Technical Data

Original Instructions

Photoelectric Sensors

Bulletins 42AF, 42CA, 42CE, 42CF, 42CM, 42CS, 42EA, 42G, 42JB, 42KL

Photoelectric sensors are used in many applications and industries to provide accurate detection of objects without physical contact.

In its most basic form, a photoelectric sensor can be thought of as a limit switch-like device, where a beam of light replaces the mechanical actuator or lever arm function.

Photoelectric sensors operate by sensing a change in the amount of light that an object to be detected (target) either reflects or blocks. The change in light could be the result of the presence or absence of the target, or as the result in a change of the size, shape, reflectivity, or color of a target.

A photoelectric sensor can be used in applications to sense targets at distances from less than 5 mm (0.2 in.) to over 250 m (820 ft).

Successful sensing with a photoelectric sensor requires that the object to be detected (target) causes a sufficient change of light level that the sensor detects and that you have a clear understanding of the sensing requirements.

The following must be clearly understood:

- The sensing requirements.
- The sensing environment.
- The capabilities and limitations of the photoelectric sensor.

Be prepared to answer the following questions:

- What is the size, shape and/or opacity of the object to be detected?
- Does the object to be detected have any reflective properties?
- What response time is required of the sensor?
- What mounting configuration is required for the sensor? Are there position or physical restraints to consider?
- What is the frequency of operation and what requirement does the operating rate impose on the output device?
- What are the load requirements, such as voltage, current, load impedance?
- What voltage and current supply are available to operate the sensor?
- What is the ambient temperature that surrounds the photoelectric sensor?
- Are there other environmental conditions such as dirt or high humidity that are unique to the area that surrounds the photoelectric sensor?

There are a vast number of photoelectric sensors to choose from. Each offers a unique combination of sensing performance, output characteristics, and mounting options. Many sensors also offer unique embedded logic or device networking capabilities.

This introduction helps you select the optimal photoelectric sensor for each application.

Terminology

Term	Definition
AC Coupled Amplifier	An amplifier in which only pulsed (AC) signals are amplified and direct (DC) signals are ignored. (Direct signals generated by sunlight, heat sources and other.
Alignment	The positioning of light source and receiver, reflector, or target in which a maximum signal strength is obtained.
Ambient Light	Illumination of a receiver that its light source does not generate.
Analog	Electronic circuit with a current or voltage output signal that varies as a function of the light intensity received by the photodetector.
Angstrom	A unit of measurement that is used to determine the wavelength of light. 10 Angstrom (A) equals 1 nanometer (nm)
Attenuation	The reduction of signal strength. An example is when light travels through a fiber-optic cable. The degree of attenuation depends on the fiber material and on the total length of the fiber-optic cable.
Bifurcated	A fiber-optic bundle that divides in two legs, which forms a Y.
Complementary Output	Output circuit with a dual output device such that when one output is energized the other output is de-energized (similar to SPDT contact.
Dark Operate	A dark operate sensor energizes an output when the light intensity on the photodetector has sufficiently decreased.
Diagnostic	Advanced warning of loss in signal strength due to misalignment, dust, and more, before loss of control output signal.
Differential Travel (Hysteresis)	The distance between the operating point and the release point (see hysteresis).
Diffuse Reflection (Proximity)	A photoelectric sensing method in which the light that the light source emits hits the target surface and is then diffused from the surface in all directions.
Digital Output	An output circuit with only two operating states that are either On or Off. These operating states are called Hi or Low.
Dwell-Time	The adjustable or fixed time length of an output pulse, independent of input signal duration.
Excess Gain	See operating margin.
False Pulse	An undesired change in the state of the output of the proximity switch that lasts for more than 2 ms.
False Pulse Protection	Circuitry designed to avoid false pulses during power-on or power-down action.
Ferrule	Tip or termination of a fiber-optic cable.
Field of View	The region that the light source illuminates and that the receiver sees. The field of view is expressed in degrees but is three dimensional.
Gating	The provision to apply an external signal to a sensor to help prevent undesirable operation.
Hysteresis	The distance between the operating point and the release point.
Infrared	Invisible light radiation that starts at a wavelength of 690 nanometer (or 6900 Angstrom) and longer.
Intrinsic Safety	A design technique that is applied to electrical equipment and wiring for hazardous locations. It is based on limiting electrical and thermal energy to a level below what is required to ignite hazardous atmospheric mixtures.
Light-emitting diode (LED)	Semi-conductor that generates monochromatic light when the current flows in the conductive direction. An LED is the standard light source for most photoelectric sensors.
Leakage Current	Small current flowing through a solid-state output when in the off state.

Term	Definition
Light Operate	A light operate sensor energizes an output when the light intensity on the photodetector has sufficiently increased.
Nanometer (nm)	1 nanometer is equal to 10^{-9} meters.
Noise	Presence of undesirable voltage, current, or light that can cause the sensor to malfunction.
Normally Closed	The output opens when an object is detected in the active switching area.
Normally Open	The output closes when an object is detected in the active switching area.
Operating Margin	The ratio of electrical signals available at a given sensing range to the minimum signal required to trigger the amplifier and output.
Operating Mode	See light and dark operate.
Optical Crosstalk	Optical crosstalk occurs when a photoelectric receiver responds to the signal from an adjacent emitter. The repositioning of the sensors can usually resolve crosstalk.
Photoelectric Sensor	Electronic device that recognizes changes in light intensity and converts these changes into a change in output state.
Pulse	A sudden fast change of a normally constant or relatively slow-changing value such as voltage, current or light intensity.
Response Time	The sum of the time needed for a string of electronic circuits to translate a change in light into a change of output status.
Reverse Polarity Protection	A circuit that uses a diode to avoid damage to the control in case the polarity of the power supply is accidentally reversed.
Ripple %	The percentage of alternating component left on a DC signal after rectifying. Measured peak to peak of the alternating component and compared to the DC signal value.
Rise Time (10% Levels)	The time that is required for an analog voltage or current output value to rise from 10% of its maximum value to 90% of its maximum value.
Sink (Current)	Transistor output that requires the current to flow from positive (+) through the load and then through the output to negative (-). A current sink output uses an NPN transistor.
Source (Current)	Transistor output that requires the current to flow from positive (+) through the output and then through the load to negative (-). A current source output uses a PNP transistor.
Transmitted Beam	A sensing mode where the light source and the receiver are opposite each other and where the target breaks the beam.
Wavelength	Distance traveled by light while completing one complete sine wave expressed in nanometers (nm). Each color has a specific wavelength.
White Paper Response	A calibration procedure that is performed on retroreflective sensors to eliminate all response to white paper with 90% reflectance.

Basic Concepts and Components

There are four basic components to any photoelectric sensor:

- Light source
- Light detector
- Lenses
- Output switching device

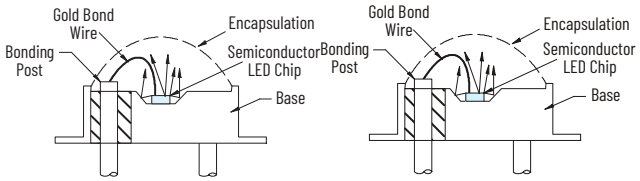
Light Source

A light-emitting diode (LED) is a solid-state semiconductor that emits light when current is applied. Figure 1 shows the construction of an LED. LEDs are made to emit specific wavelengths or colors of light. Infrared, visible red, green, and blue LEDs are used as the light source (emitter) in most photoelectric sensors.

Different LED colors offer different desirable characteristics. Infrared LEDs are the most efficient, they generate the most light and the least heat of any LED color. Infrared LEDs are used in sensors where maximum light output is required for an extended sensing range.

In many applications, a visible beam of light is desirable to aid setup or confirm sensor operation. Visible red is most efficient for this requirement.

Figure 1 - Light-emitting Diode (LED)



Visible red, blue, and yellow LEDs are also used in special applications where specific colors or color contrasts must be detected. These LEDs are also used as status indicators on photoelectric sensors.

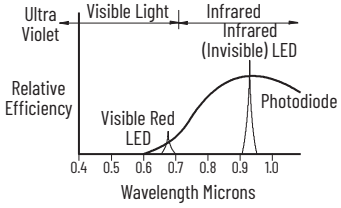
LEDs are rugged components with excellent reliability, which make them ideal for use in photoelectric sensors. They operate over a wide temperature range and are resistant to damage from shock and vibration.

Light Detector

A photodetector is the component that is used to detect the light source. A photodiode or phototransistor is a robust solid-state component that provides a change in conducted current depending on the amount of light detected.

Photodetectors are more sensitive to certain wavelengths of light. The spectral response of a photodetector determines its sensitivity to different wavelengths in the light spectrum. To improve sensing efficiency, the LED and photodetector are often spectrally matched. An example is shown in

Figure 2 - Spectral Response

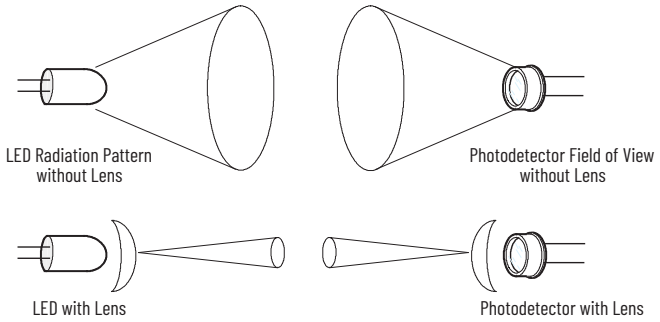


The invisible (infrared) LED is a spectral match for this silicon phototransistor, and has greater efficiency than a visible (red) LED.

The photodetector and associated circuitry are referred to as the receiver.

Lens

Figure 3 - Lenses



LEDs typically emit light and photodetectors are sensitive to light over a broad area. Lenses are used with LED light sources and photodetectors to narrow this area. As the area is narrowed, the range of the LED or photodetector increases. As a result, lenses also increase the sensing distance of photoelectric sensors (see Figure 3).

The light beam from an LED and lens combination is typically conical in shape. The area of the cone increases with distance.

Some photoelectric sensors are optimized for extra sensing distance. The light beam (or field of view) emitted by these sensors is fairly narrow. However, alignment can be difficult if the field of view is too narrow. Other photoelectric sensors are designed for the detection of objects within a broad area. These sensors have a wider field of view, but a shorter overall range.

Output Device

Once a sufficient change of light level is detected, the photoelectric sensor switches an output device to provide an interface to machine logic. Many types of discrete and variable (analog) outputs are available, each with particular strengths and weaknesses.

Margin

Margin (operating margin, excess gain) is an important concept to understand when applying photoelectric sensors. The amount of maintenance that is required for a photoelectric sensing application can be minimized by obtaining the best margin levels for that application.

Margin is a measurement of the amount of light from the light source that the receiver detects. The following are examples of margin:

- A margin of zero occurs when the light detector detects none of the light that the light source emits.
- A margin of one is obtained when enough light is detected to switch the state of the output device (from OFF to ON or from ON to OFF).
- A margin of 20 is reached when 20 times the minimum light level that is required to switch the state of the output device is detected.

Margin is defined as:

$$\frac{\text{Actual amount of light detected}}{\text{Minimum amount required to change the output device state}}$$

and is expressed as a ratio or as a whole number followed by an X. A margin of 6 can be expressed as 6:1 or as 6X.

LED Modulation

The amount of the amount of current the LED conducts determines the amount of light that the LED generates in the light source. To increase the range of a photoelectric sensor, the amount of current must be increased. However, LEDs also generate heat—there is an upper limit of heat that can be generated before an LED is damaged or destroyed.

Photoelectric sensors rapidly switch on and off or modulate the current conducted by the LED. A low duty cycle (typically less than 5%) allows the amount of current, and therefore the amount of light that is emitted, to exceed what is allowable under continuous operation, see Figure 4.

Figure 4 - Modulation

The modulation rate or frequency is often in excess of 5 kHz, faster than the eye can detect.

Synchronous Detection

The receiver is designed to detect a pulsed light source from a modulated light source. To enhance sensing reliability, the receiver and light source are synchronized. The receiver watches for light pulses that are identical to the pulses generated by the light source.

Synchronous detection helps a photoelectric sensor to ignore light pulses from other photoelectric sensors nearby or from other pulsed light sources such as fluorescent lights.

Synchronous detection is only possible when the light source and receiver are in the same housing, which is true for all sensing modes except transmitted beam as explained in the next section.

Photoelectric Sensing Modes

Different methods of sensing are referred to as sensing modes. There are three basic types:

- Transmitted beam (sometimes called through-beam or thru-beam)
- Retroreflective (sometimes referred to as reflex)
- Diffuse (also known as proximity)
- While these sensing modes can handle many applications, each offers specific strengths and weaknesses to consider. These strengths and weaknesses are summarized in Table 1 on page 5.

Transmitted Beam

In this mode, the light source and receiver are contained in separate housings. These two units are positioned opposite each other so that the light from the light source shines directly on the receiver. Targets must break (block) the beam between light source and receiver.

Figure 5 - Transmitted Beam Sensing

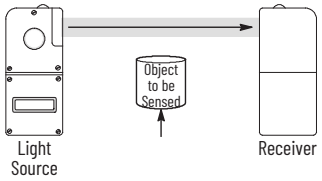


Table 1 - Photoelectric Sensing Modes Advantages and Cautions

Sensing Mode	Applications	Advantages	Cautions
Transmitted Beam	• General-purpose sensing • Parts counting	• High margin for contaminated environments • Longest sensing distances • Not affected by second surface reflections • Probably most reliable when you have highly reflective objects	• More expensive because of separate light source and required receiver, more costly wiring • Alignment is important • Avoid the detection of clear material objects
Retroreflective	General-purpose sensing	• Moderate sensing distances • Less expensive than transmitted beam because of simpler wiring • Ease of alignment	• Shorter sensing distance than transmitted beam • Less margin than transmitted beam • Can detect reflections from shiny objects (use polarized retroreflective instead)
Polarized Retroreflective	General-purpose sensing of shiny objects	• Ignores first surface reflections • Uses a visible red beam for ease of alignment	• Shorter sensing distance than standard retroreflective • Can see second surface reflections
Standard Diffuse	Applications where both sides of the object cannot be accessed	• Access to both sides of the object is not required • No reflector needed • Ease of alignment	• Can be difficult to apply if the background behind the object is sufficiently reflective and close to the object
Sharp Cutoff Diffuse	Short-range detection of objects with the need to ignore backgrounds that are close to the object.	• Access to both sides of the object is not required • Provides some protection against sensing of close backgrounds • Detects objects regardless of color within a specified distance	• Only useful for short distance sensing • Not used with backgrounds close to the object
Background Suppression Diffuse	• General-purpose sensing • Areas where you must ignore backgrounds that are close to the object	• Access to both sides of the target is not required • Ignores backgrounds beyond rated sensing distance regardless of reflectivity • Detect objects regardless of color at a specified distance	• More expensive than other types of diffuse sensors • Limited maximum sensing distance
Fixed Focus Diffuse	• Detection of small targets • Detects objects at a specific distance from the sensor • Detection of color marks	• Accurate detection of small objects in a specific location	• Short distance sensing • Not suitable for general-purpose sensing • The object must be accurately positioned
Wide Angle Diffuse	• Detection of objects not accurately positioned • Detection of fine threads over a broad area	• Ignores background reflections well • Detects objects that are not accurately positioned • No reflector needed	• Short distance sensing
Fiber Optics	Allows photoelectric sensing in areas where a sensor cannot be mounted because of size or environment considerations	• Glass fiber-optic cables available for high ambient temperature applications • Shock and vibration resistant • Plastic fiber-optic cables can be used in areas where continuous movement is required • Insert in limited space • Noise immunity • Corrosive areas placement	• More expensive than sensors with lenses • Short distance sensing

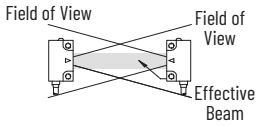
Transmitted beam sensors provide the longest sensing distances and the highest level of operating margin. For example, PHOTOSWITCH® Series 4000B transmitted beam sensors has a sensing range of up to 274 m (900 ft).

Transmitted beam application margins at ranges of less than 10 m (3.1 ft) can exceed 10,000X. For this reason, transmitted beam is the best sensing mode when operating in dusty or dirty industrial environments.

Another example: Series 9000™ Transmitted Beam photoelectric sensors offer 300X margin at a sensing distance of 3 m (9.8 ft). At this distance, these sensors continue to operate even if 99.67% of the combined lens area of the light source and receiver is covered with contamination.

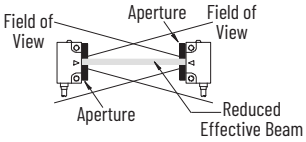
The effective beam of a transmitted beam sensor is equivalent to the diameter of the lens on the light source and receiver (Figure 6 on page 6). Reliable detection occurs when the target is opaque and breaks at least 50% of the effective beam.

Figure 6 - Effective Beam



Detection of objects smaller than the effective beam can best be achieved by reducing the beam diameter through the means of apertures that are placed in front of the light source and receiver (Figure 7). Apertures are available for most Bulletin 42KL, 42KB, and 42EF transmitted beam sensors. Some users have created their own apertures for other sensor families.

Figure 7 - Effective Beam with Apertures



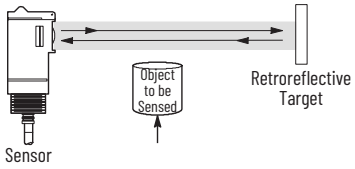
The most reliable transmitted beam applications have a high margin when the target is absent, and a margin of zero (or close to zero) when the target is present.

Transmitted beam sensing may not be suitable for the detection of translucent or transparent targets. The high margin levels allow the sensor to see through these targets. While it is often possible to reduce the sensitivity of the receiver, retroreflective or diffuse sensing can provide a better solution.

Retroreflective

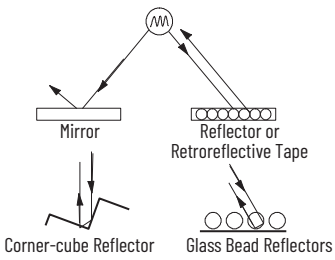
Retroreflective (reflex) is the most popular sensing mode. A retroreflective sensor contains both the light source and receiver in one housing. A special reflective object reflects the light beam from the light source, which the receiver detects. The target is detected when it breaks this light beam (Figure 8).

Figure 8 - Retroreflective Sensing



Special reflectors or reflective tapes are used for retroreflective sensing. Unlike mirrors or other flat reflective surfaces, these reflective objects do not have to be aligned perfectly perpendicular to the sensor. Misalignment of a reflector or reflective tape of up to 15° does not reduce the margin of the sensing system significantly (see Figure 9).

Figure 9 - Retroreflective Materials



A wide selection of reflectors and reflective tapes are available.

The maximum available sensing distance of a sensor and reflector depends in part upon the efficiency of the reflector or reflective tape. These reflective materials are rated with a reflective index.

The PHOTOSWITCH standard 78 mm (3 in.) diameter round reflector (catalog number 92-39) is used to determine the maximum sensing distance of most PHOTOSWITCH sensors.

The 92-39 reflector has a reflective index of 100. The 92-99 reflective tape has a reflective index of 77 meaning that it reflects only 77% as much light as a 92-39 reflector.

Retroreflective sensors are easier to install than transmitted beam sensors. Only one sensor housing must be installed and wired. However, margins when the target is absent are typically 10...1000 times lower than transmitted beam sensing, which makes retroreflective sensing less desirable in highly contaminated environments.

Caution must be used when applying standard retroreflective sensors in applications where shiny or highly reflective targets must be sensed. Reflections from the target itself may be detected. It may be possible to orient the sensor and reflector or reflective tape so that the shiny target reflects light away from the receiver. However, for most applications with shiny targets, polarized retroreflective sensing offers a better solution.

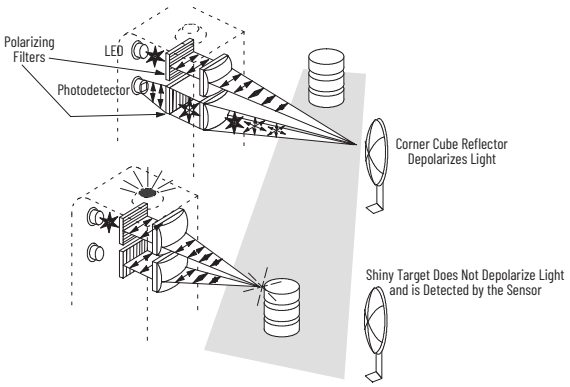
Polarized retroreflective sensors contain polarizing filters in front of the light source and receiver. These filters are perpendicular or 90° out of phase with each other (Figure 10).

The sensor cannot see the light that most targets reflect. The reflected polarized light cannot pass through the polarizing filter that is in front of the receiver.

Reflectors depolarize reflected light. Some of the reflected depolarized light can pass though the polarizing filter in front of the receiver, which the sensor detects.

In summary, the sensor can see the reflection from a reflector, and it cannot see the reflection from most shiny targets.

Figure 10 - Polarized Retroreflective Sensing



Polarized retroreflective sensors offer 30...40% shorter range (and less margin) than standard retroreflective sensors. Instead of infrared LEDs, polarized retroreflective sensors must use a less efficient visible light source (typically a visible red LED). There are additional light losses that the polarizing filters cause.

Polarized sensors only ignore first-surface reflections from an exposed reflective surface. Polarized light is depolarized as it passes through most plastic film or stretch wrap. Therefore, a shiny object may create reflections that the receiver detects when it is wrapped in clear plastic film. In the latter case, the shiny object becomes the second surface behind the plastic wrap. Other sensing modes must be considered for these applications.

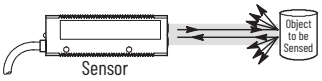
All standard reflectors depolarize light and are suitable for polarized retroreflective sensing. However, most reflective tapes do not depolarize light and are suitable only for use with standard retroreflective sensors. Specially constructed reflective tapes for polarized retroreflective sensing are available. Look for reflective tapes identified as suitable for use with polarized retroreflective sensors.

Diffuse

Transmitted beam and standard or polarized retroreflective sensing creates a beam of light between light source and receiver or between sensor and reflector. Access to opposite sides of the target is required.

Sometimes it is difficult, or even impossible, to obtain access on both sides of a target. In these applications, it is necessary to point the light source directly at the target. The surface scatters the light at all angles and a small portion is reflected back for detection by the receiver that is contained in the same housing. This mode of sensing is called diffuse or proximity (see Figure 11).

Figure 11 - Diffuse Sensing



A sensing mode in which light strikes an object surface, is diffused from the surface at all angles and detected by the sensor.

There are a number of different types of diffuse sensing. The simplest, standard diffuse, is discussed here. Other types, sharp cutoff diffuse, fixed focus diffuse, wide angle diffuse, and background suppression diffuse, are explained in later sections.

The goal of standard diffuse sensing is to obtain a relatively high margin when sensing the target. When the target is absent, reflections from any background behind the target should provide a margin as close to zero as possible.

Target reflectivity can vary widely. Relatively shiny surfaces may reflect most of the light away from the receiver, which makes detection difficult. The sensor face must be parallel with these types of target surfaces.

Dark, matte objects can absorb most of the light and reflect very little for detection. These targets may be hard to detect unless the sensor is positioned very close.

The specified maximum sensing distance of a photoelectric sensor is determined using a calibrated diffuse target. We use a 216 x 292 mm (8.5 x 11 in.) sheet of white paper that has been specially formulated to be 90% reflective, which means that the paper reflects 90% of the light energy from the light source.

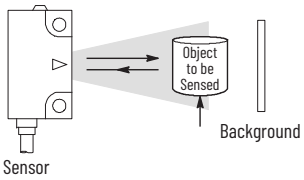
Real-world diffuse targets are often considerably less reflective, as shown in the following table.

Table 2 - Reflectivity

Target	Typical Relative Reflectivity
Polished aluminum	500
White paper (reference)	100
White typing paper	90
Cardboard	40
Cut lumber	20
Black paper	10
Neoprene	5
Tire rubber	4
Black felt	2

The detection of targets positioned close to reflective backgrounds can be challenging. It may be impossible to adjust the sensor to obtain sufficient margin from the target without detecting, or coming close to detecting, the background (Figure 12). Other types of diffuse sensing may be more appropriate.

Figure 12 - Diffuse Sensing Background Detection



Sharp Cutoff Diffuse

Sharp cutoff diffuse sensors are designed so that the light beam from the light source and the area of detection of the receiver are angled towards each other. This design makes these sensors more sensitive at short range, and less sensitive than a longer range. This design can also provide more reliable sensing of targets that are positioned close to reflective backgrounds.

