TEN TIPS FOR SELECTING AND USING A BACKGROUND SUPPRESSION PHOTOELECTRIC SENSOR

TECHNOLOGY BRIEF

Photoelectric sensing in the past decade has undergone a steady trend in which older, conventional sensors are replaced by sensors utilizing an innovative technology called background suppression. Background suppression, otherwise called BGS, is a more efficient method of sensing that doesn't rely on ***how much*** light is reflected to the sensor's light-sensitive receiver, but rather on ***where*** the light is reflected on the receiver.

This endows BGS with certain unique sensing capabilities. The most obvious is its ability to disregard machine panels, belt conveyors, or other materials behind what is to be sensed. It also consistently senses objects regardless of color or reflectivity, so glossy Mylar™ is detected similarly to brown corrugated cardboard or even black matte painted surfaces. BGS is able to precisely detect leading edges and small items, such as springs or screws. And lastly, BGS sensors simplify sensing by removing the cost and clutter of reflectors and two-housing thru-beam arrangements.

Selecting and setting up the best BGS sensor for an application doesn't have to be difficult if a few key points are kept in mind.

1. **Infrared has better performance than visible red**
   When selecting a BGS sensor, using one with an infrared (or IR) light source always results in superior sensing performance over a sensor with a visible red light source. Sensors with IR emitters have higher power and lower color sensitivity (see Figure 1) than their visible red counterparts. This means they can be used at greater sensing distances and sense different objects more consistently. IR emitters are more efficient and can be driven with higher current pulses compared to visible red versions. The best sensing performance in background suppression is accomplished with fixed-range, short sensing distance sensors with IR emitters.

   In fact, the only advantage to using a visible red emitter is when a visible light spot is needed to align the object to be detected. Alignment can be more desirable than sensing performance in some applications, especially if the item to be sensed is small or is sensed through an aperture.

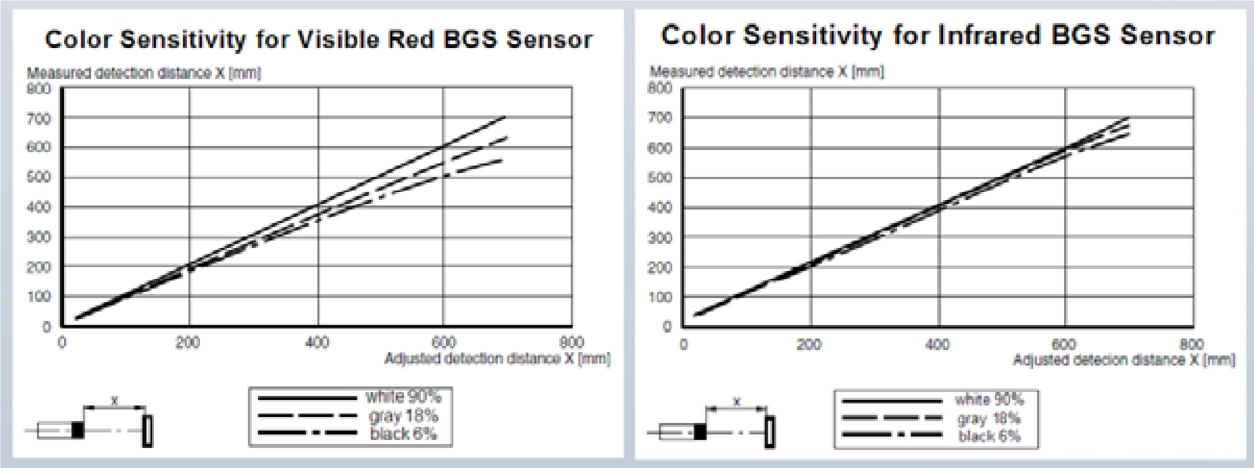

Figure 1: Effect of Object Color on Sensing Distance
The left chart shows the adjusted detection distance compared to the actual sensing distance for white, gray, and black objects using a BGS sensor with a visible red light source. Note that at an adjusted distance of 700 mm, the measured sensing distance varies by ~150 mm depending on what color is present. The right chart shows the same for a BGS sensor with an infrared source. This results in a variation in sensing distance by color that can be just one-third that of visible red versions at the same distance.

