sources. They are useful in rare applications when the preferred White Light Source fails to perform; i.e., a Blue LED light source is recommended to detect pale yellow marks on a white background.

Color Registration Mark Sensing

One example where color perception is a must is detecting registration marks printed in a wide variety of colors on packaging materials. Imagine yourself viewing a printed red mark on white paper stock. The red mark looks dark in contrast to the white paper. Now, imagine placing a red transparent filter in front of your eye while trying to view that same red mark. The red mark now becomes difficult, if not impossible, to see. If the sensor is equipped with a red LED, the sensor would have the same problem. Now, imagine yourself viewing that same red mark through a green filter. The white background now appears bright green, but the red mark appears black or very dark. That’s the contrast we are looking for!

Equipping the sensor with a green LED provides the sensor with the same advantage as the green filter did for your eye. Now, the red mark provides more than adequate response to the contrasting light reflecting off the white background.

Other Color Perception Tasks

The SMARTYE MARK II Series and VISIONEYE sensors are required for use in object sensing tasks when a difference in color is the only distinguishable feature. An example of an application where color perception is extremely useful in object sensing is identifying the contents of a container by the mere color of its cap. Please note that not all similar shades of the same color can be resolved; however, many can.

TRI-TRONICS sensors designed for color perception are all equipped with high gain amplifiers and the CONTRAST INDICATOR. They are capable of sensing differences in the color of objects introduced into the light beam path. The resulting signal level deviation is then amplified to a useful level and displayed on the 10 LED CONTRAST INDICATOR. Whenever a color perception task is presented to a TRI-TRONICS SMARTYE MARK II or VISIONEYE sensor, the CONTRAST INDICATOR eliminates all the guesswork.