This sensing mode provides some degree of improvement over standard diffuse sensing when a reflective background is present. However, a background that is very reflective may still be detected.

An even better solution is provided by background suppression diffuse sensors.

Background Suppression Diffuse

Instead of attempting to ignore the background behind a target, background suppression sensors use sophisticated electronics to actively sense the presence of both the target and the background. The two signals are compared, and the output changes state upon active detection of the target, or active detection of the background.

In simple terms, background suppression sensing can allow the sensor to ignore the presence of a very reflective background almost directly behind a dark, less-reflective target. For many applications, it is the ideal diffuse sensing mode. However, background suppression sensors are more complex, and therefore more expensive than other diffuse sensors.

Fixed Focus Diffuse

In a fixed focus (convergent beam) sensor, the light beam from the light source and the detection area of the receiver are focused to a narrow point (focal point) at a fixed distance in front of the sensor. The sensor is very sensitive at this point, and much less sensitive before and beyond this focal point.

Fixed focus sensors have three primary applications:

- Reliable detection of small targets. Because the sensor is very sensitive at the focal point, a small target can be readily detected.
- Detection of objects at a fixed distance. As a fixed focus sensor is most sensitive at the focal point, it can be used in some applications to detect a target at the focal point, and ignore it when it is in front of or behind the focal point.
- Detection of color printing marks (color registration mark detection). In some applications, it is important to detect the presence of a printing mark on a continuous web of wrapping material. A fixed focus sensor with a specific visible light source color (typically red, green, or blue) may be selected to provide the greatest sensitivity to the mark.

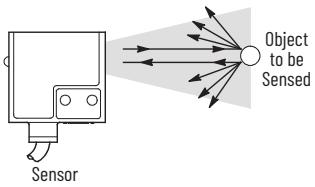
Wide-angle Diffuse

Wide-angle diffuse sensors project the light source and detection area of the receiver over a wide area (Figure 13).

These sensors are ideal for two applications:

- Thread detection—a wide-angle diffuse sensor can detect the presence of extremely thin strands of thread or other material that is positioned close to the sensor. The presence or absence (thread break) of the thread can be reliably detected even when the thread moves from side to side in front of the sensor.
- Ignoring holes or imperfections in targets—because wide-angle diffuse sensors can sense over a broad area, they can ignore small holes or imperfections in diffuse targets.

Figure 13 - Wide-angle Diffuse



Fiber Optics

Fiber-optic sensors permit the attachment of light pipes called fiber-optic cables. Emitted light from the light source is transmitted through transparent fibers in the cables and emerges at the end of the fiber. The transmitted or reflected beam is then carried back to the receiver through different fibers.

Fiber-optic cables can be mounted in locations that are otherwise inaccessible to photoelectric sensors. They can be used where there is a high ambient temperature and in applications where extreme shock and vibration or continuous movement of the sensing point is required (as described below).

Both glass and plastic are used as transparent materials to create fiber-optic cables.

Glass

Glass fiber-optic cables contain multiple strands of thin glass fiber that are bundled together in a flexible sheath.

Glass fiber-optic cables are typically more durable than plastic fiber-optic cables. Glass fiber-optic cables withstand higher temperatures. Standard glass fiber-optic cables with a stainless-steel sheath rated up to 260 °C (500 °F). Special order cables can be obtained with temperature ratings of up to 480 °C (900 °F).

Most glass fiber-optic cables are available with a choice of PVC or flexible stainless-steel sheath. PVC-sheathed cables are typically less expensive. Stainless-steel sheathing adds even greater durability and allows the cables to operate at higher temperatures

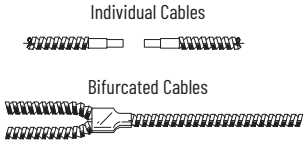
Plastic

Plastic fiber-optic cables are typically constructed of one acrylic monofilament. There is no protective sheathing, which makes plastic fiber-optic cables less durable, but typically less expensive than glass fiber-optic cables.

Plastic fiber-optic cables can be used in applications where continuous flexing of the fiber-optic cable is required. Coiled plastic cables are also available for these applications.

Fiber-optic cables are available in individual or bifurcated configurations (Figure 14).

Figure 14 - Fiber-optic Cables



Two individual cables are used for transmitted beam sensing. Some individual cables are packaged separately, others are sold in packages of two. Order carefully to receive two cables.

Bifurcated cables are used for diffuse or retroreflective sensing modes. Standard diffuse sensing with fiber-optic cables are similar to sensing with lensed photoelectric sensors.

Retroreflective sensing is possible with either reflectors or reflective tapes. Polarized retroreflective sensing is not possible. In some applications, it is necessary to reduce the sensitivity of the sensor to help prevent diffuse detection of the target.

Glass fibers can be used with infrared or visible LEDs. Plastic fibers absorb infrared light and therefore are most efficient when used with visible red LEDs.

A wide selection of fiber-optic cables is available and many special configurations can be obtained.

Table 3 - Comparison of Fiber-optic Cables

	Glass	Plastic
Construction	Thin glass strands that are bundled in stainless-steel or PVC sheath	Single acrylic monofilament
Temperature Range	-40...+260 °C (-40...+500 °F) with stainless-steel sheath. Special order up to 480 °C (900 °F).	-30...+70 °C (-20...+158 °F)
Durability	Very durable	Adequate for many applications
Continuous Flexing	Quickly breaks glass fibers	Works well, coiled versions available
Light Source	Visible or infrared OK	Must use visible light
Range	Can be longer range because of its larger diameter	Adequate for many applications

Clear Object Detection

Clear materials present a unique application challenge for photoelectric sensors. Most clear objects and films provide insufficient contrast to be reliably detected using general-purpose retroreflective or polarized retroreflective sensors. Various forms of diffuse sensing do not offer a preferred solution because the exact location of the clear target cannot be detected.

We offer ClearSight™ photoelectric sensors that are designed for clear object and clear film sensing applications. These modified polarized retroreflective sensors contain special optical assemblies that are designed to optimize the amount of contrast that clear objects and films generate. Special electronics and software features further enhance sensing reliability.

Table 4 - 45FVL/FSL Light Source Selector Guide for Color Contrast Sensing

		Target						
		White	Yellow	Orange	Red	Green	Blue	Black
Background	White	(1)	B	B	B	R	R	R
	Yellow	B	(1)	G	G	R	R	R
	Orange	B	G	(1)	G	G	G	R
	Red	B	G	G	(1)	R	B	R
	Green	R	R	G	R	(1)	B	G
	Blue	R	R	G	B	B	(1)	B
	Black	R	R	R	R	G	B	(1)

(1) 42QA ColorSight™ sensor suggested for shades of the same color.

R = Red; B = Blue; G = Green

Note: White LED light source can be used selectively in place of red, blue, and green.

Photoelectric Sensor Specifications

Light/Dark Operate Output

The terms light operate and dark operate are used to describe the action of a sensor output when a target is present or absent.

A light operate output is ON (energized, logic level one) when the receiver can see sufficient light from the light source.

For transmitted beam and retroreflective sensing, a light operate output is ON when the target is absent and light can travel from the light source to the receiver. For diffuse sensing (all types), the output is ON when the target is present and reflects light from the light source to the receiver.

A dark operate output is ON (energized, logic level one) when the receiver cannot see the light from the light source.

For transmitted beam and retroreflective sensing, a dark operate output is ON when the target is present and light from the light source is blocked and cannot reach the receiver. For diffuse sensing (all types), a dark operate output is ON when the target is absent.

Maximum Sensing Distance

This specification refers to the sensing distance from:

- Sensor to reflector in retroreflective and polarized retroreflective sensors.
- From sensor to specified target in all types of diffuse sensors.
- Light source to receiver in transmitted beam sensors.

The manufacturer guarantees this sensing distance. PHOTOSWITCH photoelectric sensors are conservatively rated; the actual available sensing distance typically exceeds this specification.

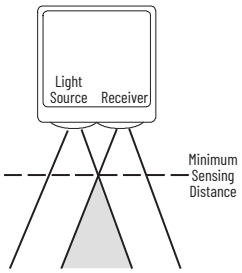
This distance is specified at a margin of 1X, meaning that the receiver detects enough light from the light source to change the state of the output.

Most industrial environments create contamination on the sensor lenses and reflectors or targets. Sensors should be applied at shorter distances to increase the margin to an acceptable value and enhance application reliability.

Minimum Sensing Distance

Many retroreflective, polarized retroreflective, and diffuse (most types) sensors have a small blind area near the sensor (Figure 15). Reflectors, reflective tapes, or diffuse targets should be located further away from the sensor than this minimum sensing distance for reliable operation.

Figure 15 - Blind Area



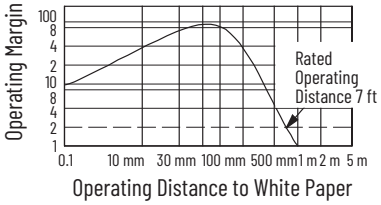
Typical Response Curve

The catalog pages for most PHOTOSWITCH photoelectric sensors contain a curve that shows what the typical margin is depending on sensing distance.

A margin of at least 2X is generally recommended for industrial environments.

The following image shows an example curve for a diffuse sensor. The maximum sensing range (margin = 1X) of this sensor is 1 m (39.4 in.) to a specified white paper target. A margin of 4X can be achieved at approximately half that distance, or 500 mm (19.7 in.).

Figure 16 - Margin



Response Time

The response time of a sensor is the amount of time that elapses between the detection of a target and the change of state of the output device from ON to OFF or from OFF to ON. It is also the amount of time that it takes for the output device to change state once the target is no longer detected by the sensor.

For most sensors, the response time is one specification for both the ON time and OFF time. For other sensors, two different values may be given.

Response times are dependent on sensor design and choice of output device. Slower sensors usually offer longer sensing ranges. Fast sensors typically have shorter sensing ranges. PHOTOSWITCH photoelectric sensors response times vary from 30 µs to 30 ms.

Field of View

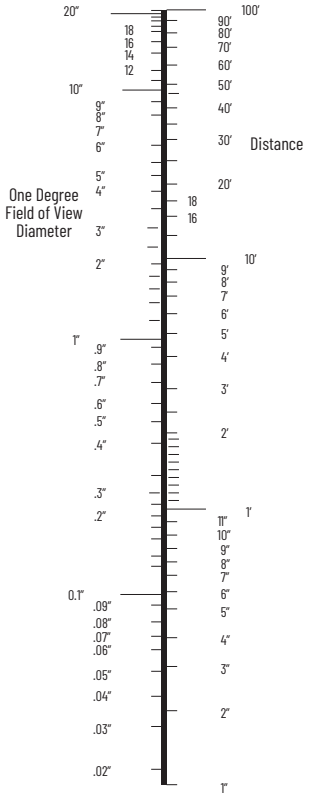
For most photoelectric sensors, the light beam from the light source and the area of detection in front of the receiver project away from the sensor in a conical shape. Field of view is a measurement (in degrees) of this conical area.

The Field of View is a useful specification to determine the available sensing area at a fixed distance away from a photoelectric sensor.

The 42SRU-6002 retroreflective sensor has a 3° field of view. The following figure shows that at a sensing distance of 3.0 m (10 ft), the detection area is a circle that is approximately 168 mm (6.6 in.) diameter (56 mm (2.2 in.) per degree).

Sensors with a wide field of view typically have shorter sensing distances. However, a wider field of view can make alignment easier.

Figure 17 - Field of View Diameter vs. Distance



Beam Patterns

Beam patterns are included for several lines of our photoelectric sensors to help predict the performance of these sensors in various applications. A beam pattern is defined as the sensing area for a photoelectric sensor. It is the pattern that is generated by comparing the response of the receiver to the emitted signal over the operating distance of the sensor.

All beam patterns are drawn in two dimensions and are assumed to be symmetrical in all planes about the optical axis of the sensor. The maximum operating margin is at the optical axis and decreases towards the outer boundary of the beam pattern.

All beam patterns are generated under clean sensing conditions with optimal sensor alignment. The beam pattern represents the largest typical sensing area, and should not be considered exact. Dust, contamination, fog, and so on, decreases the sensing area and operating range of the sensor.

Transmitted Beam Patterns

The beam pattern for a transmitted beam sensor represents the boundary where the receiver effectively receives the signal of the emitter, assuming there is no angular misalignment. Angular misalignment between the emitter and receiver decreases the size of the sensing area. Beam patterns for transmitted beam sensors are useful for determining the minimum spacing that is required between adjacent transmitted beam sensor pairs to help prevent optical crosstalk from one pair of sensors to the next.

Retroreflective Beam Patterns

Beam patterns for retroreflective and polarized retroreflective sensors represent the boundary within which the sensor responds to a retroreflective target as it passes by the sensors optics. The retroreflective target is held perpendicular to the sensor's optical axis while the beam diameter is plotted. The 76 mm (3 in.) diameter retroreflective target (catalog number 92-39) is used to generate retroreflective beam patterns unless otherwise noted.

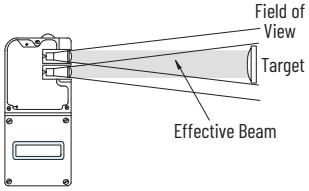
For reliable operation, the object to be sensed must be equal to or larger than the beam diameter indicated in the beam pattern. A smaller retroreflective target should be used for accurate detection of smaller objects.

Diffuse, Sharp Cutoff, and Background Suppression Beam Patterns

The beam pattern for a diffuse sensor represents the boundary within which the edge of a white reflective target that is detected as it passes by the sensor. Diffuse beam patterns are generated using a 90% reflective sheet of 216 x 279 mm (8.5 x 11 in.) white paper held perpendicular to the sensor's optical axis. The sensing area is smaller for materials that are less reflective, and larger for more reflective materials. Smaller objects may decrease the size of the beam pattern of some diffuse sensors at longer ranges. Diffuse targets with surfaces that are not perpendicular to the optical axis of the sensor also significantly decrease sensor response.

It is important to note that the effective size of the beam of the retroreflective control is equal to the size of the retroreflective target. Additional reflective targets in the field of view increase the excess gain and operating distance, if the field of view is bigger than the initial target as shown in the following image.

Figure 18 - Retroreflective Sensors



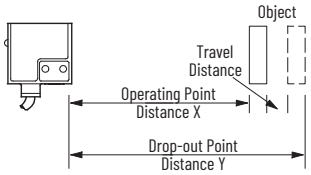
Hysteresis

Photoelectric sensors exhibit hysteresis (or differential).

The hysteresis of a photoelectric sensor is the difference between the distance when a target can be detected as it moves towards the sensor, and the distance it has to move away from the sensor to no longer be detected.

An example is shown in the following image. As the target moves toward the sensor, it is detected at distance X. As it then moves away from the sensor, it is still detected until it gets to distance Y.

Figure 19 - Hysteresis



$$\frac{\text{Distance y} - \text{Distance x}}{\text{Distance x}} = \%\ \text{differential}$$

The high hysteresis in most photoelectric sensors is useful for detecting large opaque objects in retroreflective, polarized retroreflective, and transmitted beam applications. In diffuse applications, a large difference in reflected light from target and background also allows the use of high hysteresis sensors.

Low hysteresis requires smaller changes in light level. The Series 10000 and 42FT allow selection of low hysteresis for these applications.

Align a Photoelectric Sensor

Proper alignment of the sensor creates a more rugged sensing solution that requires less maintenance.

Retroreflective or Polarized Retroreflective

Aim the sensor at the reflector (or reflective tape). Slowly pan the sensor left until the reflector is no longer detected. Note this position, then slowly scan the sensor to the right and note when the reflector is no longer detected. Center the sensor between these two positions, then pan it up and down to center it in the vertical plane.

Diffuse (all types)

Aim the sensor at the target. Pan the sensor up and down, left and right to center the beam on the target.

Reduce the sensitivity just until the target is no longer detected and note the position of the sensitivity adjustment.

Remove the target and increase the sensitivity until the background is detected. Adjust the sensitivity to the midpoint between detection of the target and detection of the background.

Transmitted Beam

Aim the receiver at the light source. Slowly pan the receiver left until the light source is no longer detected. Note this position, then slowly scan the receiver to the right and note when the reflector is no longer detected. Center the receiver between these two positions, then pan it up and down to center it in the vertical plane.

Digital Output Devices

Once the sensor has detected the target, an output device switches the electrical power in your control circuit. The output is either ON or OFF, which makes the sensor a digital device.

There are many types of outputs available, each with different benefits and weaknesses. The types available with PHOTOSWITCH photoelectric sensors are described below, and summarized in the following table.

Table 5 - Output Types

Output Type	Strengths	Weaknesses
Electromechanical Relay AC or DC switching	• Output is electrically isolated from supply power • Easy series and/or parallel connection of sensor outputs • High switching current	• No short circuit protection is possible • Finite relay life
FET AC or DC switching	• Low leakage current • Fast switching speed	• Low output current
Power MOSFET AC or DC switching	• Low leakage current • Fast switching speed	• Moderately high output current
TRIAC AC switching only	• High output current	• Relatively high leakage current • Slow output switching
NPN or PNP Transistor DC switching only	• Low leakage current • Fast switching speed	• No AC switching

Electromechanical Relay

An electromechanical relay (or simply relay) offers a reliable, positive means of switching electrical energy. Its major advantages are high switching current and electrical isolation from the sensor power source.

Because of the electrical isolation from the power source of the sensor, and due to the absence of leakage current, relays from multiple sensors can readily be connected in series and/or parallel.

Contact ratings vary from 1...5 A at 120/240V AC 50/60 Hz resistive, depending on the sensor selected.

There are a number of different contact arrangements available:

- SPST—Single pole, single throw
- SPDT—Single pole, double throw
- DPDT—Double pole, double throw

Relays have a finite life span, typically measured in millions of operations. Inductive loads can shorten the life span considerably. Solid-state outputs should be considered for applications that require frequent switching by the sensor.

Response times of relays are typically 15...25 ms, slower than most solid-state outputs.

FET

The FET (Field Effect Transistor) is a solid-state device that provides for fast switching of AC or DC power and low leakage current. Its switching current is limited. The FET output on the Series 4000B switches only 30 mA of current.

FET outputs can be connected in parallel like electromechanical relay contacts.

Power MOSFET

A Power MOSFET (Metal Oxide Semiconductor Field Effect Transistor) provides the low leakage and fast response time benefits of an FET with high switching current capacity.

The Power MOSFET used in Series 6000 and Series 9000 sensors can switch up to 300 mA of current.

TRIAC

A TRIAC is a solid-state output device that is designed for AC switching only. TRIACs offer a high switching current, which makes them suitable for connection to large contactors and solenoids.

TRIACs exhibit higher leakage current than FETs and Power MOSFETs. Leakage current from TRIACs can exceed 1 mA, which makes them unsuitable as input devices for programmable controllers and other solid-state inputs. A zero-crossing of the 50/60 Hz AC power cycle is required to activate a TRIAC, meaning that the minimum response time is 8.3 ms.

For most applications, Power MOSFETs provide better output characteristics.

NPN/PNP Transistor

Transistors are the typical solid-state output device for low-voltage DC sensors.

A sensor with an NPN transistor output device has a sinking output. The load must be connected between the sensor output and the (+) power connection.

A sensor with a PNP transistor output device has a sourcing output. The load must be connected between the sensor output and the (-) power connection.

Transistors exhibit low leakage current (measured in ìA) and relatively high switching current (typically 100 mA) for easy interface to most DC loads. Response times of sensors with transistor outputs can vary from 2 ms to as fast as 30 ìs.

Analog Output

Analog sensors provide an output that is proportional, or inversely proportional, to the quantity of light seen by the receiver.

Series 5000 analog output sensors provide a selectable voltage or current output that is proportional or inversely proportional to the amount of light detected by the receiver.

Timing and Logic

Photoelectric sensors are unique among presence sensors because many offer timing or logic functions. These functions may be available in special versions of the sensors, or in plug-in modules.

On Delay and Off Delay

On Delay and Off Delay are the most common timing modes.

An On Delay timer delays the operation of an output after a target is detected.

An Off Delay timer delays the operation of an output after the target is no longer detected.

The delay time of most sensors is adjustable from less than a second to 10 seconds or more.

Some high-speed sensors (less than 1 ms response time) such as the 42FB and 42FT contain a selectable 50 ms off delay time. This pulse stretcher is useful when it is necessary to slow down the OFF response time to allow a slower PLC or other machine logic to respond to the movement of materials in high-speed applications.

One-Shot

One-shot logic provides one pulse output regardless of the speed that a target moves past the sensor. The length of the pulse is adjustable.

One-shot operation can provide different application solutions:

- In high-speed operations — Provides a pulse each time a target moves past the sensor that is sufficiently long to allow other slower logic to respond.
- In slower-speed operations — Provides a brief pulse each time a target moves past the sensor to trigger a solenoid or other impulse device.
- Provides a leading-edge signal regardless of target length.
- Provides a trailing-edge signal regardless of target length.

Delayed One-shot

Delayed one-shot logic adds an adjustable time delay before the one-shot output pulse occurs.

Motion Detector

Motion detection logic provides the unique capability to detect the continuous movement of targets. The sensor provides an output if it does not detect the motion of successive targets within the adjustable delay time.

Motion detector logic is useful to detect a jam or void in material handling applications.

42AF RightSight M30 Photoelectric Sensor

The RightSight™ M30 family of photoelectric sensors offers high-performance general-purpose sensing in a robust flexible package. They are designed for applications where simplified installation and maintenance are required.

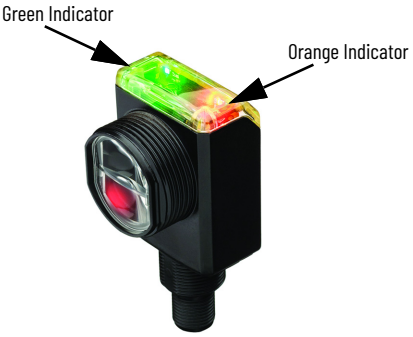
Features

- Maximum sensing distance
  - Background suppression without physical adjustments [(a)]: 400 mm (15.7 in.) and 600 mm (23.6 in.)
  - Background suppression with push button teach [(a)]: 1.2 m (3.94 ft)
  - Background reflection with push button teach [(a)]: 800 mm (31.5 in.)
  - Polarized retroreflective: 10 m (32.8 ft) with catalog number 92-125 reflector
  - Transmitted beam: 80 m (262.5 ft)
- High powered light source for ease of alignment
- 360° highly visible user interface helps operators verify the proper operation, regardless of the sensor installation location
- Background suppression performance helps minimize false detections due to highly reflective backgrounds
- Dual Auto PNP/NPN helps streamline inventory by reducing the number of catalog numbers to stock
- A push button lock helps prevent unauthorized operators from changing the sensor settings
- Embedded IO-Link 1.1 communications protocol
- Adjustable sensing ranges and response time via IO-Link provides additional flexibility to detect targets at longer or shorter distances depending on the application requirements.
- IP67 and IP69K rated enclosure

Available Models

- Polarized retroreflective
- Transmitted beam
- Background suppression
- Background reflection

Status Indicators



Specifications

Attribute	Value
Certifications	cULus and CE Marked for all applicable directives
Vibration	10…55 Hz, 1 mm (0.04 in.) amplitude, meets, or exceeds 60947-5-2
Shock	30 g (1.1 oz) with 1 ms pulse duration per IEC 60947-5-2
Ambient light immunity	• Direct Illumination: 20,000 lux • Indirect Illumination: 5000 lux • Sunlight immunity; 108,000 lux
User Interface	
Status indicators	Green and orange light-emitting diodes (LED)
Electrical	
Adjustments	No physical adjustment. IO-Link adjustable
Operating voltage	• DC models: 10…30V DC, IO-Link: 18…30V • AC/DC models: AC: 24…250V AC/DC: 20…250V DC
Current consumption	35 mA, max
Sensor protection	DC: Reverse polarity and short circuit; AC/DC: Reverse polarity
Discrete Output	
Response time	• DC: 1 ms • AC/DC: 15 ms max
Output type	• DC: Dual Auto PNP or NPN • AC/DC: EM Relay
Load current	• DC: 100 mA max • AC/DC SPDT: 10…30V DC: 3 A; 31…125V DC: 200 mA; 24…250V AC: 3 A
IO-Link	
Communications mode	COM2
Cycle time, min	2 ms
Process data bit length	32 bits (4 bytes)
Specifications	1.1
Mechanical	
Housing material	PBT
Lens material	PMMA
Cover material	Polysulfone
Reliability Data	
Transmitted Beam and Polarized Retroreflective AC/DC	
MTTFd (hours)	6548788.474
T10d	78.76
Transmitted Beam and Polarized Retroreflective DC	
MTTFd (hours)	9310986.965
T10d	111.9875

(a) All models can be taught to detect targets up to 4 m (13.1 ft.) when using IO-Link to adjust the response time

Attribute	Value
Transmitted Beam Emitter AC/DC	
MTTFd (hours)	24271844.66
T10d	291.9285467
Transmitted Beam Emitter DC	
MTTFd (hours)	24271844.66
T10d	291.9285467
Environmental	
Enclosure type rating	IP67 and IP69K per ISO 20653 rated enclosure
Operating temperature	-40...+70 °C (31...158 °F) (1)
Connection type	• 2 m (6.6 ft) cable • 4-pin Integral M12 QD • 4-pin M12 QD on a 150 mm (5.9 in.) pigtail • 4-pin mini QD on 150 mm (5.9 in.) pigtail • 5-pin mini QD on 150 mm (5.9 in.) pigtail

(1) The sensing range for all sensing modes can be reduced up to 20% when operated between -40...-25 °C (-40...-13 °F).