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2. **A fixed background is better than no background**
   BGS sensors are designed to compare two signals: light reflected from near objects (such as the material being sensed) and light reflected from far objects (namely, the background).
   When a defined signal from a fixed background is present, it minimizes the effect of disturbances in the application, such as dust particles collecting on the lens of the sensor in a dirty environment. The reflected signal from the background is easier to see and compare as opposed to no reflected signal if there is no background object present.

3. **No background is best for detecting small objects**
   Equally important, a BGS sensor should always be selected so its light spot is smaller than the objects it will detect. This is for good reason, as if the sensor's light spot isn't completely covered by the object, then the object reflects some of the sensor's light, but a background material can reflect the remainder of it. And because the sensor determines object presence based on a comparison of reflected light from the near field and far field, it is possible for a small object to not be seen if the sensor's light spot does not cover enough of the object.

   BGS sensors are available with laser light spots or fine focal points to detect items that are as small as just a few millimeters in size.

4. **Tilting the sensor at a slight angle is best to sense shiny objects**
   Especially when sensing a highly reflective material such as glossy packaging or a Mylar web, it is best to position the BGS sensor so its optical axis is ~5° off perpendicular to the detection plane. In scenario (a) of Figure 2, a very reflective object can result in glaring or blinding in which the reflected light beam floods the receiver and covers both receiver elements. But mounting the sensor with the slight angle shown in (b) reduces the glaring reflection considerably so the object can be detected.

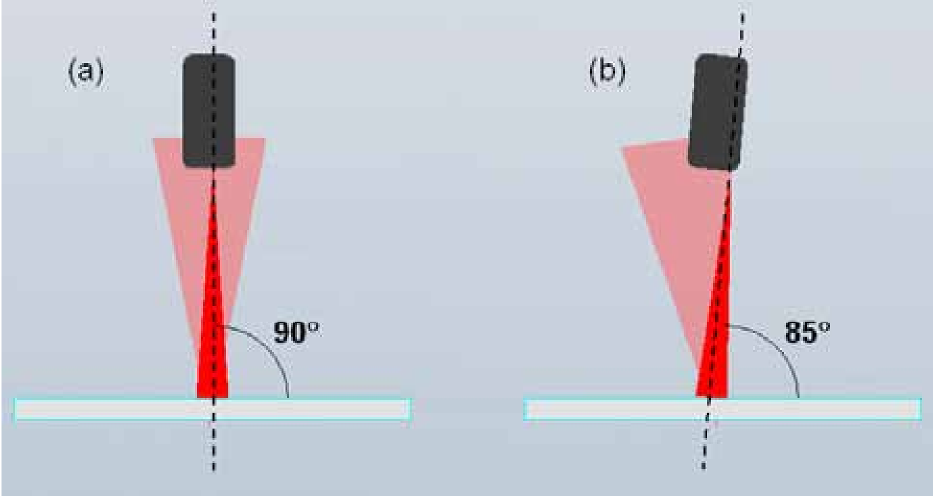

Figure 2: Effect of angular position of BGS sensor
Caption for Figure 2: (a) A BGS sensor is aimed directly at a reflective object. Note its optical axis is at right angles to the object being detected. The reflective object reflects the light directly to the sensor's receiver, which can cause the sensor's receiver to go into saturation. In (b), a slight 5° angle is enough to minimize this glare so the sensor can discern object presence. (Not to scale.)

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5. **Adjust or mount a BGS sensor from the background, not the object**
After a BGS sensor has been selected and is installed in the application, it may be necessary to adjust its sensitivity so that the object to be sensed is in the detection field and the background is beyond the maximum sensing distance. This is normally accomplished using a potentiometer on the sensor housing: turning it clockwise effectively increases the distance from the sensor where it detects objects and turning it counter-clockwise decreases this distance.

A common mistake is to place an object to be detected in front of the sensor and adjust its sensitivity just to the point where that object is sensed. But because there is a slight difference in sensing distances based on color (refer to Figure 1), it is possible that a darker object could not be detected.

Instead, it is best to adjust the sensitivity to the background rather than to the object. This allows the greatest range of object colors to be repeatably detected. That means turning the potentiometer until the background is sensed, then turning it slightly in the opposite direction until the background is not sensed. For tamperproof models with no adjustment, adjusting the potentiometer is replaced by physically positioning the sensor relative to the object.