Product Selection

Sensing Mode	Operating Voltage	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No.
Background Suppression	10...30V DC	Infrared	Default setting: 10...400 mm (0...15.7 in.)	No physical adjustment. IO-Link teach: 4 m (13.1 ft) (1)	Light and dark operate	Dual auto PNP or NPN	42AF-B1MAB1-D4
			Default setting: 10...600 mm (0...23.6 in.)	No physical adjustment. IO-Link teach: 4 m (13.1 ft) (1)			42AF-B1MAB2-D4
			Default setting: 10...1.2 m (0...3.9 ft)	Push button teach: 3 m (9.8 ft) IO-Link teach: 4 m (13.1 ft) (1)			42AF-B1MAC1-D4
Background Reflection	10...30V DC	Infrared	0...800 mm (0...31.5 in.)	Push button teach: 3 m (9.8 ft) IO-Link teach: 4 m (13.1 ft) (1)	Light and dark operate	Dual auto PNP or NPN	42AF-N1MAC1-D4
Polarized Retroreflective	10...30V DC	Visible red	0.025...10 m (0.03...33 ft) with 92-125 reflector	No adjustment (IO-Link adjustable)	Light and dark operate	Dual auto PNP or NPN	42AF-P2MAB1-D4
	20...250V DC 24...250V AC			No adjustment	Light operate	SPDT EM relay	42AF-P2RHB1-G4
					Dark operate		42AF-P2SHB1-G4
					Light and dark operate		42AF-P2CHB1-A2
Transmitted Beam	10...30V DC	Infrared	0...80 m (0...262 ft)	No adjustment (IO-Link adjustable)	Transmitted beam emitter	—	42AF-E1EZB1-D4
	20...250V DC 24...250V AC						42AF-E1UZB1-G4
	10...30V DC			No adjustment	Light and dark operate	Dual auto PNP or NPN	42AF-R1MAB1-D4
	20...250V DC 24...250V AC				Light operate	SPDT EM relay	42AF-R1RHB1-G4
					Dark operate		42AF-R1SHB1-G4
					Light and dark operate		42AF-R1CHB1-A2

(1) Sensor response time can be changed up to 75 ms to achieve distance of up to 4 m (13.1 ft). A higher distance between target and high reflectivity background may be needed when operating the sensors at distances greater than 2 m (6.6 ft).

IMPORTANT Connection Options (1): The following suffixes describe the available connection options:

- D4: Describes an integral 4-pin DC micro (M12) quick-disconnect for DC models.
- G4: Describes a 4-pin AC micro (M12) quick-disconnect on a 150 mm (6 in.) length pigtail on AC/DC models.
- F4: Describes a 4-pin DC micro (M12) quick-disconnect on a 150 mm (6 in.) length pigtail on DC models.
- A2: Describes a 2 m (6.6 ft) PVC cable.
- M4: Describes a 4-pin mini quick-disconnect on a 150 mm (6 in.) length pigtail. Transmitted beam emitter only.
- M5: Describes a 5-pin mini quick-disconnect on a 150 mm (6 in.) length pigtail on AC/DC models. Polarized retroreflective and transmitted beam receivers only.

(1) Additional connection options may be available. See the ProposalWorks™ tool for available options by sensing mode.

Table 6 - Standard I/O (Auto PNP/NPN) Operating Mode Indication

Color	Status	Description
Green	OFF	Power is off
	ON	Power is on
	Flash (6 Hz)	Unstable light: 0.8 X <margin<1.5X
	Flash (1.4 Hz)	Output short circuit protection active
Orange	OFF	Output de-energized
	ON	Output energized

Table 7 - IO-Link Operating Mode Indication

Color	Status	Description
Green	OFF	Power is off
	Flash (1 Hz)	Power is on
Orange	OFF	Output de-energized
	ON	Output energized

See rockwellautomation.com/en-us/products/hardware/sensors-and-switches.html for additional details about the operation of the RightSight M30 in IO-Link mode.

Sensor User Interface

The green status indicator can also serve as a setup alignment aid. As the sensor is adjusted,

- A flashing green indicator shows that the sensor has detected a margin of 0.8 X
- A flashing green indicator and steady orange output indicator shows a margin greater than 1
- Steady green and orange indicators show a margin greater than 1.5. This status means that the sensor is receiving at least 1.5 times the signal strength back from the target that is required to trigger an output signal.

In general, it is desirable to have a higher margin to help overcome any deteriorating environmental conditions (dust build-up on the sensor lens). When aligning the sensor, the optimum performance can be obtained if this margin indicator is illuminated with the target in place.

Table 8 provides indicator status in the RUN mode, during operation. The sensor is always in run mode except when being taught.

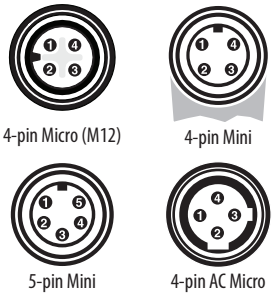
Table 8 - Connection Types

Description	Cat. No. Suffix
2 m (6.6 ft) cable	-A2
4-pin DC micro (M12) QD on 150 mm (6 in.) pigtail	-F4
Integral 4-pin DC micro (M12) QD	-D4
4-pin AC micro on 150 mm (6 in.) pigtail	-G4
4-pin mini QD on 150 mm (6 in.) pigtail	-M4
5-pin mini QD on 150 mm (6 in.) pigtail	-M5

Wiring

The quick-disconnect connector is shown in Figure 20. The pin numbers correspond to the convex connectors on the sensor.

Figure 20 - Pinouts



DC Models

Figure 21 - Polarized Retroreflective (Cat. Nos. 42AF-P2MAB1-F4 and 42AF-P2MAB1-D4) Light Operate and Dark Operate (Auto PNP or NPN)

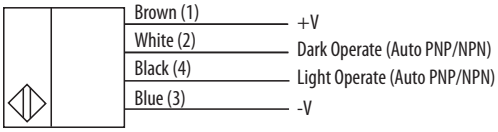


Figure 22 - Transmitted Beam Receiver (Cat. Nos. 42AF-R1MAB1-F4 and 42AF-R1MAB1-D4) Light Operate and Dark Operate (Auto PNP or NPN)

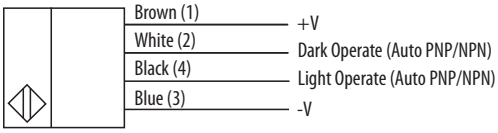
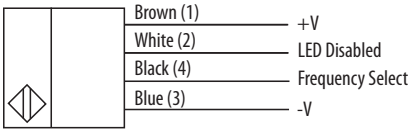


Figure 23 - Transmitted Beam Emitter (Cat. Nos. 42AF-E1EZB1-F4 and 42AF-E1EZB1-D4)



Item	Description
LED Disable	For normal operation, the white wire needs no connection. To disable the light source, connect the white wire to +V.
Frequency Select	For normal operation, the white wire needs no connection. To change the emitter operating frequency, connect the black wire to +V. This feature is supported in future firmware revisions of the Transmitted Beam Receiver.

IMPORTANT For transmitted beam emitter only:
Do not connect pin 2 and pin 4 for normal operation. Unless a change in frequency is required when working with a receiver, these two pins remain unconnected when wiring the transmitted beam emitter sensor to an ArmorBlock® I/O module.

AC/DC Models

Figure 24 - Polarized Retroreflective and Transmitted Beam Emitter Light Operate (Cat. Nos. 42AF-P2RHB1-G4 and 42AF-R1RHB1-G4)

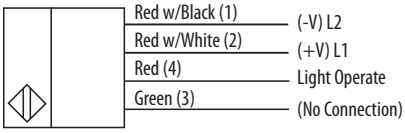


Figure 25 - Dark Operate (Cat. Nos. 42AF-P2SHB1-G4 and 42AF-R1SHB1-G4)

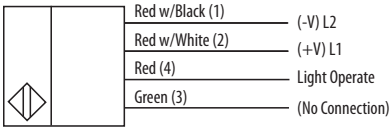


Figure 26 - Polarized Retroreflective and Transmitted Beam (Cat. Nos. 42AF-P2CHB1-A2 and 42AF-R1CHB1-A2)

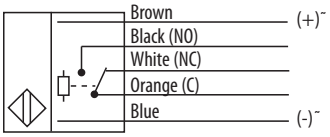


Figure 27 - Polarized Retroreflective and Transmitted Beam (Cat. Nos. 42AF-P2CHB1-M5 and 42AF-R1CHB1-M5)

Figure 28 - Transmitted Beam Emitter (Cat. Nos. 42AF-E1UZB1-A2 and 42AF-E1UZB1-G4)

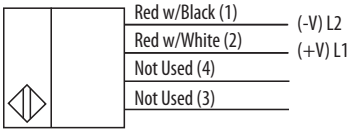


Table 9 - UL508 Overcurrent Protection

Conductor Size		Ampere Rating of the Overcurrent Protection, Max
AWG	mm^2	
20	0.52	5
22	0.32	3
24	0.20	2
26	0.13	1
28	0.08	0.8
30	0.05	0.5

Approximate Dimensions

Figure 29 - Integral M12 Connector [mm (in.)]

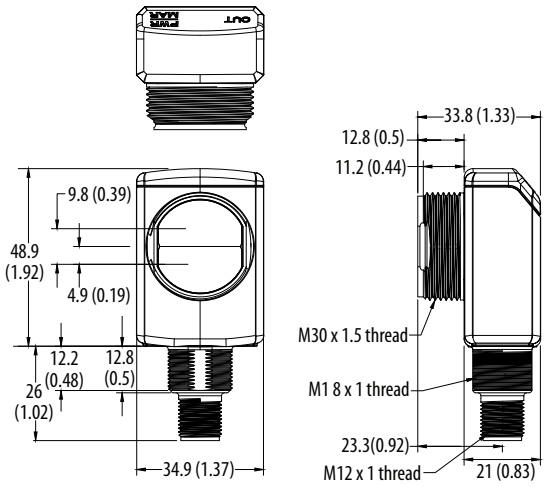
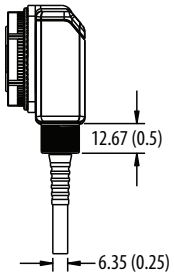


Figure 30 - M12 Pigtail and Cable Models [mm (in.)]



Typical Response Curves

Figure 31 - Visible Red Polarized Retroreflective — 10 m (32.81 ft) Margin Curve

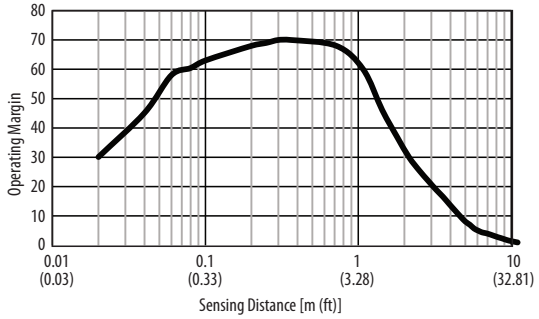


Figure 32 - Visible Red Polarized Retroreflective — 10 m (32.81 ft) Beam Pattern

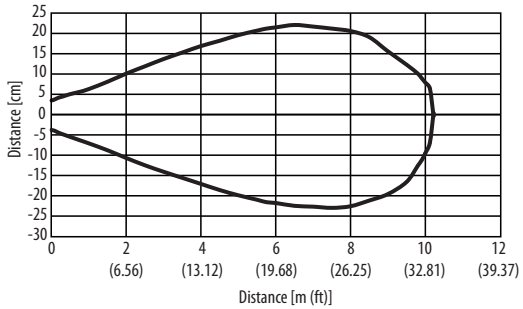


Figure 33 - Infrared Transmitted Beam Emitter — 80 m (262.5 ft) Margin Curve

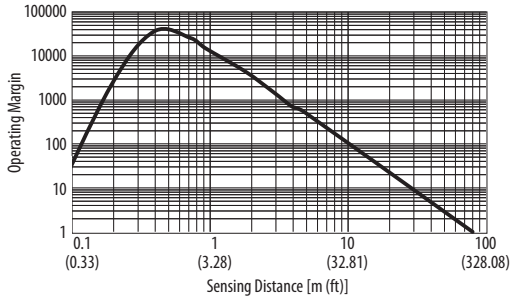
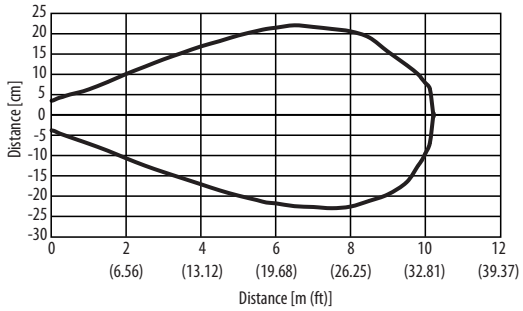


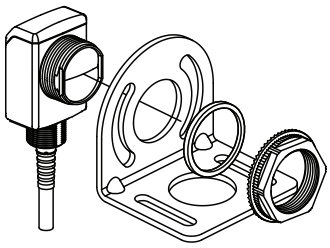
Figure 34 - Infrared Transmitted Beam Emitter — 80 m (262.5 ft) Beam Pattern



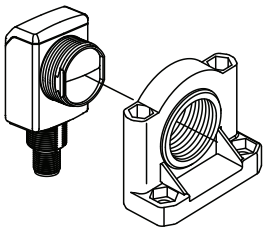
Accessories

Figure 35 - 30 mm (1.2 in.) Right Angle Mounting Bracket

Cat. No. 60-2421



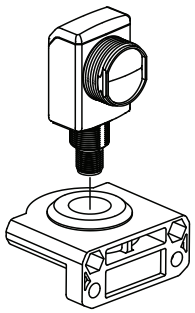
Cat. No. 60-2439



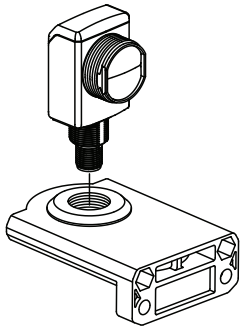
IMPORTANT	For polarized retroreflective sensors only: For optimal detection performance, when highly reflective targets pass between the emitter and the reflector, we recommend that you always install the rubber washer that is provided with the polarized sensor.

Figure 36 - 18 mm (0.7 in.) Swivel/tilt Mounting Bracket

Cat. No. 60-2649



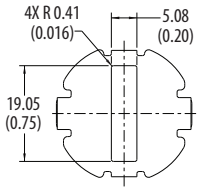
Cat. No. 60-2681



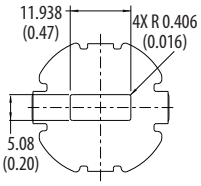
Description	Cat. No.
4-pin DC micro, 2 m (6.6 ft) cordset	889D-F4AC-2
18 mm (0.7 in.) straight bracket	60-2656
18 mm (0.7 in.) right angle bracket	60-2657
30 mm (1.2 in.) mounting bracket, stainless steel	60-2421
30 mm (1.2 in.) swivel/tilt bracket	60-2439
18 mm (0.7 in.) swivel/tilt bracket	60-2649
Extended 18 mm (0.7 in.) swivel/tilt bracket	60-2681
76 mm (3 in.) diameter reflector	92-39
47 mm (1.85 in.) diameter reflector	92-47
84 mm (3.3 in.) diameter reflector	92-125
18 mm (0.7 in.) base mount, U-shaped protective bracket	60-BAF-US
18 mm (0.7 in.) base mount bracket, stainless steel	60-BAF-BM
30 mm (1.2 in.) nose mount bracket, stainless steel	60-BAF-SM
Aperture, 5 x 17 mm (0.2 x 0.67 in.) vertical slot, stainless steel	60-AAF1-VS
Aperture, 5 x 12 mm (0.2 x 0.47 in.) horizontal slot, stainless steel	60-AAF1-HS
Aperture, 2.5 x 12 mm (0.1 x 0.47 in.) horizontal slot, stainless steel	60-AAF2-HS
Aperture, 5 mm (0.2 in.) diameter, stainless steel	60-AAF1-DS
Aperture, 2.5 mm (0.1 in.) diameter, stainless steel	60-AAF2-DS
U-shaped protective bracket	60-BAF-US
18 mm (0.7 in.) base mount bracket, stainless steel	60-BAF-BM
30 mm (1.2 in.) nose mount bracket, stainless steel	60-BAF-SM
Aperture, 5 x 17 mm (0.2 x 0.67 in.) vertical slot, stainless steel	60-AAF1-VS
Aperture, 5 x 12 mm (0.2 x 0.47 in.) horizontal slot, stainless steel	60-AAF1-HS
Aperture, 2.5 x 12 mm (0.1 x 0.47 in.) horizontal slot, stainless steel	60-AAF2-HS
Aperture, 5 mm (0.2 in.) diameter, stainless steel	60-AAF1-DS
Aperture, 2.5 mm (0.1 in.) diameter, stainless steel	60-AAF2-DS

Figure 37 - Apertures [mm (in.)]

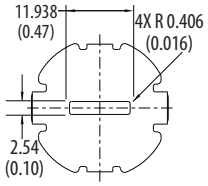
Cat. No. 60-AAF1-VS
5x17 mm (0.2x0.67 in.)
Vertical Slot



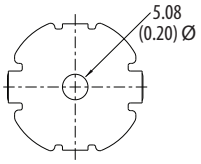
Cat. No. 60-AAF1-HS
5x12 mm (0.2x0.47 in.)
Horizontal Slot



Cat. No. 60-AAF2-HS
2.5x12 mm (0.1x0.47 in.)
Horizontal Slot



Cat. No. 60-AAF1-DS
5 mm (0.2 in.)
Diameter



Cat. No. 60-AAF2-DS
2.5 mm (0.1 in.)
Diameter

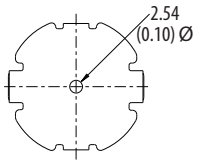


Figure 38 - Cat. No. 60-BAF-US 18 mm (0.7 in.) Mounting Bracket [mm (in.)]

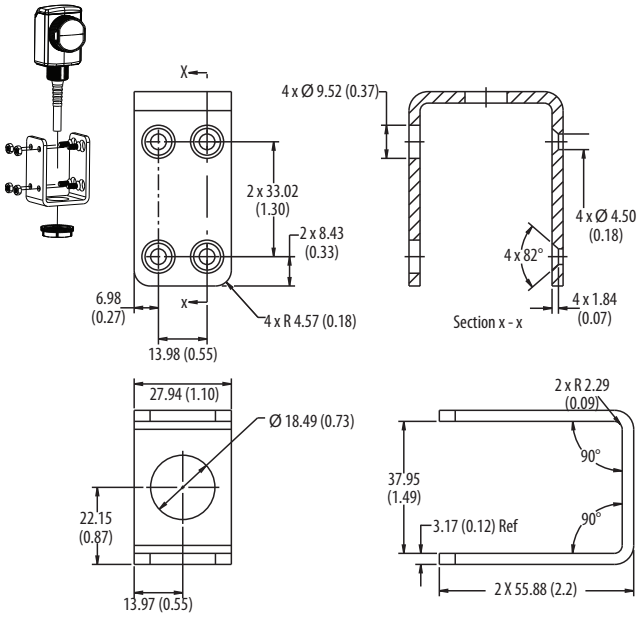


Figure 39 - Cat. No. 60-BAF-SM 30 mm (1.2 in.) Bracket Side [mm (in.)]

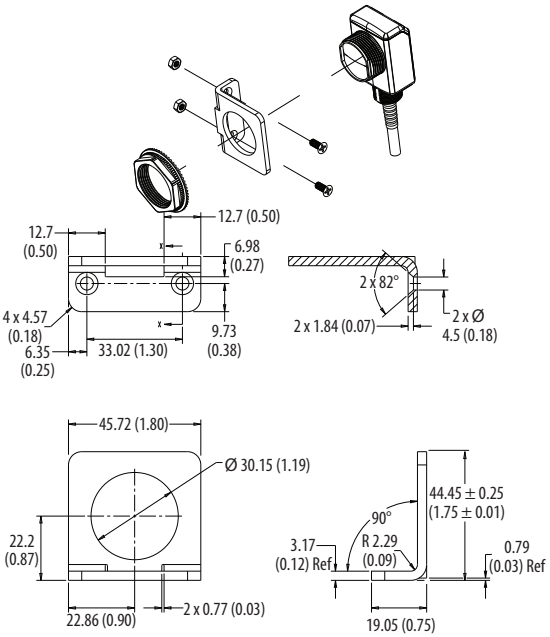
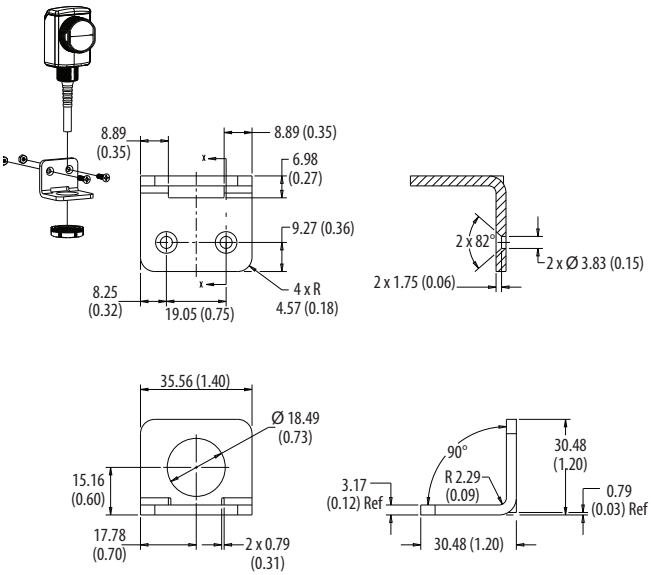


Figure 40 - Cat. No. 60-BAF-BM 18 mm (0.7 in.) Bracket Back [mm (in.)]



42CA 18 mm (0.71 in.) Plastic Cylindrical Sensor

Features

- Plastic 18 mm (0.71 in.) industry standard enclosure
- Extended range high-speed models
- Complementary light and dark operate
- Patented ASIC design offers linear sensitivity adjustment, stability indication, and excellent noise immunity
- Two highly visible LEDs help operators confirm proper sensor operation
- IP67 rated enclosure

Available Models

- Retroreflective
- Polarized retroreflective
- Standard diffuse
- Fixed background suppression
- Transmitted beam

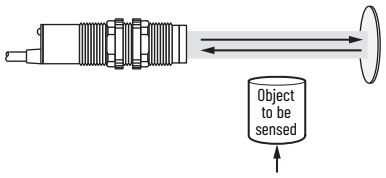
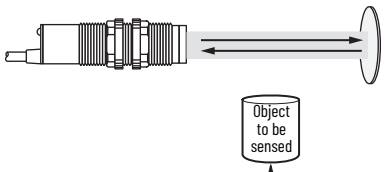
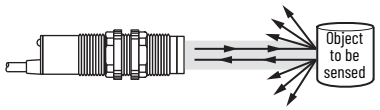
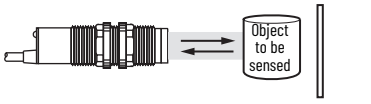
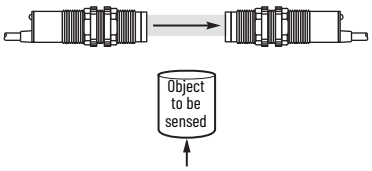
Specifications

Attribute	42CA 18 mm (0.71 in.) Plastic Cylindrical Sensor
Certifications	cULus Listed and CE Marked for all applicable directives
Shock	30 g with 11 ms pulse duration, meets or exceeds IEC 600947-5-2
Vibration	10…55 Hz, 1 mm amplitude, meets or exceeds IEC 600947-5-2
Environmental	
Enclosure type rating	IP67
Operating temperature	-25…+70 °C (-13…+158 °F)
Relative humidity	5…95% (noncondensing)
Ambient light immunity	Incandescent light 5000 lux
User Interface	
Indicator LEDs	Orange: Output status Green: Power, short circuit, and margin
Electrical	
Operating voltage	10…30V DC
Current consumption	30 mA max
Protection type	Short circuit, reverse polarity, false pulse, overload
Outputs	
Output type	See Product Selection on page 21.
Output function	Light operate and dark operate
Load current	100 mA
Leakage current	0.1 mA (DC), max
Mechanical	
Housing material	Polybutylene terephthalate (PBT)
Lens material	Polymethyl methacrylate (PMMA)
Connection type	2 m (6.6 ft) cable, 4-pin DC micro (M12) integral QD
Supplied accessories	Two 18 mm (0.71 in.) fastener nuts

Optical and Response Time Characteristics

Attribute	Sensing Mode				
	Retroreflective	Polarized Retroreflective	Diffuse	Background Suppression	Transmitted Beam
Field of View	1.2°	1.3°	3° 7.5° 5°	5.7° 3.4°	1.5°
Spot Size	102 mm @ 4.8 m 168 mm @ 7.2 m	92 mm @ 3.8 m	5 mm @ 100 mm 67 mm @ 400 mm 89 mm @ 1 m	6 mm @ 50 mm 6 mm @ 100 mm	420 mm @ 16 m
Light Source	Visible red 660 nm		Infrared	Visible red 660 nm	Infrared
Response Time	1 ms (4.8 m) 1 ms (7.2 m)	1 ms	1 ms	0.5 ms	2 ms (0.5 ms for background suppression)

Product Selection

Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No.[1]
 Retroreflective	Visible red 660 nm	0.002...4.8 m (0.0...15.7 ft)	No adjustment	Light and dark operate	NPN	42CA-U2MNB-D4
					PNP	42CA-U2MPB-D4
		0.002...7 m (0.0...23 ft)	Single-turn potentiometer		NPN	42CA-U2MNA-D4
					PNP	42CA-U2MPA-D4
 Polarized Retroreflective	Visible red 660 nm	0.002...3.8 m (0.0...12.5 ft)	No adjustment	Light and dark operate	NPN	42CA-P2MNB-D4
					PNP	42CA-P2MPB-D4
 Diffuse	Infrared	0...100 mm (0...3.9 in.)	Single-turn potentiometer	Light and dark operate	NPN	42CA-D1MNAE-D4
					PNP	42CA-D1MPAE-D4
		0...400 mm (0...15.7 in.)			NPN	42CA-D1MNAJ-D4
					PNP	42CA-D1MPAJ-D4
		0...1 m (0...39.4 in.)			NPN	42CA-D1MNAL-D4
					PNP	42CA-D1MPAL-D4
 Background Suppression	Visible red 660 nm	50 mm (2 in.)	No adjustment	Light and dark operate	NPN	42CA-B2LNBC-D4
					PNP	42CA-B2LPBC-D4
		100 mm (3.9 in.)			NPN	42CA-B2LNBE-D4
					PNP	42CA-B2LPBE-D4
 Transmitted Beam	Infrared	0.003...16 m (0.01...52.5 ft)	No adjustment	— (Emitter)	—	42CA-E1EZB1-D4
				Selectable light or dark operate	NPN	42CA-R1MNA1-D4
					PNP	42CA-R1MPA1-D4
Recommended standard 4-pin DC micro (M12) quick-disconnect cordset						889D-F4AC-2
Recommended reflector						92-47

(1) Connection Options: The -D4 suffix describes a 4-pin DC micro (M12) quick-disconnect connector. For additional connection options, replace the -D4 suffix with -A2 for a 2 m cable without quick-disconnect connection (for example, 42CA-P2MPB-A2).

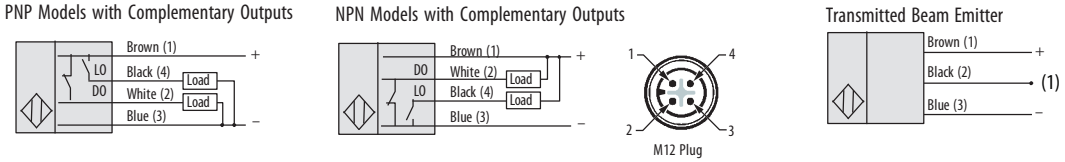
User Interface

LED Color	State	Status
Yellow	Off	Output is de-energized [1]
	On	Output is energized [1]
Green	Off	Power is off
	On	Power is on
	Flashing (6 Hz)	Unstable (0.5 < Margin < 2)
	Flashing (1.5 Hz)	Output short-circuit protection active

(1) Black wire or pin 4 of the connector.

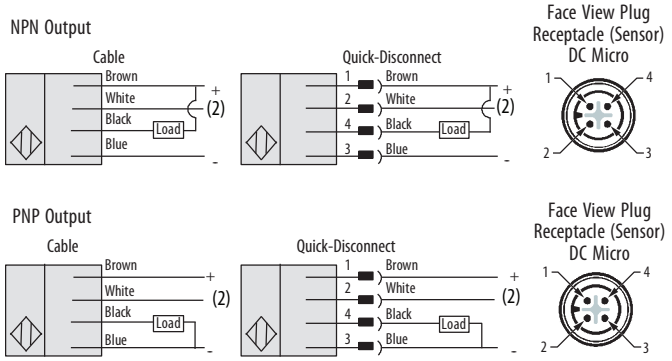
Wiring Diagrams

Figure 41 - Retroreflective, Polarized Retroreflective, Diffuse, and Transmitted Beam Wiring Diagrams



(1) For normal operation, black wire (pin 2) needs no connection. To disable the light source, connect the black wire (pin 2) to -V.

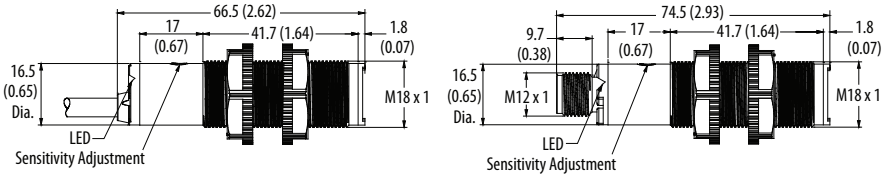
Figure 42 - Background Suppression Wiring Diagrams



(2) Open circuit or tie white (2) and brown (1) conductors together for L.O. Tie white (2) and blue (3) conductors together for D.O.

Approximate Dimensions

Dimensions shown in mm (in.).



Typical Response Curves

Figure 43 - Standard and Background Suppression

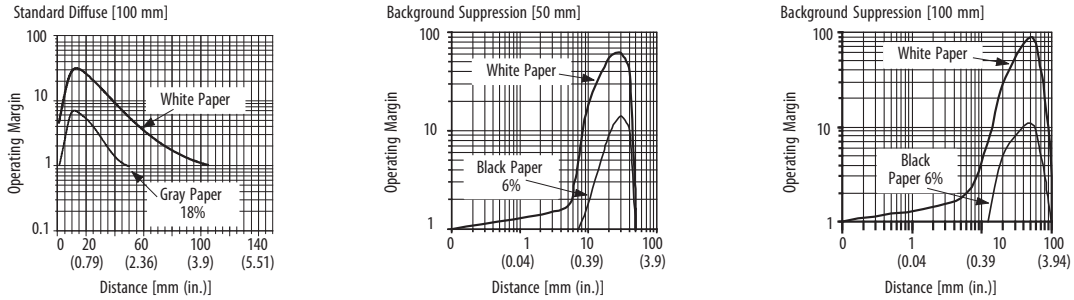


Figure 44 - Operating Margin

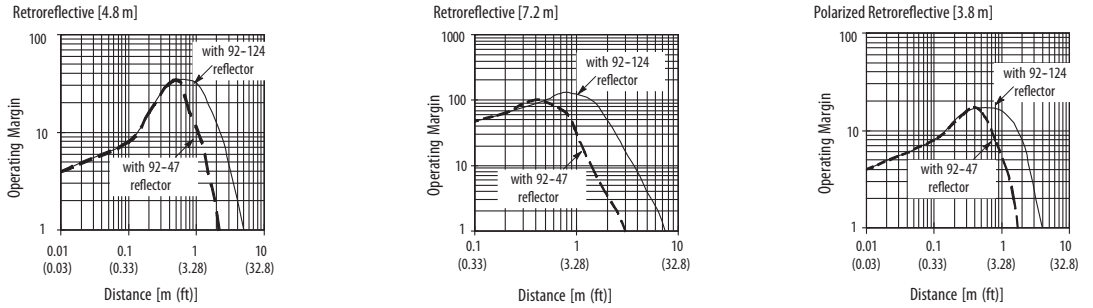


Figure 45 - Beam Pattern

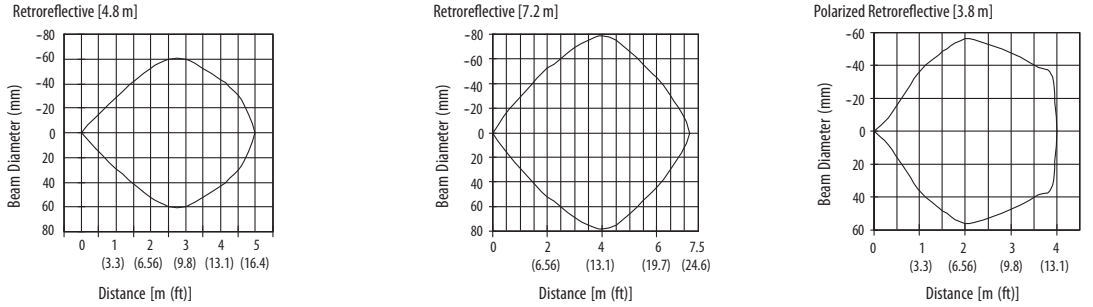


Figure 46 - Operating Margin

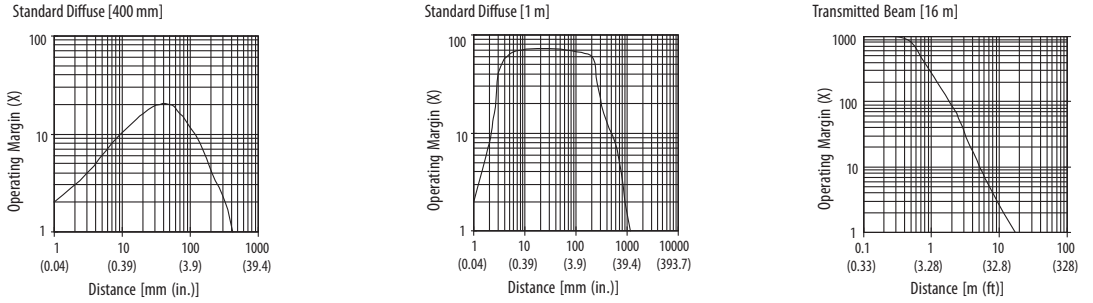
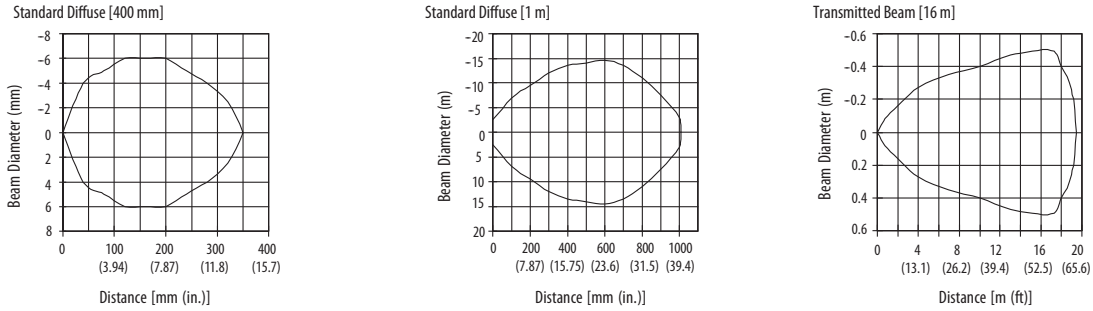


Figure 47 - Beam Pattern



Cordsets and Accessories

Description	Cat. No.
DC micro QD cordset, straight, 4-pin, 2 m (6.6 ft)	889D-F4AC-2
DC micro QD cordset, right angle, 4-pin, 2 m (6.6 ft)	889D-R4AC-2
Mounting bracket, snap-clamp	871A-SCBP18
Mounting bracket, right angle	60-2657
Mounting bracket, swivel/tilt	60-2649
Mounting bracket, straight	60-2656
76 mm (3 in.) diameter reflector	92-39
32 mm (1.25 in.) diameter reflector	92-47

42CE RightSight C18 Photoelectric Sensors

The RightSight™ C18 family offers a wide range of sensing modes and an adjustment knob that simplifies sensitivity adjustment for maximum application flexibility.

The RightSight sensor offers an industry standard 18 mm (0.71 in.) cylindrical housing ideal for compact housing installations.

Features

- Visible light source offered on select models for ease of alignment
- Embedded IO-Link 1.1 communication protocol with enhanced IO-Link parameters
- Input to disable light source on transmitted beam emitter
- IP67 rated enclosure
- -40...+65 °C (-40...+149 °F) operating temperatures

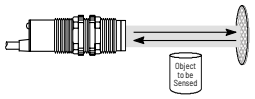
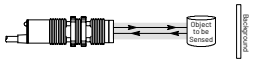
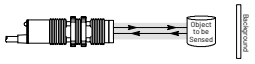
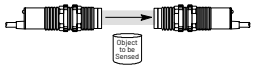
Available Models

- Polarized retroreflective
- Diffuse
- Background suppression
- Background reflection
- Transmitted beam

Specifications

Attribute	Value
Certifications	CE Marked for all applicable directives, cULus Listed, KCC, RCM, UKCA Marked for all applicable regulations
EMC Directive	EN 60947-5-2
Standards	UL 60947-5-2
Ambient light immunity	EN 60697-5-2:2007+A:2012
For declarations of conformity and certification details, visit rok.auto/certifications.	
Functional Safety Parameters	
MTTFd	860 a
User Interface	
Status indicators	Green and orange
Adjustments	Adjustment knob depending on catalog number
Optical	
LED	Visible red on all models
Electrical	
Operating voltage	10 ...30V DC
Current consumption	Less than 35 mA
Sensor protection	Reverse polarity and short circuit
Output	
Output types	NPN or PNP by catalog number
Output mode	Light and dark operate
Response Time	
Diffuse, max	0.5 ms
Transmitted beam, max	0.5 ms
Polarized retroreflective, max	0.5 ms
Clear object detection, max	0.5 ms
Background suppression, max	0.66 ms
Background reflection, max	0.66 ms
Load Current	
Resistive load, max	100 mA
Mechanical	
Housing material	ABS
Lens material	Acrylic
Environmental	
Enclosure rating	IP67
Operating temperature	-40...+65 °C (-40...+149 °F)

Product Selection

Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No.
 Polarized Retroreflective	Visible red	6 m (19.7 ft) with Cat. No. 92-125 reflector	No adjustment knob	Complementary light and dark operate	NPN	42CE-P2MNB1-D4
					PNP	42CE-P2MPB1-D4
			Adjustment knob		NPN	42CE-P2MNA1-D4
					PNP	42CE-P2MPA1-D4
 Diffuse	Visible red	800 mm (31.5 in.)	Adjustment knob	Complementary light and dark operate	NPN	42CE-D2MNA1-D4
					PNP	42CE-D2MPA1-D4
 Background Suppression	Visible red	50 mm (2 in.)	No adjustment knob	Complementary light and dark operate	NPN	42CE-B2MNB1-D4
					PNP	42CE-B2MPB1-D4
		100 mm (3.9 in.)			NPN	42CE-B2MNB2-D4
					PNP	42CE-B2MPB2-D4
		210 mm (8.3 in.)	Adjustment knob		NPN	42CE-B2MNA3-D4
					PNP	42CE-B2MPA3-D4
 Background Reflection	Visible red	210 mm (8.3 in.)	Adjustment knob	Complementary light and dark operate	NPN	42CE-N2MNA1-D4
					PNP	42CE-N2MPA1-D4
 Transmitted Beam	Visible red	25,000 mm (984.2 in.)	No adjustment knob	–	–	42CE-E2EZB1-D4
				Complementary light and dark operate	NPN	42CE-R2MNB1-D4
					PNP	42CE-R2MPB1-D4

IMPORTANT Connection Options [1]: The following suffixes describe the available connection options:

- D4: Describes an integral 4-pin DC micro (M12) quick-disconnect for DC models.
- A2: Describes a 2 m (6.6 ft) PVC cable.

(1) Additional connection options may be available. See the ProposalWorks™ tool for available options by sensing mode.

Status Indicators and User Interface

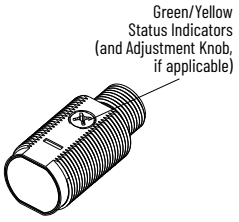


Table 10 - Standard I/O Operating Mode Indication

Color	Status	Description
Green	OFF	Power is OFF
	ON	Power is ON
	Flash (6 Hz)	Unstable light: 0.8 X <margin<1.5X
	Flash (1.4 Hz)	Output short circuit protection active
Orange	OFF	Output de-energized
	ON	Output energized

Table 11 - IO-Link Operating Mode Indication

Color	Status	Description
Green	OFF	Power is OFF
	Flash (1 Hz)	Power is ON
Orange	OFF	Output de-energized
	ON	Output energized

See rockwellautomation.com/en-us/products/hardware/allen-bradley/sensors-and-switches/presence-sensors/photoelectric-sensors for additional details about the operation of the RightSight C18 in IO-Link mode.

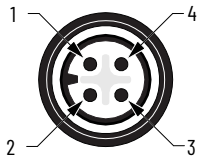
The green status indicator can also serve as a setup alignment aid that indicates that a margin of 1.5 has been reached. The sensor receives at least 1.5 times the signal strength back from the target that is required to trigger an output signal. In general, it is desirable to have a higher margin to help overcome any deteriorating environmental conditions, that is, dust build-up on the sensor lens. When aligning the sensor, the optimum performance can be obtained if this margin indicator is illuminated with the target in place. When aligning diffuse mode sensors, verify that the sensitivity is set at its maximum setting; use the single-turn adjustment knob. Pan the sensor left, right, up, and down to center the beam on the target. Decrease this setting to help prevent the sensor from detecting a background object. If this problem persists, the application requires the use of a background suppression, background reflection, or retroreflective sensing mode.

For sensor alignment, see the 42CE RightSight C18 Photoelectric Sensors Installation Instructions, publication 42CE-IN001.

Wiring

The quick-disconnect connector is shown in the following diagrams. The pin numbers correspond to plug connectors on the sensor.

Figure 48 - Integral Micro (M12) QD Pinout



Output Wiring

Figure 49 - PNP Complementary Models

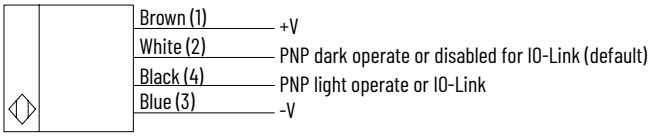
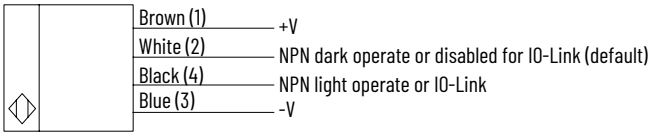
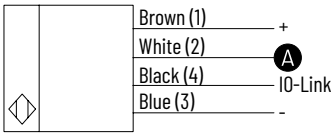


Figure 50 - NPN Complementary Models



Transmitted Beam Emitter



Item	Description
A	For normal operation, the black wire (Pin 4) needs no connection. To deactivate the light source, connect the black wire (Pin 4) to +V.

The IO-Link output Pin 4 (black) does not support the connection of multiple sensors in series (for example, one sensor powers the next sensor). The connection of multiple sensors in series can be achieved when using Pin 2 (white) outputs or by ordering a non-IO-Link catalog number.

Visit rok.auto/knowledgebase or contact your local Allen-Bradley distributor or Rockwell Automation sales office for specific ordering information.

Typical Response Curves

Diffuse

Figure 51 - 800 mm (31.5 in.) Sensing Distance - Margin Curves

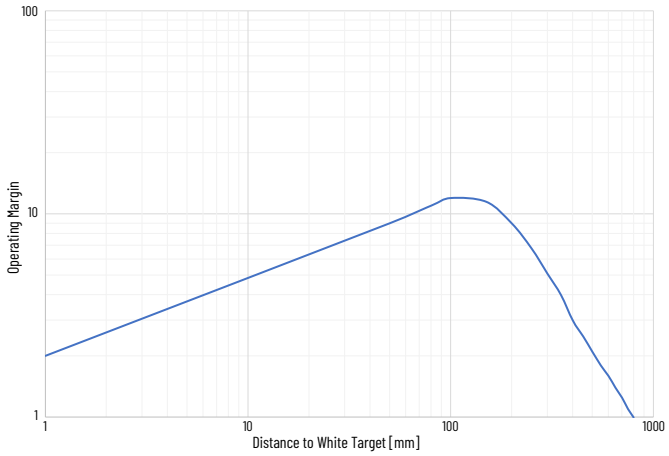
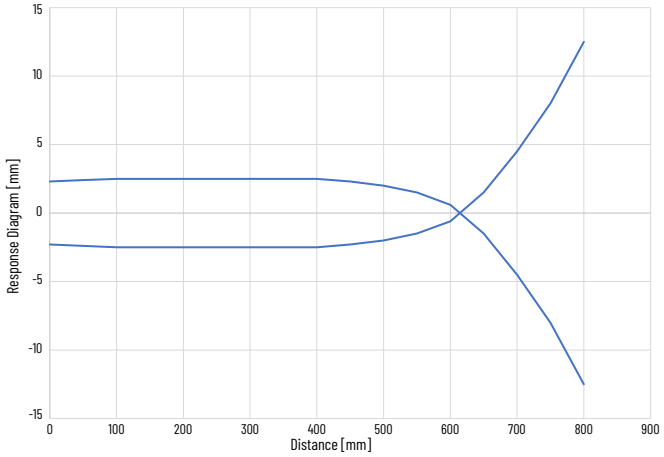


Figure 52 - 800 mm (31.5 in.) Sensing Distance - Beam Pattern



Polarized Retroreflective

Figure 53 - 6 m (19.7 ft) Sensing Range - Margin Curve

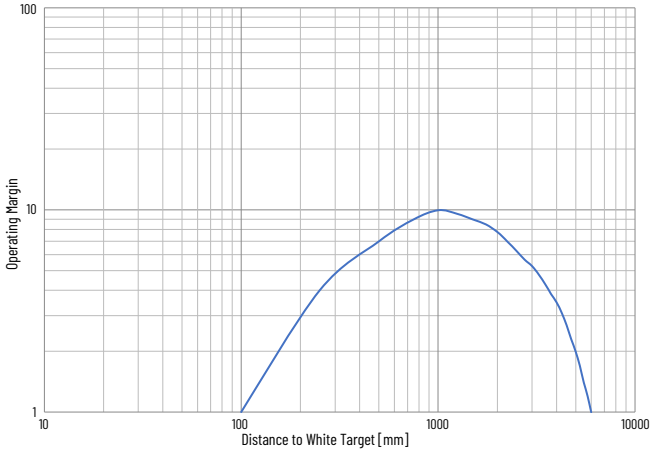
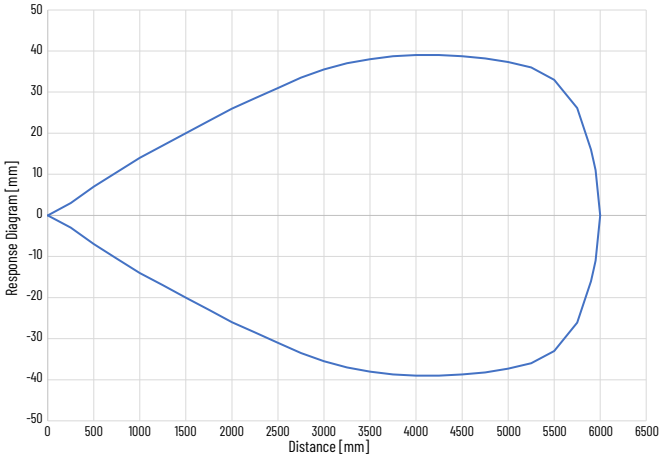