6. **Movement direction can be a factor in how BGS detects**
Although a less common occurrence, the direction an object travels through the sensing field of a BGS sensor can determine if it is detected. Three simultaneous conditions could result in a brief moment where the object is not sensed. The object must (a.) move in the plane directly at the sensing threshold, (b.) have a high contrast pattern (such as black-white), and (c.) move parallel to the emitter-to-receiver axis. With these conditions, a BGS sensor may not detect the object. This is because the sensor's light spot straddles the high contrast such that the dark portion reflects less to the near element receiver compared to what the light portion reflects to the far element receiver. Turning the sensor or object by 90° or moving the object closer to the sensor remedies this occurrence (which is called the Pepita effect.)

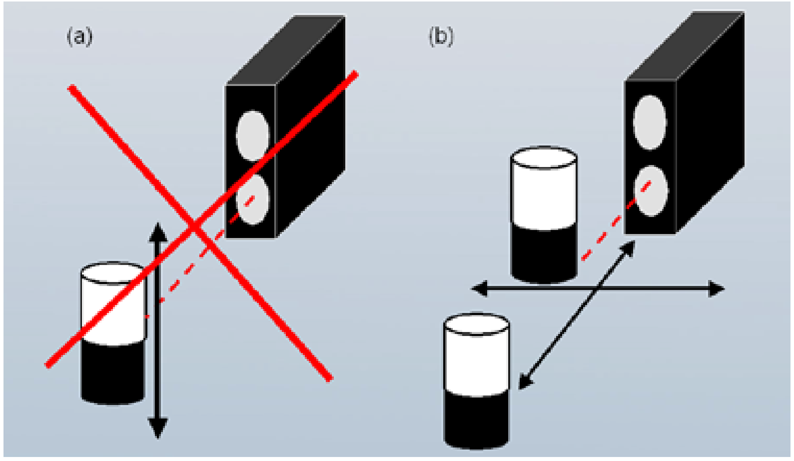

Figure 3: Object movement direction with BGS sensor
If a high-contrast object, such as the white-black cylinder depicted in this image, is to be detected at the sensing threshold, the sensor should be positioned in a specific way. (a) It should not move parallel to the axis that the emitter and receiver lenses are located. (b) It should move in another axis, either toward or away from the sensor or perpendicular to the emitter and receiver axis.

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7. **BGS sensors optically "burn through" many transparent media**
   By design, a BGS sensor has a small light spot size compared to conventional sensors. The smaller the light spot, the more likely it is to pass through ¾ rather than be reflected from ¾ a clear or transparent object, like shrink-wrap. This can be called optical "burn-through." As such, BGS sensing is not optimized to always detect transparent objects. Instead, a wide-beam diffuse or a retroreflective sensor specifically designed for clear object detection are the best methods of sensing transparent films, wraps, glass, and other objects.

   On the other hand, BGS sensors can often be used when mounted directly against a clear Plexiglas™ or glass shield to detect an object on the other side.

8. **BGS sensors are not contrast sensors**
   While excellent at precise detection with sharply defined sensing ranges, BGS sensors are, by design, not for contrast sensing. A contrast sensor is a different type of sensor that is used to detect differences in colors, such as when sensing registration marks on a web to trigger a cut. In fact, BGS sensors are closer to polar opposite of contrast sensors, as the former are intentionally designed to detect variously colored objects, from totes to papers to circuit boards, at a similar distance.

9. **Hysteresis < black-white difference < maximum sensing distance**
   A helpful rule of thumb for BGS sensors is the relationship between some of their specifications. Hysteresis is the difference between the distance at which an approaching object is seen and the distance that a retreating object is no longer seen. Hysteresis is typically very tight for BGS sensors. The black-white difference is the difference between the maximum distance at which a black test object is sensed and the distance at which a white test object is sensed. It is a good indication of the sensor's sensitivity to colors. And the maximum sensing distance is the distance beyond which no objects are detected. Hysteresis is typically smaller than black-white difference, which are both smaller than the maximum sensing distance.

10. **Be aware of not only maximum sensing distance, but also minimum**
    While the specification of the maximum distance that a BGS sensor can see an item is certainly important, it may be easy to overlook the specification of the minimum sensing distance. Generally, the minimum sensing distance, also called blind range, is only a few millimeters to a few centimeters. For applications that require sensing up to the face of the sensor, a related technology called background evaluation may be a better alternative.

Background suppression remains one of the fastest-growing segments of photoelectric sensing. Keeping these tips in mind can optimize this technology for any application.

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