Figure 54 - 6 m (19.7 ft) Sensing Range - Beam Pattern



Background Suppression

Figure 55 - 50 mm (1.97 in.) Sensing Range - Margin Curves

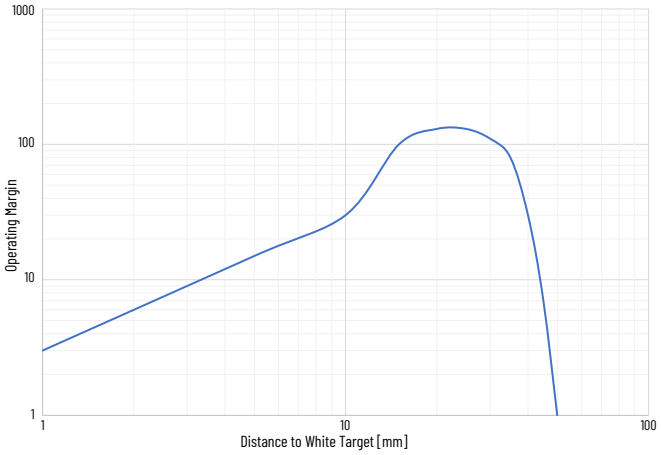


Figure 56 - 50 mm (1.97 in.) Sensing Range - Beam Pattern

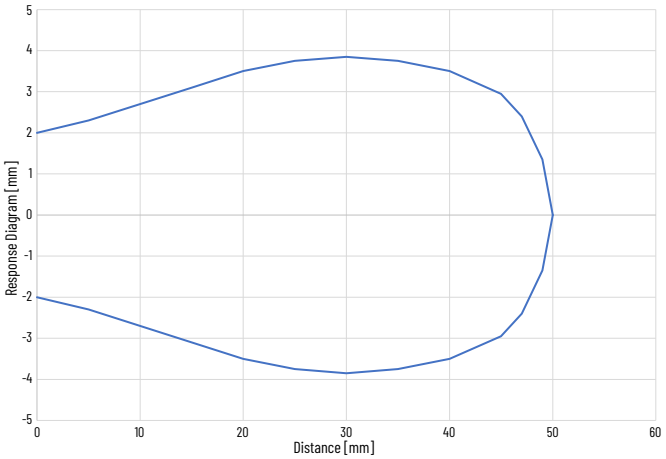


Figure 57 - 100 mm (3.94 in.) Sensing Range - Margin Curves

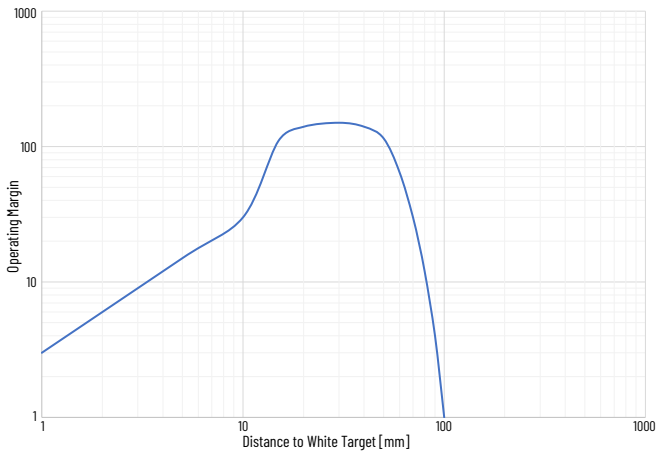


Figure 58 - 100 mm (3.94 in.) Sensing Range - Beam Pattern

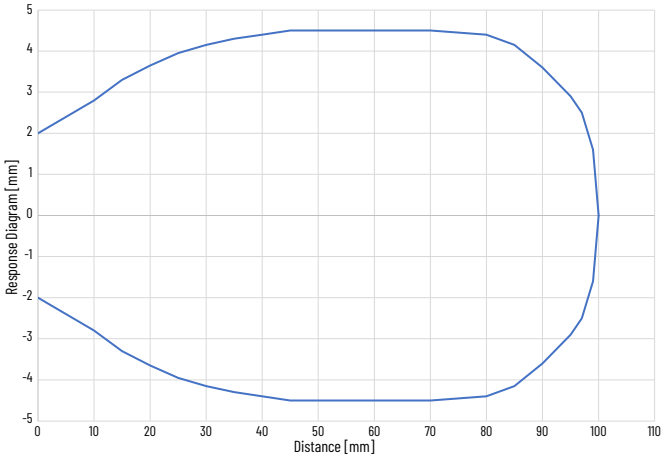


Figure 59 - 210 mm (8.27 in.) Sensing Range - Margin Curves

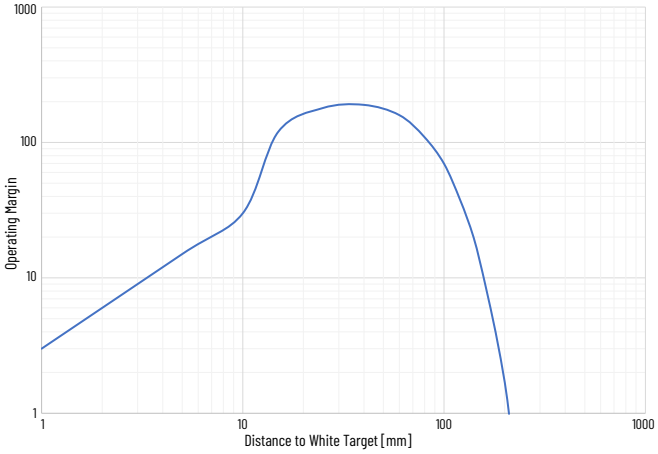
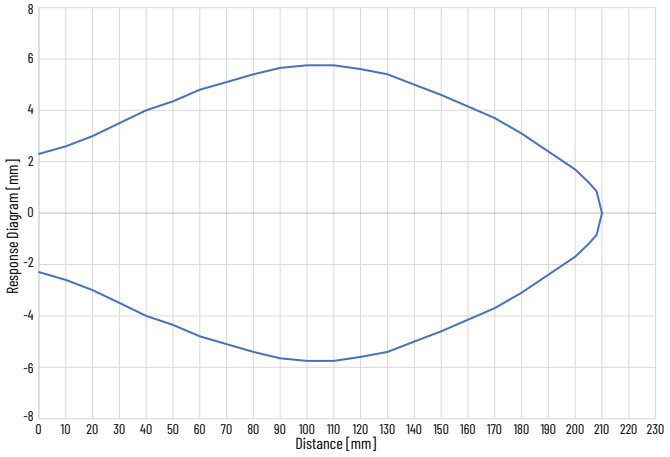


Figure 60 - 210 mm (8.27 in.) Sensing Range - Beam Pattern



Background Reflection

Figure 61 - 210 mm (8.27 in.) Sensing Range - Margin Curves

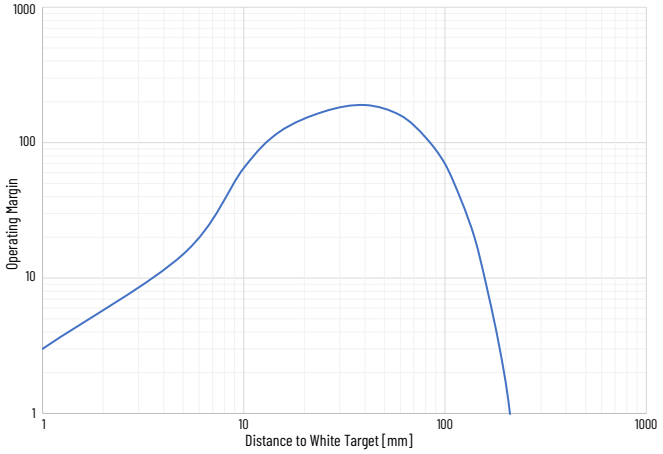
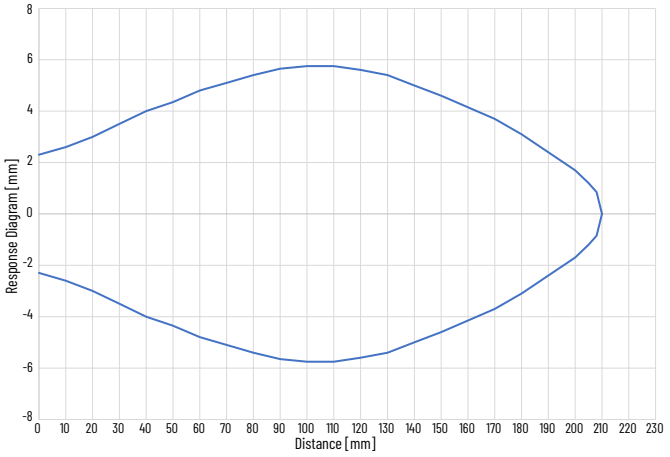


Figure 62 - 210 mm (8.27 in.) Sensing Range - Beam Patterns



Transmitted Beam

Figure 63 - 25 m (82 ft) Sensing Range - Margin Curves

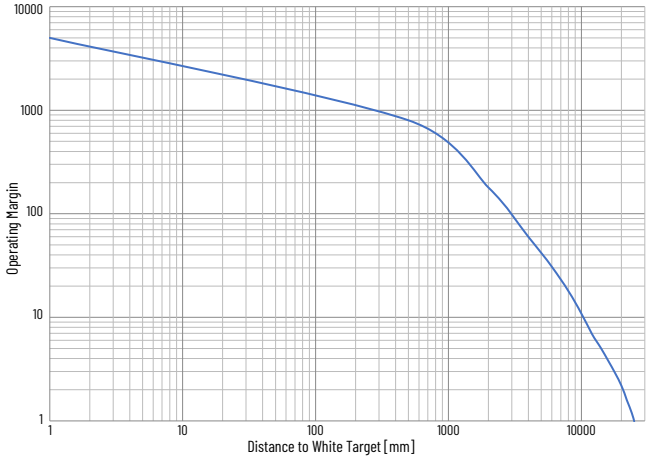
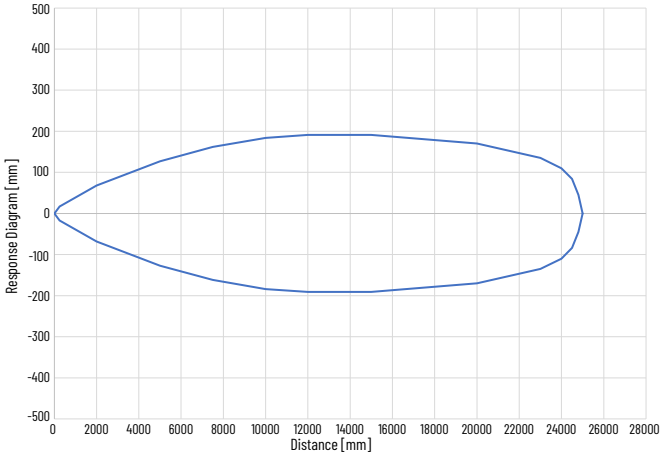


Figure 64 - 25 m (82 ft) Sensing Range - Beam Pattern



Approximate Dimensions

Figure 65 - 2 m (6.6 ft) Cable Models [mm (in.)]

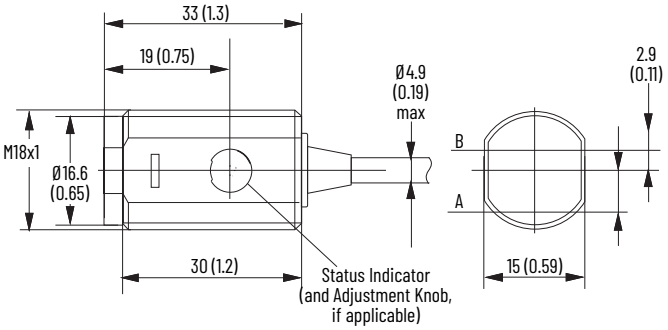


Figure 66 - Integral Micro (M12) QD Models [mm (in.)]

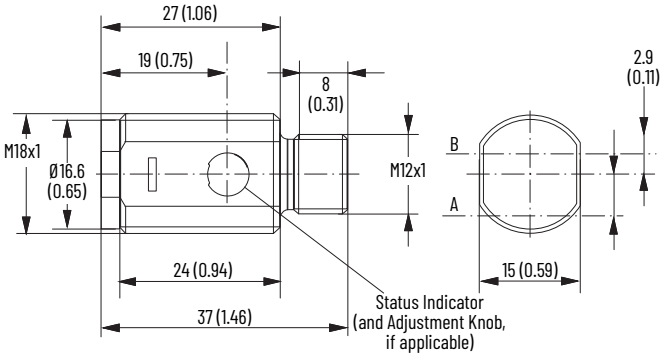


Table 12 - Emitter and Receiver Axis Position

Sensing Mode	A [mm (in.)]	B [mm (in.)]
Diffuse	3.5 (0.14)	3.5 (0.14)
Background suppression	4.5 (0.18)	2.9 (0.11)
Background reflection	3.5 (0.14)	3.5 (0.14)
Polarized retroreflective	3.5 (0.14)	3.5 (0.14)
Transmitted beam emitter	0 (0)	
Transmitted beam receiver	0 (0)	

42CF 12 mm (0.5 in.) Metal Cylindrical Sensor

Features

- Metal 12 mm (0.5 in.) industry-standard enclosure
- Teach button simplifies sensitivity setup
- Selectable light and dark operate outputs provide added flexibility
- Remote teach for diffuse and polarized retroreflective model
- IP67 rated enclosure

Available Models

- Polarized retroreflective
- Standard diffuse
- Transmitted beam

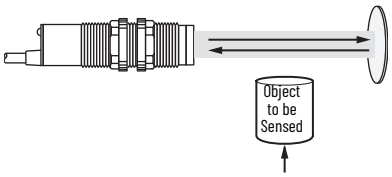
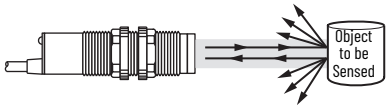
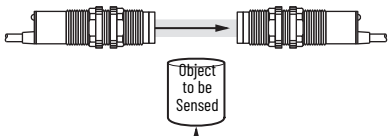
Specifications

Attribute	42CF 12 mm (0.5 in.) Metal Cylindrical Sensor
Certifications	cULus Listed and CE Marked for all applicable directives
Shock	30 g with 1 ms pulse duration, meets or exceeds IEC 600947-5-2
Vibration	10…55 Hz, 1 mm amplitude, meets or exceeds IEC 600947-5-2
Environmental	
Enclosure type rating	IP67
Operating temperature	-25…+70 °C (-13…+158 °F)
Relative humidity	5…95% (noncondensing)
Ambient light immunity	Incandescent light 3000 lux
User Interface	
Indicator LED	Orange LED for output indication
Electrical	
Operating voltage	10…30V DC
Current consumption	30 mA max
Protection type	False pulse, reverse polarity, short circuit
Outputs	
Output type	See Product Selection on page 31.
Output function	Selectable light or dark operate
Load current	100 mA
Leakage current	0.1 µA (DC) max [10 µA, max]
Mechanical	
Housing material	Nickel-plated brass
Lens material	Acrylic
Connection type	2 m (6.6 ft) cable, 4-pin DC micro (M12) QD
Supplied accessories	Two 12 mm (0.5 in.) fastening nuts

Optical and Response Time Characteristics

Attribute	Sensing Mode		
	Polarized Retroreflective	Diffuse	Transmitted Beam
Field of View	2.3°	11.4° for 100 mm 5.3° for 300 mm	1.4°
Spot Size	88 mm @ 2 m (6.6 ft)	11.4° for 100 mm 29.5 mm @ 300 mm	53.3 mm @ 2 mm
Light Source	Visible red 660 nm	Infrared 880 nm	Infrared 880 nm
Response Time	1.25 ms	1.25 ms	2 ms

Product Selection

Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No.(1)
 Polarized Retroreflective	Visible red 660 nm	0.025…2 m (0.08…6.6 ft)	Push button	Selectable light or dark operate	NPN	42CF-P2LNA1-D4
					PNP	42CF-P2LPA1-D4
 Diffuse	Infrared 880 nm	1…100 mm (0…3.9 in.)	Push button	Selectable light or dark operate	NPN	42CF-D1LNA1-D4
					PNP	42CF-D1LPA1-D4
		1…300 mm (0…12.2 in.)			NPN	42CF-D1LNA2-D4
					PNP	42CF-D1LPA2-D4
 Transmitted Beam	Infrared 880 nm	2 m (6.6 ft)	No adjustment	— (Emitter)	—	42CF-E1EZB-D4
				Selectable light or dark operate	NPN	42CF-R1LNB1-D4
					PNP	42CF-R1LPB1-D4
Recommended standard 4-pin DC micro (M12) quick-disconnect cordset						889D-F4AC-2
Recommended reflector						92-39

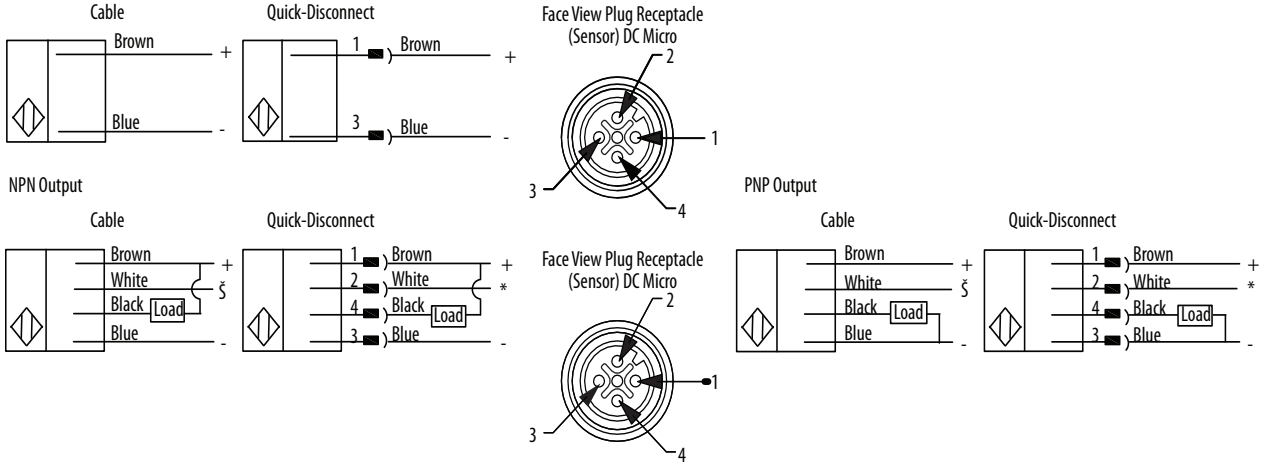
(1) Connection Options: The -D4 suffix describes a 4-pin DC micro (M12) quick-disconnect connector. For additional connection options, replace the -D4 suffix with: -A2 for a 2 m cable without quick-disconnect connection (for example, 42CF-P2LPA-A2).

User Interface

LED Color	State	Status
Orange	Off	Sensor output is deactivated
	On	Sensor output is activated

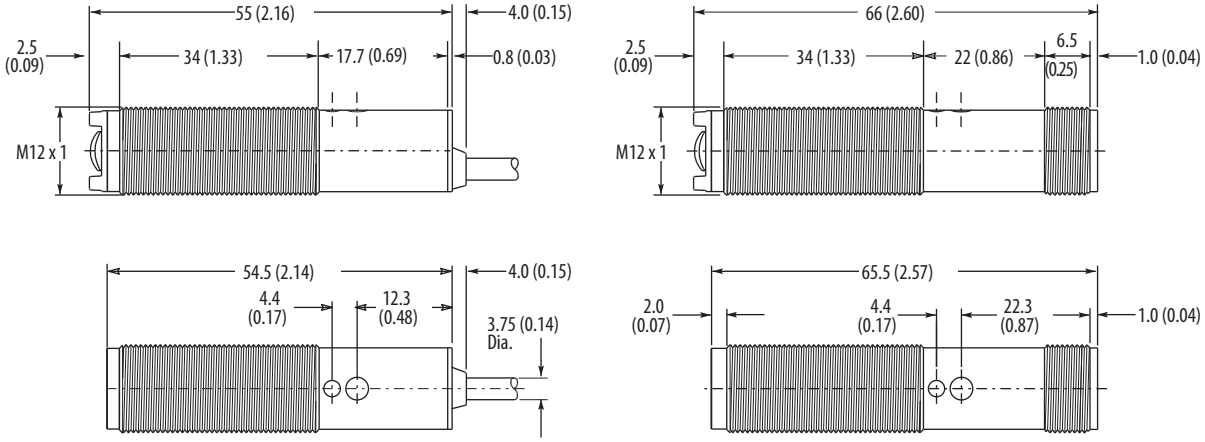
Wiring Diagrams

Figure 67 - Diffuse, Polarized Retroreflective, and Transmitted Beam Wiring Diagrams

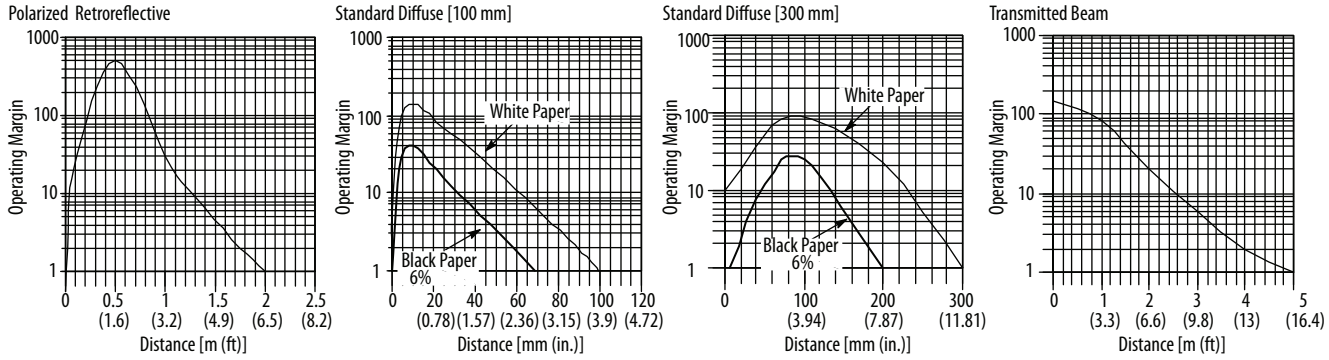


Approximate Dimensions

Dimensions shown in mm (in.).



Typical Response Curves



Cordsets and Accessories

Description	Cat. No.
DC Micro QD cordset, straight, 4-pin, 2 m (6.6 ft)	889D-F4AC-2
Mounting bracket	871A-BRNR
Snap-clamp mounting bracket	871A-SCBP12
Reflectors	92-39

42CM 18 mm (0.71 in.) Metal Cylindrical Sensor

Features

- Metal 18 mm (0.71 in.) industry-standard enclosure
- Visible red and Class 1 eye safe laser beam in laser models
- Small spot size in laser models verifies the detection of small objects
- Complementary light and dark operate outputs provide added flexibility
- IP67 rated enclosure

Available Models

Model	Sensing Mode
Standard	• Retroreflective • Polarized retroreflective • Standard diffuse • Background suppression • Transmitted beam
Laser	• Polarized retroreflective • Standard diffuse • Transmitted beam

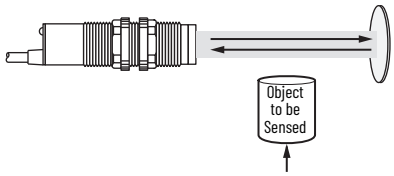
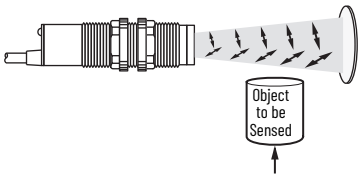
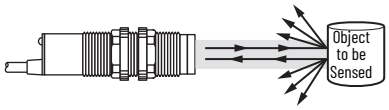
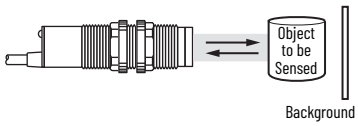
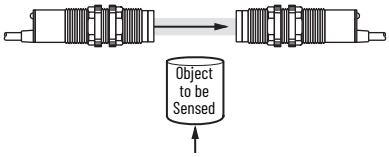
Specifications

Attribute	42CM 18 mm (0.71 in.) Metal Cylindrical Sensor
Certifications	cULus Listed and CE Marked for all applicable directives
Shock	30 g with 11 ms pulse duration, meets or exceeds IEC 600947-5-2
Vibration	10…55 Hz, 0.5 mm amplitude, meets or exceeds IEC 600947-5-2
Environmental	
Enclosure type rating	IP67
Operating temperature	-25…+70 °C (-13…+158 °F)
Relative humidity	5…95% (noncondensing)
Ambient light immunity	Incandescent light 5000 lux
User Interface	
Standard model indicator LED	Orange
Electrical	
Current consumption	30 mA max
Protection type	Short circuit, reverse polarity, false pulse, overload
Outputs	
Output type	See Product Selection on page 34.
Output function	Light operate and dark operate, selectable light operate and dark operate
Load current	100 mA
Leakage current	<10 µA DC
Mechanical	
Housing material	Nickel-plated brass
Lens material	Acrylic
Connection type	2 m (6.6 ft) cable, 4-pin DC micro (M12) QD
Supplied accessories	Mounting brackets, reflectors, cordsets; 18 mm (0.71 in.) fastener nuts

Optical and Response Time Characteristics

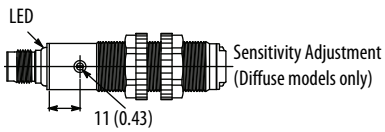
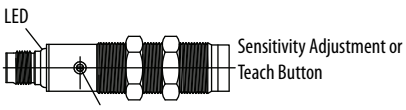
Attribute	Sensing Mode							
	Standard					Laser		
	Retroreflective	Polarized Retroreflective	Diffuse	Background Suppression	Transmitted Beam	Polarized Retroreflective	Diffuse	Transmitted Beam
Response Time	4 ms	4 ms	2 ms	0.5 ms	2 ms (0.5 ms for background suppression)	—		
Field of View	1.9°	1.8°	6.6°	5.7°	1.6°	—		
Light Source	Infrared 880 nm	Visible red 660 nm		Class 1 laser 650 nm	Infrared 880 nm	Class 1 laser 650 nm		

Product Selection

Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No.(1)
 Retroreflective	Infrared 880 nm	0.003...4 m (0.009...13.2 ft)	No adjustment	Light and dark operate	NPN	42CM-U1MNB-D4
					PNP	42CM-U1MPB-D4
 Polarized Retroreflective	Visible red 660 nm	0.003...3 m (0.009...9.8 ft)	No adjustment	Light and dark operate	NPN	42CM-P2MNB-D4
					PNP	42CM-P2MPB-D4
	Class 1 laser 650 nm	0.003...30 m (0.009...98 ft)	Teach button	Light and dark operate	NPN	42CM-P8MNB-D4
					PNP	42CM-P8MPB-D4
 Diffuse	Visible red 660 nm	3...100 mm (0.12...3.9 in.)	Potentiometer	Light and dark operate	NPN	42CM-D2MNAE-D4
		3...400 mm (0.12...15.7 in.)			PNP	42CM-D2MNAE-D4
		3...100 mm (0.12...3.9 ft)			NPN	42CM-D2MPAE-D4
		3...400 mm (0.12...15.7 in.)			PNP	42CM-D2MPAE-D4
	Class 1 laser 650 nm	3...300 mm (0.12...11.8 in.)	Teach button		NPN	42CM-D8MNA-D4
					PNP	42CM-D8MPA-D4
 Background Suppression	Class 1 laser Visible red 660 nm	50 mm (2 in.)	No adjustment	Selectable light or dark operate	NPN	42CM-B2LNBC-D4
		100 mm (3.9 in.)				42CM-B2LNBE-D4
		50 mm (2 in.)			PNP	42CM-B2LPBC-D4
		100 mm (3.9 in.)				42CM-B2LPBE-D4
 Transmitted Beam	Infrared 880 nm	0...20 m (0...65.6 ft)	No adjustment	– (Emitter)	–	42CM-E1EZB-D4
	Class 1 laser 650 nm	3...50 m (9.8...164 ft)			PNP	42CM-E8EZB-D4
	Infrared 880 nm or Visible red 660 nm	3...20 m (9.8...65.6 ft)	No adjustment	Light and dark operate	NPN	42CM-R1MNB-D4
					PNP	42CM-R1MPB-D4
		3...50 m (9.8...164 ft)	Potentiometer		NPN	42CM-R8MNB-D4
					PNP	42CM-R8MPB-D4
Recommended standard 4-pin DC micro (M12) quick-disconnect cordset						889D-F4AC-2

(1) Connection Options: The -D4 suffix describes a 4-pin DC micro (M12) quick-disconnect connector. For additional connection options, replace the -D4 suffix with: -A2 for a 2 m cable without quick-disconnect connection (for example, 42CA-P2MPB-A2).

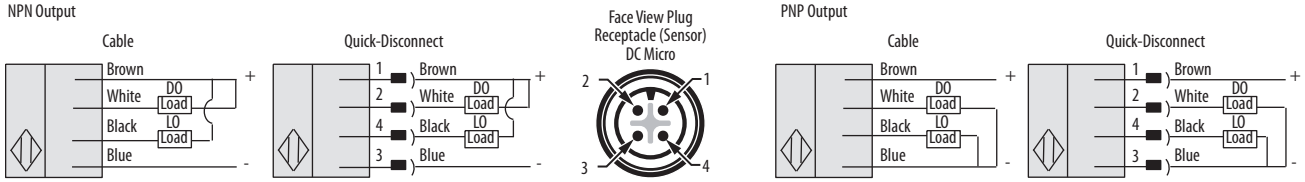
User Interface

Model		LED Color	State	Status	L.O. Output	D.O. Output
Standard		Yellow	Off	Sensor output is de-activated	–	–
			On	Sensor output is activated	–	–
Laser		Orange	Off	Dark condition	Off	On
			Flashing (1)	Light condition (excess gain < 2)	On	Off
			On	Light condition (excess gain > 2)	On	Off
		Green	On	Output	–	–

(1) Transmitted beam receivers do not have a flashing (low margin) state.

Wiring Diagrams

Figure 68 - Diffuse Wiring Diagrams



(1) Black open circuit to enable laser. Tie black to blue/V- to disable the laser.
(2) Pin2/white open circuit to enable laser. Tie pin2/white to blue/V- to disable the laser.

Figure 69 - Transmitted Beam (42CM Standard), Retroreflective, Polarized Retroreflective Wiring Diagrams

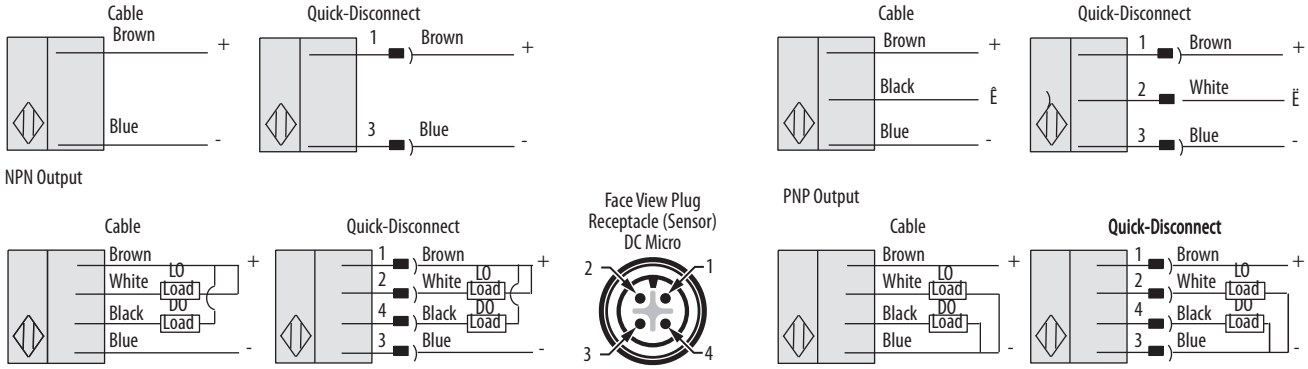
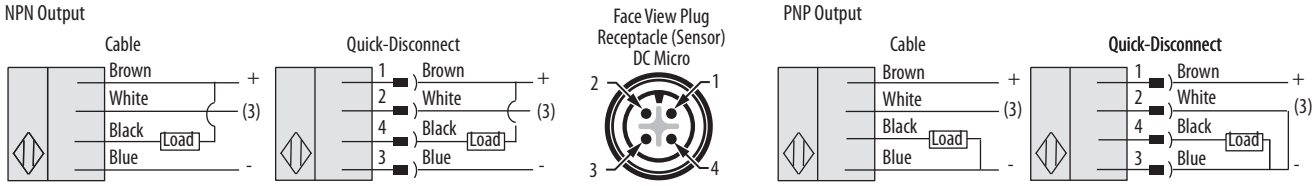
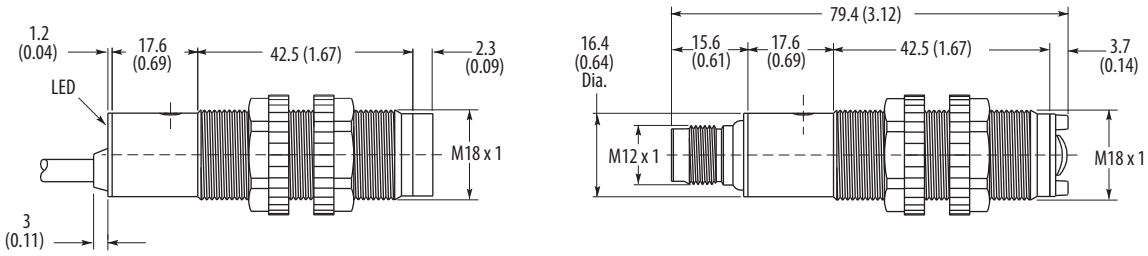


Figure 70 - Background Suppression (42CM Standard Only) Wiring Diagrams



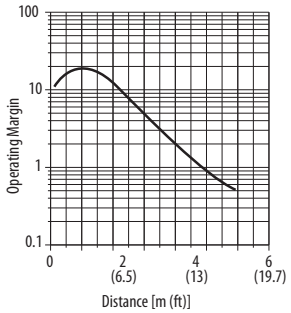
Approximate Dimensions

Dimensions shown in mm (in.).

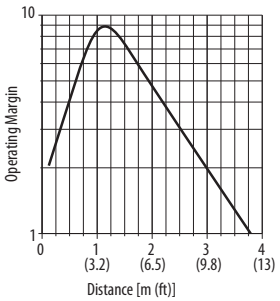


Typical Response Curves

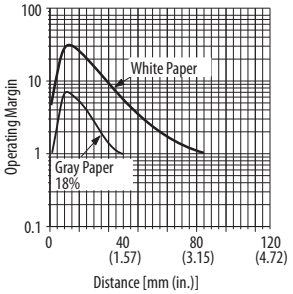
Retroreflective



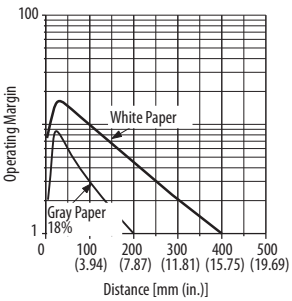
Polarized Retroreflective



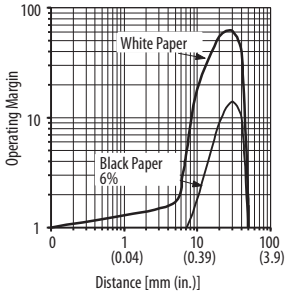
Standard Diffuse [100 mm]



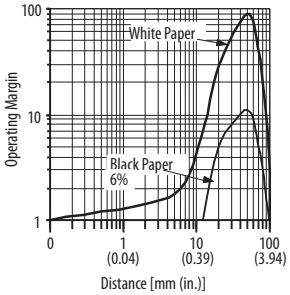
Standard Diffuse [400 mm]



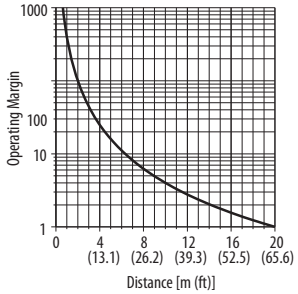
Background Suppression [50 mm]



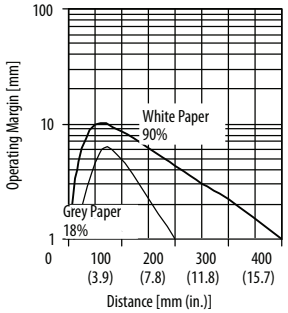
Background Suppression [100 mm]



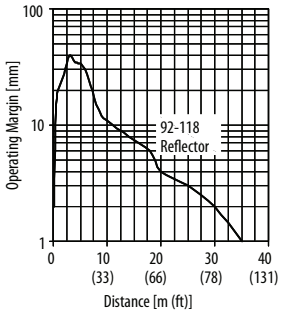
Transmitted Beam



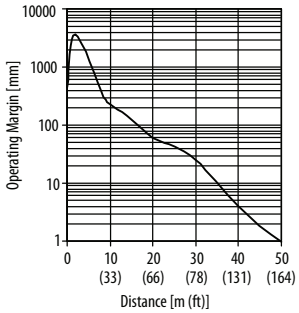
Diffuse



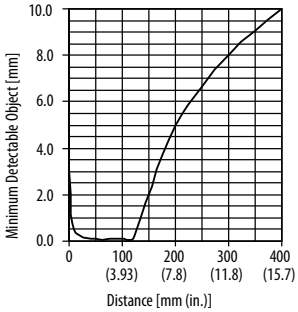
Laser Polarized Retroreflective



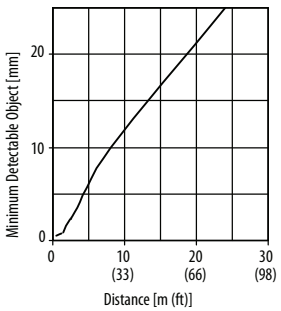
Transmitted Beam



Standard Diffuse



Polarized Retroreflective



Cordsets and Accessories

Description	Cat. No.
DC micro QD cordset, straight, 4-pin, 2 m (6.6 ft)	889D-F4AC-2
DC micro QD cordset, right angle, 4-pin, 2 m (6.6 ft)	889D-R4AC-2
Mounting bracket, snap-clamp	871A-SCBP18
Mounting bracket, right angle	60-2657
Mounting bracket, swivel/tilt	60-2649
Mounting bracket, straight	60-2656
76 mm (3 in.) diameter reflector	92-39
32 mm (1.25 in.) diameter reflector	92-47

42CS 18 mm (0.71 in.) Stainless-steel Cylindrical Sensor

Features

- Patented ferromagnetic teach for easy sensor programming
- Extended temperature operating range -25...+85 °C (-13...+185 °F)
- Clean design minimizes the accumulation of undesired particles that allow for a fast and easy cleanup
- 18 mm (0.71 in.) stainless-steel 316L enclosure with laser etched markings
- Two teaching modes: standard and precision
- Complementary light and dark operate outputs
- Teach lockout feature helps prevent unauthorized users from changing the settings
- Clear object detection models are available
- Input to disable light source on transmitted beam emitter
- IP69K, ECOLAB, and Johnson Diversey rated

Available Models

- Retroreflective
- Polarized retroreflective
- Standard diffuse
- Background suppression
- Transmitted beam

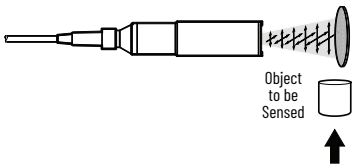
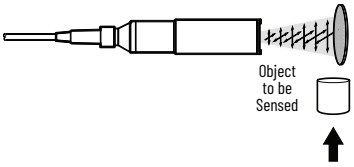
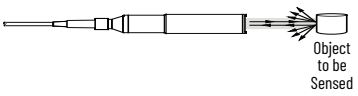
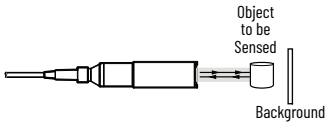
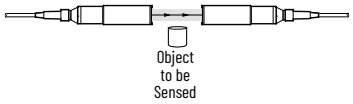
Specifications

Attribute	42CS 18 mm (0.71 in.) Stainless-steel Cylindrical Sensor
Certifications	cULus Listed and CE Marked for all applicable directives
Shock	30 g with 1 ms pulse duration, meets or exceeds IEC 600947-5-2
Vibration	10...55 Hz, 1 mm amplitude, meets or exceeds IEC 600947-5-2
Environmental	
Enclosure type rating	IP69K, ECOLAB, and Johnson Diversey rated
Operating temperature	-25...+85 °C (-13...+185 °F)
Relative humidity	5...95% (noncondensing)
Ambient light immunity	5000 lux (incandescent light) and 10,000 lux (sunlight)
Optical	
Light source	Visible red (660 nm) or infrared (880 nm)
Sensitivity adjustment	Ferromagnetic teach
User Interface	
Indicator LEDs	Green: Power/margin Orange: Output
Electrical	
Operating voltage	10...30V DC
Current consumption	35 mA max
Protection type	Short circuit, transient noise, reverse polarity
Outputs	
Output type	See Product Selection on page 38.
Output function	Light operate and dark operate
Load current	100 mA
Leakage current	10 µA DC, max
Mechanical	
Housing material	316L stainless steel
Lens material	PMMA
Connection type	4-pin DC Micro (M12) QD
Supplied accessories	Stainless-steel teach rod, mounting nuts (threaded models only)
Optional accessories	Mounting brackets, cordsets, reflectors

Optical and Response Time Characteristics

Attribute	Sensing Mode				
	Polarized Retroreflective	Clear Object Detection	Diffuse	Background Suppression	Transmitted Beam
Field of View	3°	3°	100 mm = 6° 400 mm = 6° 800 mm = 8°	9° for 100 mm	4°
Spot Size	190 mm @ 4 m	153 mm @ 1 m	100 mm = 10.4 mm 400 mm = 48.3 mm 800 mm = 127 mm	16 mm @ 100 m	640 mm @ 20 m
Light Source	Visible red 660 nm		100 mm = Visible red 660 nm 400 mm = Infrared 880 nm 800 mm = Infrared 880 nm	Visible red 660 nm	Infrared 880 nm
Response Time	1 ms	1 ms	1 ms	1 ms	1 ms

Product Selection

Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No. (1)
 Polarized Retroreflective	Visible red 660 nm	0.1...4 m (0.33...13.1 ft)	No adjustment	Light and dark operate	NPN	42CSS-P2MNB1-D4
					PNP	42CSS-P2MPB1-D4
 Clear Object Detection	Visible red 660 nm	0.05...1 m (0.16...3.28 ft)	Ferromagnetic teach	Light and dark operate	NPN	42CSS-C2MNA1-D4
					PNP	42CSS-C2MPA1-D4
 Diffuse	Visible red 660 nm	0...100 mm (0...3.94 in.)	Ferromagnetic teach	Light and dark operate	NPN	42CSS-D2MNA1-D4
					PNP	42CSS-D2MPA1-D4
	Infrared 880 nm	0...400 mm (0...15.7 in.)	Ferromagnetic teach		NPN	42CSS-D1MNA2-D4
					PNP	42CSS-D1MPA2-D4
		0...800 mm (0...31.5 in.)			NPN	42CSS-D1MNA3-D4
					PNP	42CSS-D1MPA3-D4
 Background Suppression	Visible red 660 nm	60...100 mm (2.4...3.9 in.)	Ferromagnetic teach	Light and dark operate	NPN	42CSS-B2MNA1-D4
					PNP	42CSS-B2MPA1-D4
 Transmitted Beam	Infrared 880 nm	0...20 m (0...65.6 ft)	No adjustment	— (Emitter)	—	42CSS-E1EZB1-D4
				Light and dark operate	NNP	42CSS-R9MNB1-D4
					PNP	42CSS-R9MPB1-D4

(1) The prefix 42CSS denotes a smooth enclosure. For threaded models replace the 42CSS with 42CST (for example, 42CST-P2MPB1-D4).

IMPORTANT All sensor models are rated for 10...30V DC and can drive loads requiring up to 100 mA.

User Interface

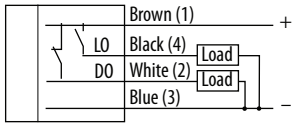
LED Color	State	Status
Green	Off	Teach function is locked
	On	Teach function is enabled
	Flashing (8 Hz)	Short circuit
Yellow	Off	Output de-energized
	On	Output energized (1)
	Flashing (3 Hz)	Output energized (margin < 2) (1)

(1) Pin 4 of micro (M12) QD. L.O. for diffuse and background suppression. D.O. for polarized retroreflective and transmitted beam.

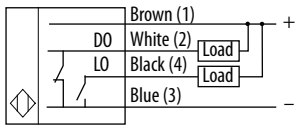
Wiring Diagrams

Figure 71 - Diffuse and Background Suppression Wiring Diagrams

PNP Models with Complementary Outputs



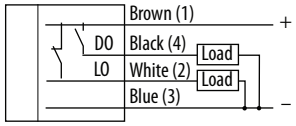
NPN Models with Complementary Outputs



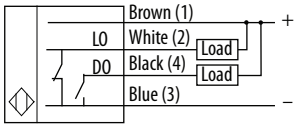
(2) For normal operation, white wire (pin 2) needs no connection. To disable the light source, connect the white wire (pin 2) to +V.

Figure 72 - Polarized Retroreflective, Clear Object, and Transmitted Beam Receiver Wiring Diagrams

PNP Models with Complementary Outputs

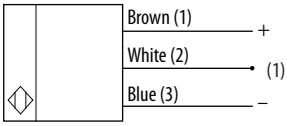


NPN Models with Complementary Outputs



M12 Plug

Transmitted Beam Emitter

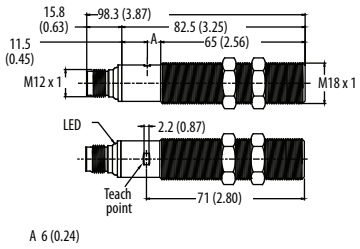


(1) For normal operation, white wire (pin 2) needs no connection. To disable the light source, connect the white wire (pin 2) to +V.

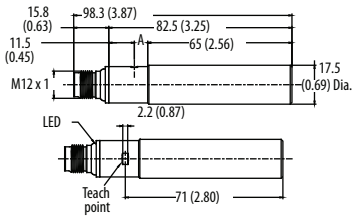
Approximate Dimensions

Dimensions shown in mm (in.).

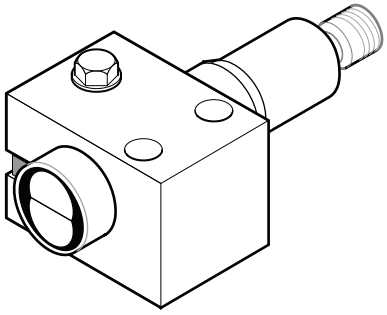
Threaded Barrel Models



Smooth Barrel Models

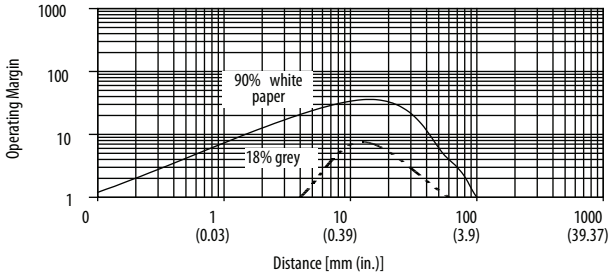


60-BCS-18B—Mounting Bracket

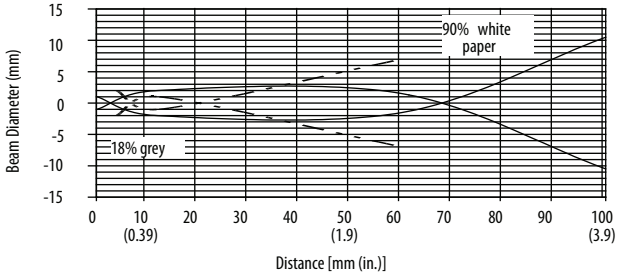


Typical Response Curves

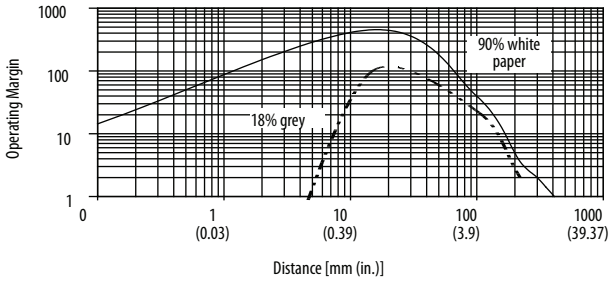
Standard Diffuse [100 mm]



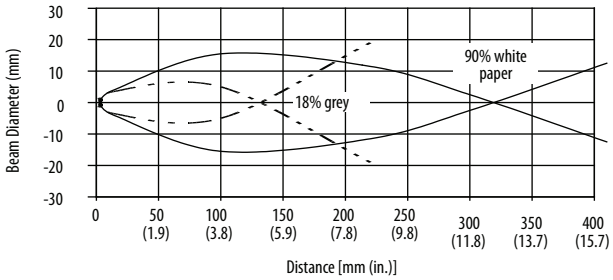
Beam Pattern [100 mm]



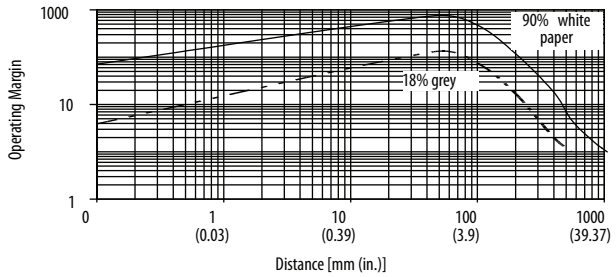
Standard Diffuse [400 mm]



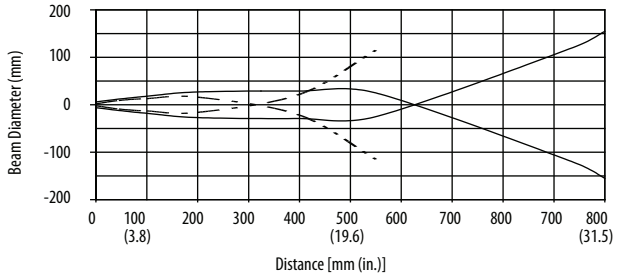
Beam Pattern [400 mm]



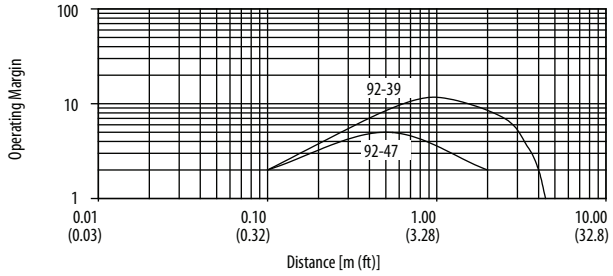
Standard Diffuse [800 mm]



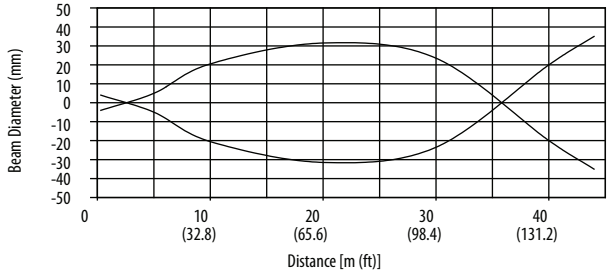
Beam Pattern [800 mm]



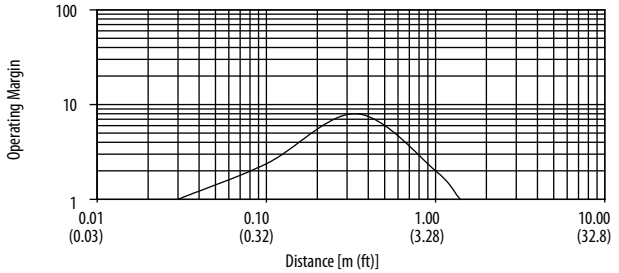
Polarized Retroreflective [4 m]



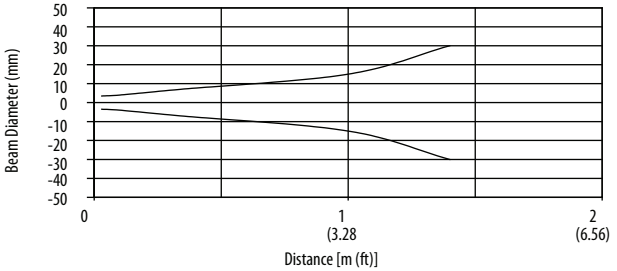
Beam Pattern [4 m]



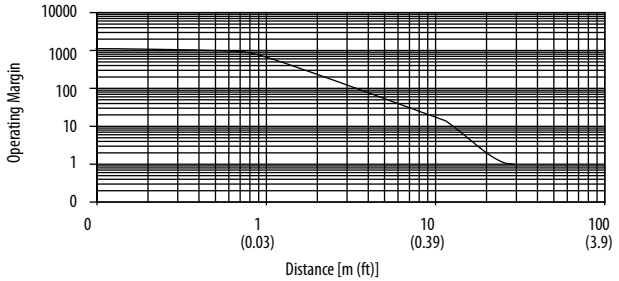
Clear Object [1 m]



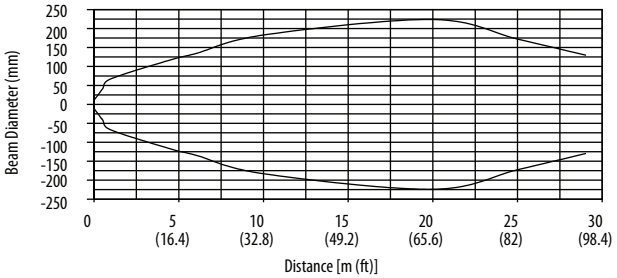
Beam Pattern [1 m]



Transmitted Beam [20 m]



Beam Pattern [20 m]



Cordsets and Accessories

Description	Cat. No.
DC micro (M12) QD cordset, 4-pin	889DS-F4AC-2
DC micro (M12) QD patchcord, 4-pin	889D-F4ACDM-2
Block mounting bracket for smooth barrel housing	60-BCS-18B
Straight mounting bracket for threaded models	60-2656
Right angle mounting bracket for threaded models	60-2657

42EA RightSight S18 General-purpose Sensors

The RightSight™ S18 family of photoelectric sensors offers a wide range of sensing modes, an adjustment knob that simplifies sensitivity adjustment, and push-pull (PNP and NPN) outputs for maximum application flexibility.

The RightSight offers an industry standard 18 mm (0.71 in.) housing and 25.4 mm (1 in.) for fast mounting and replacement.

Features

- Selectable light operate or dark operate based on wiring
- 360° visible light-emitting diode (LED) status indicators
- 4-in-1 PNP and NPN outputs, light, and dark operate
- Input to disable light source on transmitted beam emitter
- IP67 rated enclosure

Available Models

- Diffuse
- Background suppression
- Polarized retroreflective
- Transmitted beam

Specifications

Attribute	42EA RightSight S18 General-purpose Sensors
Certifications	cULus Listed, CE Marked for all applicable directives, and UKCA Marked for all applicable regulations
EMC Directive	EN 60947-5-2
Standards	UL 60947-5-2
Ambient light immunity	EN 60697-5-2:2007+A:2012
Functional Safety Parameters Diffuse	
MTBF	514 years
MTTFd	1028.6 years
Background Suppression	
MTBF	510 years
MTTFd	1021 years
Polarized Retroreflective	
MTBF	540.6 years
MTTFd	1081.2 years
Transmitted Beam Emitter	
MTBF	844.6 years
MTTFd	1689.2 years
Transmitted Beam Receiver	
MTBF	658 years
MTTFd	1316 years
User Interface	
Status indicators	Green and orange
Adjustments	Adjustable knob (specific models)
Optical	
Light-emitting diode (LED)	Red and infrared (specific models)
Electrical	
Operating voltage	10…30V DC
Current consumption	Less than 25 mA
Sensor protection	Reverse polarity and short circuit
Output	
Output types	Two push-pull outputs (PNP and NPN), light operate, and dark operate
Response Time	
Diffuse, background suppression, and polarized retroreflective	1 ms, max
Transmitted beam	3 ms, max
Load current	100 mA, max (resistive load)
Mechanical	
Housing material	ABS
Lens material	Acrylic
Environmental	
Enclosure rating	IP67
Operating temperature	-20…+55 °C (-4…+131 °F)

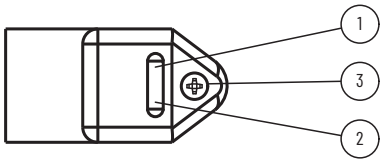
Product Selection

Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No. (1)
Polarized retroreflective	Visible red (626 nm)	3.5 m (11.5 ft) with 92-125 reflector	Adjustment knob	Light operate and dark operate	PNP and NPN (push-pull)	42EA-P2MEA1-*x*
Diffuse	Infrared (950 nm)	10...450 mm (0.39...17.72 in.)	Adjustment knob		PNP and NPN (push-pull)	42EA-D1MEA1-*x*
Background suppression	Visible red (626 nm)	10...50 mm (0.39...1.97 in.)	No adjustment knob		PNP and NPN (push-pull)	42EA-B2MEB1-*x*
		10...100 mm (0.39...3.94 in.)				42EA-B2MEB2-*x*
Transmitted beam	Infrared (950 nm)	10 m (32.81 ft)	No adjustment knob		—	42EA-E1EZB1-*x*
			Adjustment knob		PNP and NPN (push-pull)	42EA-R1MEA1-*x*

(1) Replace the *x* with the following connection option suffixes:
D4: An integral 4-pin DC micro (M12)
P4: An integral 4-pin pico (M8) QD
A2: A 2 m (6.6 ft) PVC cable
RJ11: An RJ11 connector on a 2 m (6.6 ft) length cable (only available for 42EA-P2MEA1-RJ11)
Additional connection options are available. See ProposalWorks™ for available options by sensing mode.

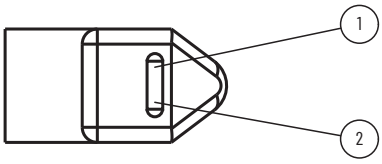
Status Indicators and User Interface

Figure 73 - Diffuse, Polarized Retroreflective, and Transmitted Beam Receiver Models



1 - Orange status indicator
2 - Green status indicator
3 - Sensitivity Adjustment

Figure 74 - Background Suppression and Transmitted Beam Emitter Models



1 - Orange status indicator
2 - Green status indicator

The following table provides an indicator status in RUN mode during operation for all sensing models: diffuse, polarized retroreflective, background suppression, background reflection, and transmitted beam.

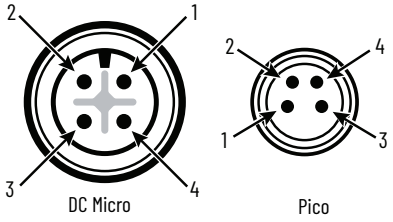
Table 13 - Operating Mode Indication

Status Indicator Color	Status	Description
Green	OFF	Power is OFF
	ON	Power is ON
Orange	OFF	Output de-energized
	ON	Output energized

Wiring

The following image shows the quick disconnect connector. The pin numbers correspond to the convex connectors on the sensor.

Figure 75 - Pinouts



Wiring Diagrams

Figure 76 - NPN and PNP - Pin 4 (Light Operate), Pin 2 (Dark Operate)

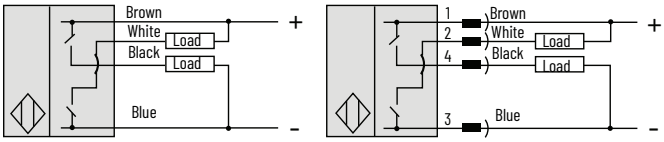


Figure 77 - NPN and PNP - Pin 4 (Dark Operate), Pin 2 (Light Operate)

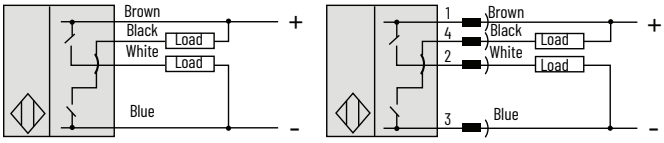
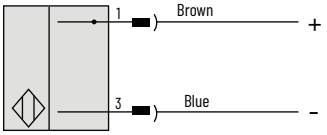


Figure 78 - Transmitted Beam Emitter



Typical Response Curves

Figure 79 - Background Suppression - 50 mm (1.97 in.) Beam Pattern

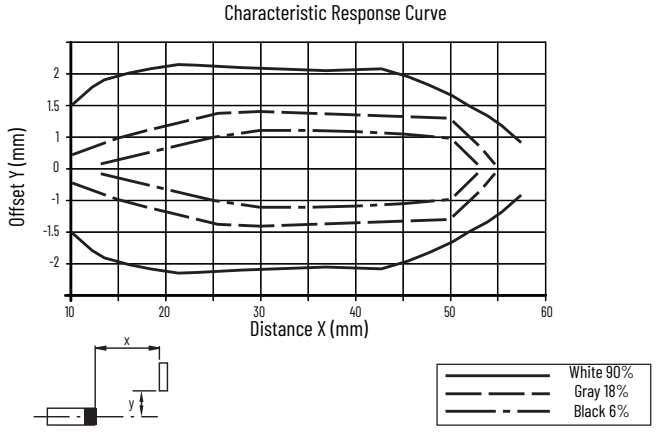


Figure 80 - Background Suppression - 50 mm (1.97 in.) Detection Distance

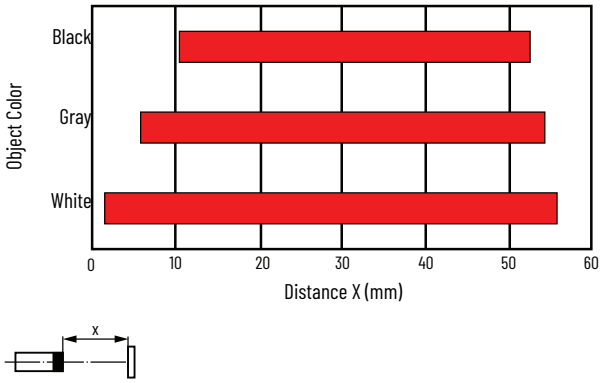


Figure 81 - Background Suppression - 100 mm (3.94 in.) Beam Pattern

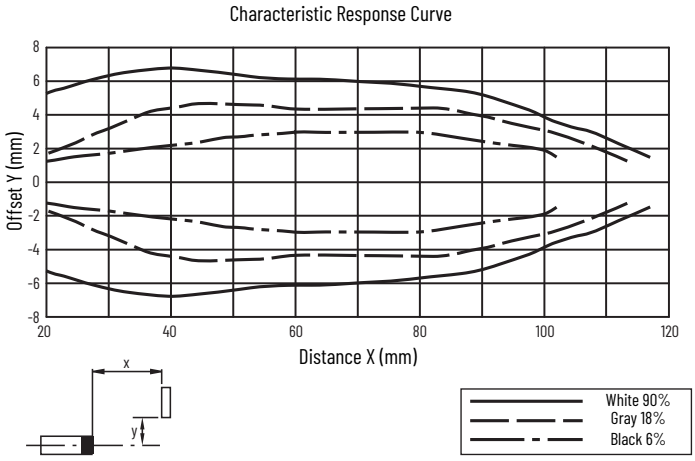


Figure 82 - Background Suppression - 100 mm (3.94 in.) Detection Distance

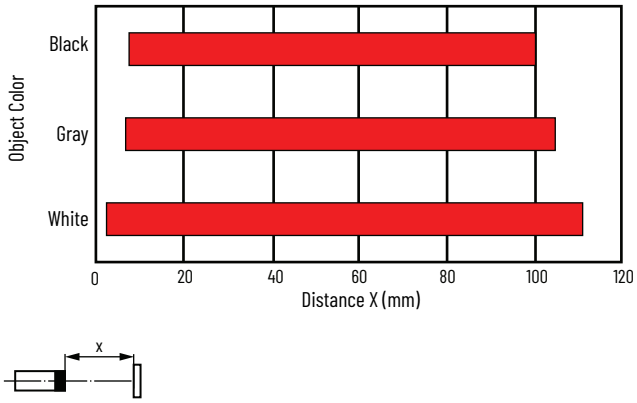


Figure 83 - Diffuse - Beam Pattern

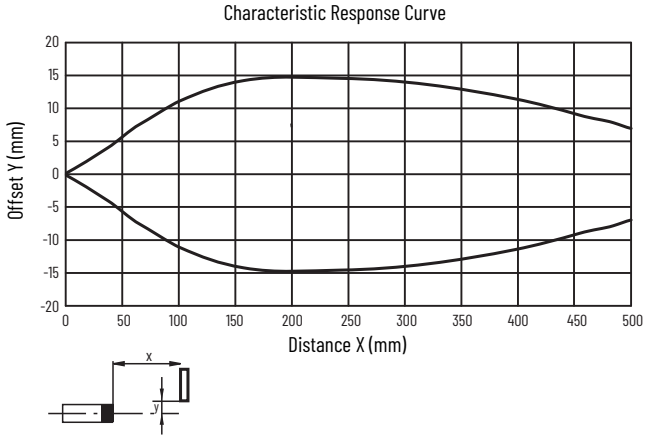


Figure 84 - Diffuse - Margin Curve

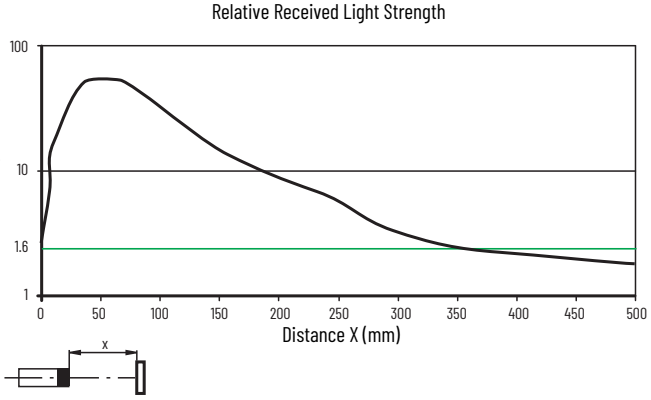


Figure 85 - Polarized Retroreflective - Beam Pattern

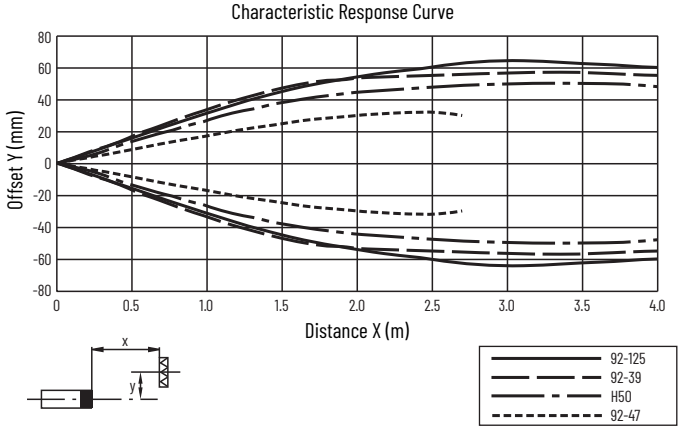


Figure 86 - Transmitted Beam - Beam Pattern

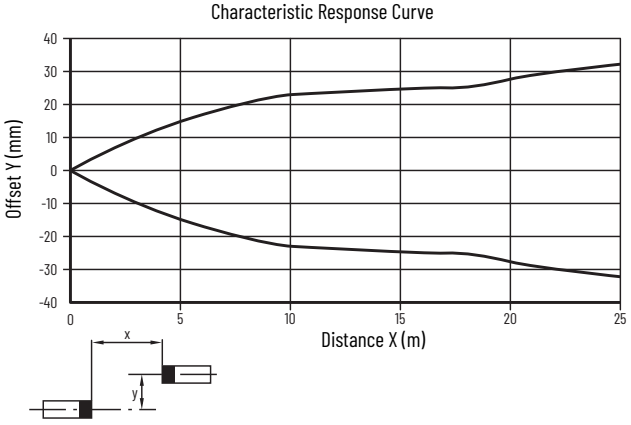
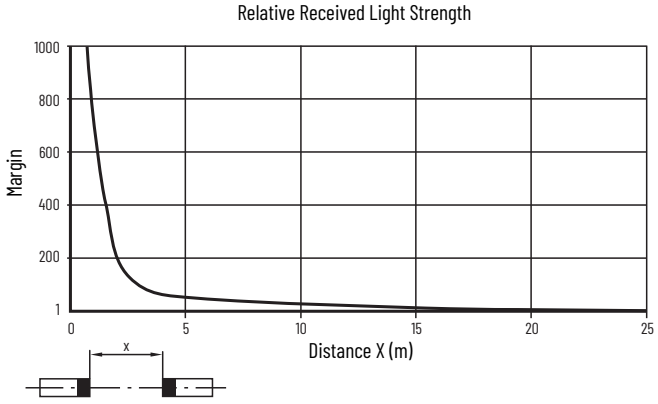


Figure 87 - Transmitted Beam - Margin Curve



Approximate Dimensions

Figure 88 - 2 m (6.6 ft) Cable Models [mm (in.)]

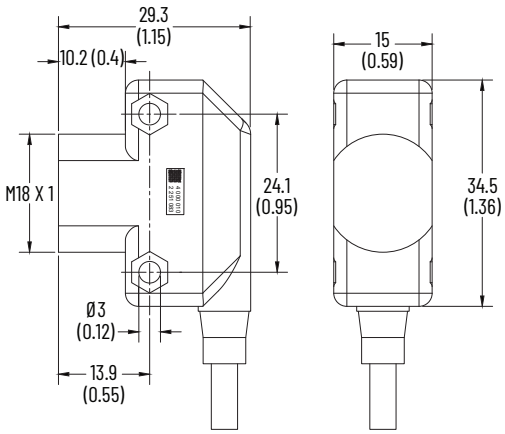


Figure 89 - Integral M8 Pico QD Models [mm (in.)]

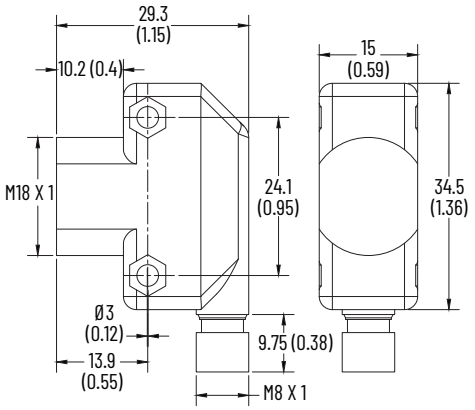
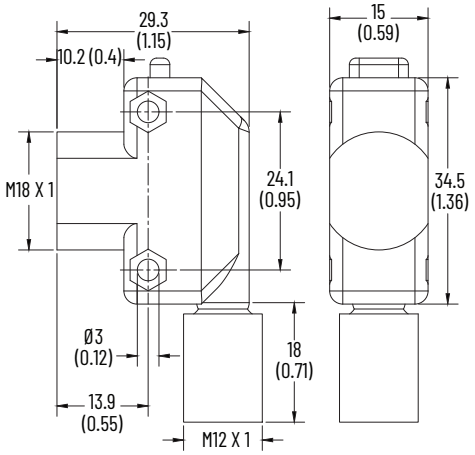


Figure 90 - Integral M12 Micro QD Models [mm (in.)]



42G Series 9000 PHOTOSWITCH Photoelectric Sensors

Features

- Extended sensing range for maximum application flexibility
- Class 1 laser models ideal for the detection of small parts
- DC (PNP and NPN) and AC/DC (relay output, solid-state) models
- Time delay models
- Dual (NPN and PNP) output models
- IP69K, IP67 with 1200 psi, NEMA, and ECOLAB rated enclosures

Available Models

The following standard models are available:

- Retroreflective
- Polarized retroreflective
- Clear object detection
- Diffuse
- Transmitted beam
- Large aperture fiber-optic
- Small aperture fiber-optic

The following laser models are available:

- Polarized retroreflective
- Standard diffuse

Specifications

Table 14 - All Models

Attribute	Value
Certifications	cULus Listed, CSA Certified, and CE Marked for all applicable directives
Shock	30 g with 1 ms pulse duration, meets or exceeds IEC 60947-5-2
Vibration	10…55 Hz, 1 mm amplitude, meets or exceeds IEC 60947-5-2
Environmental	
Enclosure type rating	IP69K, IP67 with 1200 psi; NEMA 3, 4X, 6P, 12, 13; ECOLAB rated
Relative humidity	5…95%
Ambient light immunity	Incandescent light 5000 lux
Electrical	
Operating voltage	See Table 19 on page 47.
Mechanical	
Material	• Housing: Valox • Lens: Acrylic
Connection type	See Table 19 on page 47.

Table 15 - Standard Models

Attribute	Value
Environmental	
Operating temperature	-34…+70 °C (-29…+158 °F)
User Interface	
Status indicator	See Table 21 on page 50.
Electrical	
Current consumption	30 mA max
Protection type	• Short circuit • Reverse polarity • False pulse • Overload
Outputs	
Output type	See Table 19 on page 47.
Output function	Selectable light or dark operate
Load current	• 250 mA at 30V DC (all models except 42GLP and 42GSP) • 2 A at 132V AC and 1 A at 264V AC (SPDT relay models) • 300 mA at 264V AC (MOSFET models)

Table 16 - Laser Models

Attribute	Value
Environmental	
Operating temperature	-10…+50 °C (-14…+122 °F)
Electrical	
Current consumption, max	• DC models: 45 mA • AC/DC models: 10 mA • AC models: 70 mA
Protection type	• Overload and short circuit (DC models) • Reverse polarity • False pulse
Outputs	
Output type	See Table 19 on page 47.
Output function	Selectable light or dark operate
Leakage current, max	10 µA (DC models)

Optical and Response Time Characteristics

Table 17 - Optical and Response Time Characteristics—Standard and Intrinsically Safe Transmitted Beam Models

Attribute	Sensing Mode					
	Retroreflective	Polarized Retroreflective	Diffuse	Transmitted Beam	Small Aperture Fiber Optic	Large Aperture Fiber Optic
Field of view	1.5°		3.5° for 1.5 m (4.92 ft) 6.5° for 3 m (9.8 ft) and 4 m (13 ft) range	1.5°	Depends on fiber-optic cable	
Light source	Visible red 660 nm					Infrared 880 nm
Response time	2 ms (DC), SPDT EM relay (15 ms), 2 ms (MOSFET AC/DC)					

Table 18 - Optical and Response Time Characteristics—Laser Models

Attribute	Sensing Mode	
	Polarized Retroreflective	Diffuse
Spot size	20 x 25 mm (0.98 in.) at 40 m (131.23 ft)	2 x 3.5 mm (0.14 in.) at 800 nm
Response time	0.5 ms	

Product Selection

Table 19 - Product Selection

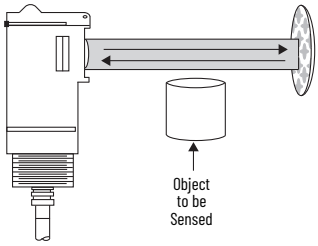
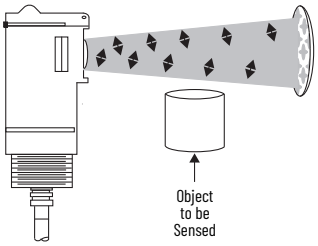
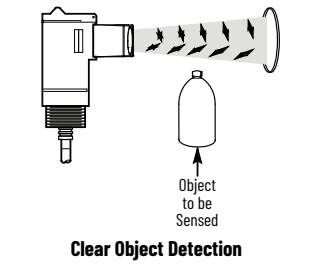
Sensing Mode	Operating Voltage	Light Source	Sensing Distance	Output Type	Sensor Type	Cat. No. (1)
 **Retroreflective**	10...30V DC	Visible red 660 nm	0.050...9.1 m (0.16...30 ft)	PNP and NPN	Standard ON/OFF	42GRU-9000-QD
				NPN and PNP	Timing	42GTU-9000-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRU-9001-QD
					Timing	42GTU-9001-QD
	70...264V AC/DC				Standard ON/OFF	42GRU-9002-QD
					Timing	42GTU-9002-QD
				N-MOSFET	Standard ON/OFF	42GRU-9003-QD
					Timing	42GTU-9003-QD
 **Polarized Retroreflective**	10...30V DC	Visible red 660 nm	0.050...4.9 m (0.16...16 ft)	NPN and PNP	Standard ON/OFF	42GRU-9200-QD
					Timing	42GTU-9200-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRU-9201-QD
					Timing	42GTU-9201-QD
	70...264V AC/DC				Standard ON/OFF	42GRU-9202-QD
					Timing	42GTU-9202-QD
				N-MOSFET	Standard ON/OFF	42GRU-9203-QD
					Timing	42GTU-9203-QD
	10...30V DC	Class 1 Laser	0.3...40 m (1...130 ft)	NPN and PNP (DC only), EM relay	Standard ON/OFF	42GRU-92L0-QD
	105...132V AC			SPDT EM relay	Standard ON/OFF	42GRU-92L2-QD
 **Clear Object Detection**	10...30V DC	Visible red 660 nm	0.050...1.2 m (0.16...4 ft)	NPN and PNP	Standard ON/OFF	42GRC-9200-QD
					Timing	42GTC-9200-QD
	70...264V AC/DC			SPDT EM relay	Standard ON/OFF	42GRC-9202-QD
					Timing	42GTC-9202-QD
				N-MOSFET	Standard ON/OFF	42GRC-9203-QD
					Timing	42GTC-9203-QD

Table 19 - Product Selection (Continued)

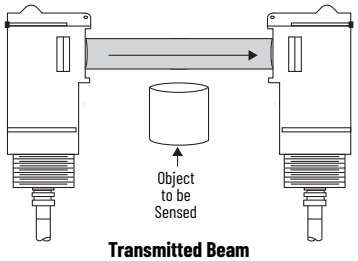
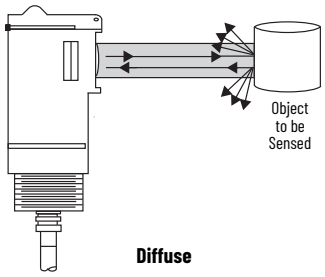
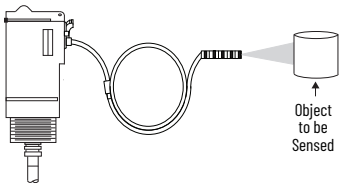
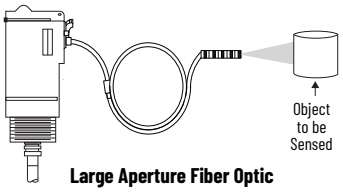
Sensing Mode	Operating Voltage	Light Source	Sensing Distance	Output Type	Sensor Type	Cat. No. [1]
 **Transmitted Beam**	10...264V AC/DC	Infrared 880 nm	0.025...61 m (0.83...200 ft)	– (Emitter)	–	42GRL-9000-QD
			0.025...152 m (0.83...500 ft)			42GRL-9040-QD
	1...30V DC		Depends on transmitted beam emitter	NPN and PNP	Standard ON/OFF	42GRR-9000-QD
					Timing	42GTR-9000-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRR-9001-QD
	70...264V AC/DC				Standard ON/OFF	42GRR-9002-QD
					Timing	42GTR-9002-QD
				N-MOSFET	Standard ON/OFF	42GRR-9003-QD
			0.050...4.9 m (0.16...16 ft)		Timing	42GTU-9203-QD
 **Diffuse**	10...30V DC	Visible red 660 nm	0.050...1.5 m (0.16...5 ft)	NPN and PNP	Standard ON/OFF Linear Adjustment	42GLP-9000-QD
					Standard ON/OFF Teach Push Button	42GSP-9000-QD
					Standard ON/OFF	42GRP-9000-QD
					Timing	42GTP-9000-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRP-9001-QD
					Timing	42GTP-9001-QD
	70...264V AC/DC				Standard ON/OFF	42GRP-9002-QD
					Timing	42GTP-9002-QD
				N-MOSFET	Standard ON/OFF	42GRP-9003-QD
					Timing	42GTP-9003-QD
	10...30V DC	Class 1 Laser	1...800 mm (0.03...31.5 in.)	NPN and PNP	Standard ON/OFF	42GRP-92L0-QD
	105...132V AC			SPDT EM relay		42GRP-92L2-QD
	10...30V DC	Infrared 880 nm	0.050...3.04 m (0.16...10 ft)	NPN and PNP	Standard ON/OFF	42GRP-9040-QD
					Timing	42GTP-9040-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRP-9041-QD
					Timing	42GTP-9041-QD
	70...264V AC/DC				Standard ON/OFF	42GRP-9042-QD
					Timing	42GTP-9042-QD
	70...264V DC; 40...264V AC			N-MOSFET	Standard ON/OFF	42GRP-9043-QD
					Timing	42GTP-9043-QD
	10...30V DC		0.050...4.2 m (0.16...14 ft)	NPN and PNP	Standard ON/OFF	42GRP-9070-QD
	70...264V AC/DC		50.8 mm...4.2 m (2 in....14 ft)	SPDT EM relay	Standard ON/OFF	42GRP-9072-QD
 **Small Aperture Fiber Optic**	10...30V DC	Visible red 660 nm	Depends on fiber-optic cable	NPN and PNP	Standard ON/OFF	42GRF-9100-QD
					Timing	42GTF-9100-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRF-9101-QD
					Timing	42GTF-9101-QD
	70...264V AC/DC				Standard ON/OFF	42GRF-9102-QD
					Timing	42GTF-9102-QD
				N-MOSFET	Standard ON/OFF	42GRF-9103-QD
					Timing	42GTF-9103-QD

Table 19 - Product Selection (Continued)

Sensing Mode	Operating Voltage	Light Source	Sensing Distance	Output Type	Sensor Type	Cat. No. (1)
 Large Aperture Fiber Optic	10...30V DC	Infrared 880 nm	Depends on fiber-optic cable	NPN and PNP	Standard ON/OFF	42GRF-9000-QD
					Timing	42GTF-9000-QD
	10...55V DC; 20...40V AC			SPDT EM relay	Standard ON/OFF	42GRF-9001-QD
					Timing	42GTF-9001-QD
	70...264V AC/DC				Standard ON/OFF	42GRF-9002-QD
					Timing	42GTF-9002-QD
				N-MOSFET	Standard ON/OFF	42GRF-9003-QD
					Timing	42GTF-9003-QD
Recommended DC micro (M12) quick-disconnect cordset, straight, 4-pin, 2 m (6.6 ft)						889D-F4AC-2
Recommended DC pico (M8) quick-disconnect cordset, straight, 4-pin, 2 m (6.6 ft)						889D-F4AB-2

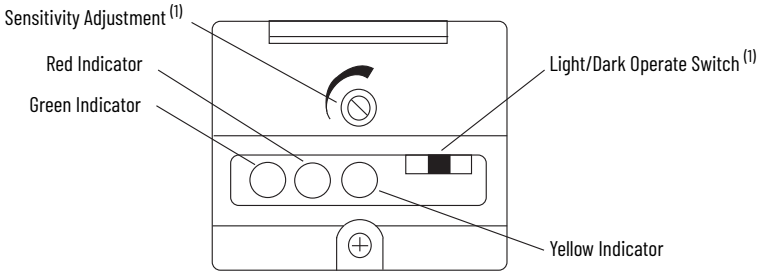
(1) Connection Options: The -QD suffix describes a 4-pin DC micro (M12) integral QD for DC models, a 5-pin mini QD for SPDT EM Relay models, and a 4-pin mini (M12) integral QD for N-MOSFET models.
For additional connection options:
- Remove the -QD suffix for a 2 m (6.6 ft) cable without QD (Example: 42GRU-9200).
- For NPN and PNP models replace the -QD suffix with a -QD1 for a 4-pin mini-integral QD (for example, 42GRU-9200-QD1). For N-MOSFET models, replace the -QD suffix with a -QD1 for a 4-pin AC micro (M12) integral QD (for example, 42GRU-9203-QD1).
- See ProposalWorks™ for available connection options in 600V 2 m (6.6 ft) cables.

Cordsets and Accessories

Description		Cat. No.
Cordsets	AC micro QD, straight, 4-pin, 2 m (6.5 ft)	889D-F4AEA-2
	Mini QD, 1.8 m (6 ft) 5-pin	889N-F5AF-6F
	Mini QD, 2 m (6 ft) 4-pin	889N-F4AF-6F
Mounting bracket	30 mm (1.2 in.) swivel/tilt	60-2439
	Heavy-duty impact	60-2702
Spare reflector, corner cube	76 mm (3 in.) diameter with mounting hole	92-39
	32 mm (1.25 in.) diameter with mounting hole	92-47
Extended range lens assembly [260 °C (500 °F)]		60-1844
		60-2559
Fiber-optic cable lens extender		60-2738

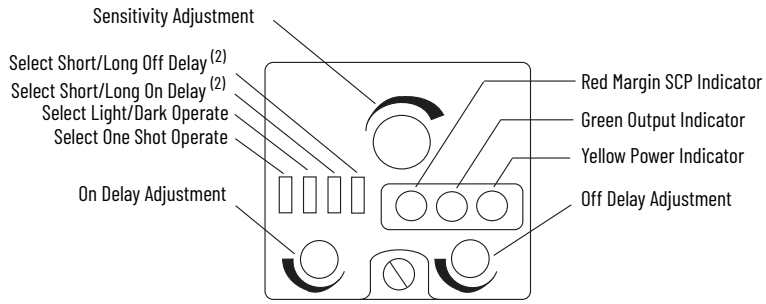
Sensor User Interface

Table 20 - Standard Sensors

42GRx Versions — Top View Detail	Status Indicator Color	State	Status
	Red	OFF	Margin < 2.5X
		ON	Margin > 2.5X
	Green	OFF	Output is de-energized
		ON	Output is energized
	Yellow	OFF	Power is OFF
		ON	Power is ON

(1) Transmitted beam receivers do not have a flashing (low margin) state.

Table 21 - Time-delay Sensors

42GTx Versions — Top View Detail	Status Indicator Color	State	Status
	Red	OFF	Margin < 2.5X
		ON	Margin > 2.5X
	Green	OFF	Output is de-energized
		ON	Output is energized
	Yellow	OFF	Power is OFF
		ON	Power is ON

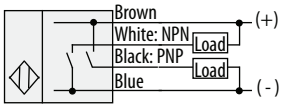
(2) The sensors timing can be set as short (0…1.5 s) or long (0…15 s).

Wiring Diagrams

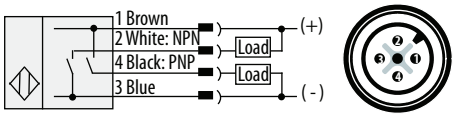
IMPORTANT Do not connect an NPN and PNP load simultaneously.

Figure 91 - Standard and Laser Models

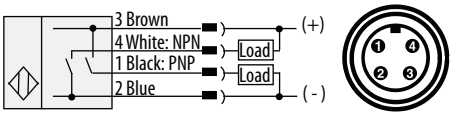
Cable Model: 9_ _0



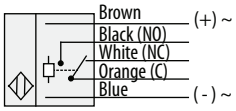
4-pin DC Micro QD Model: 9_ _0-QD



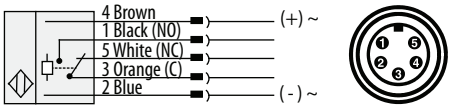
4-pin DC Mini QD Model: 9_ _0-QD1



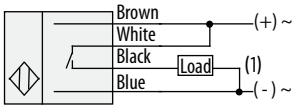
Cable Model: 9_ _1, 9_ _2



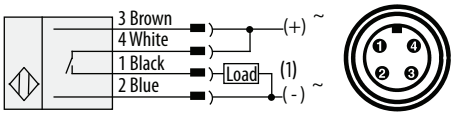
5-pin AC/DC Mini QD Model: 9_ _1-QD, 9_ _2-QD



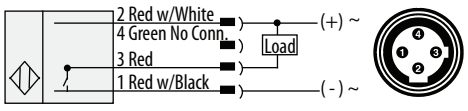
Cable Model: 9_ _3



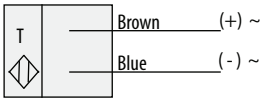
AC/DC Mini QD Model: 9_ _3-QD



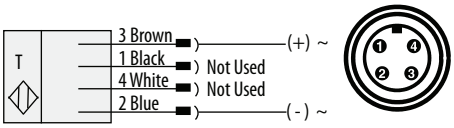
AC/DC Micro QD Model: 9_ _3-QD1



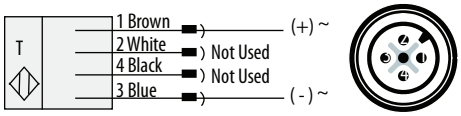
Transmitted Beam Source
Cable Model: 42GRL-90_ _



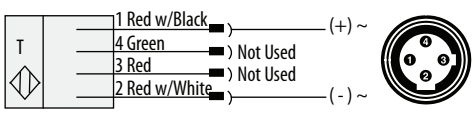
AC/DC Mini QD Model: 42GRL-9_2-QD



DC Micro QD Model: 42GRL-9_0-QD



4-pin DC Micro QD Model: 42GRL-90_3-QD1



(1) Load can be placed on either black wire to create sourcing or on white wire to create sinking.

Approximate Dimensions

Figure 92 - All Versions (Except Fiber Optic) — Cable [mm (in.)]

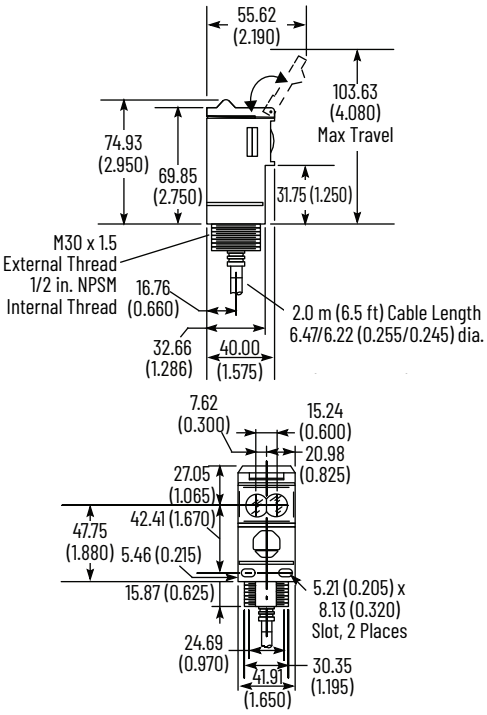


Figure 93 - Fiber-optic Versions — Cable [mm (in.)]

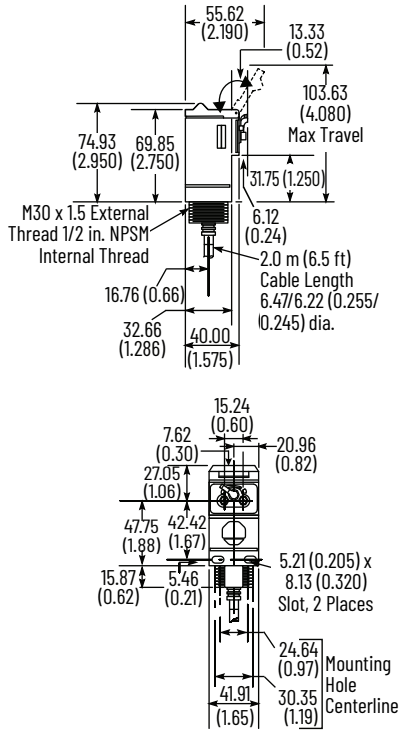


Figure 94 - ClearSight™ 9000 Sensor — Cable [mm (in.)]

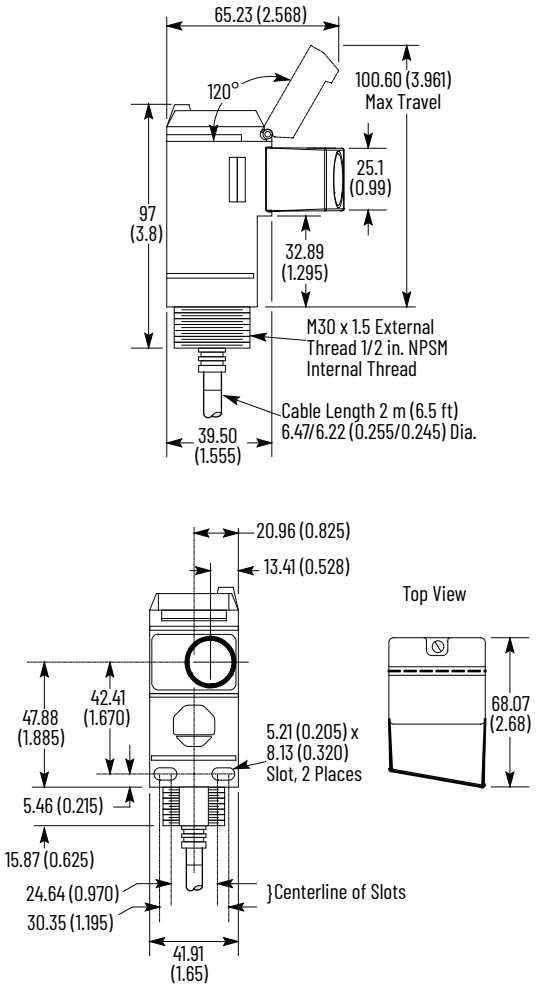


Figure 95 - Connector [mm (in.)]

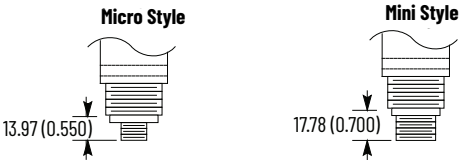


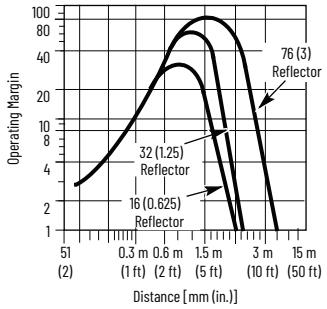
Table 22 - Thread Sizes

Style	AC	DC
Micro	1/2-20 UNF 2 keyways	M12 x 1 1 keyway
Mini	7/8-16 UN 1 keyway	

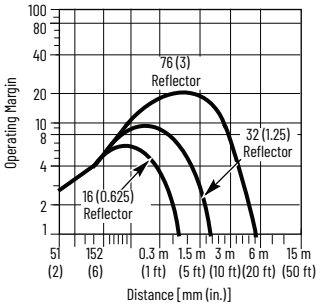
Typical Response Curves

Table 23 - Non-clear Object Detection Versions

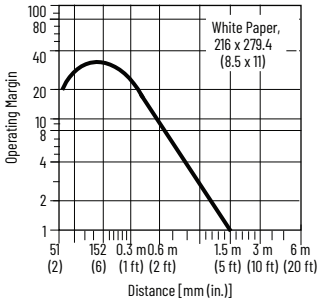
Retroreflective



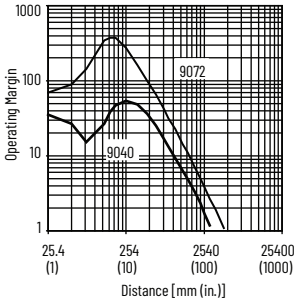
Polarized Retroreflective



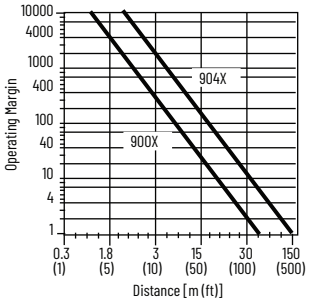
Standard Diffuse



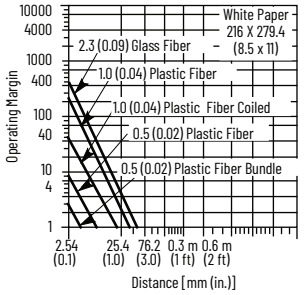
Long Range Diffuse



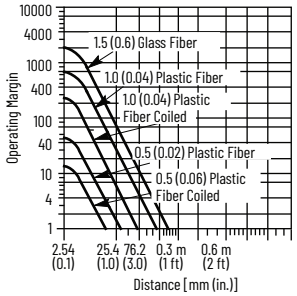
Transmitted Beam with 61 m (200 ft) Light Source



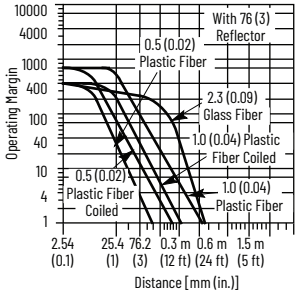
Visible Red Fiber-optic Standard Diffuse



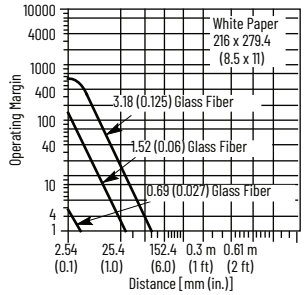
Visible Red Fiber-optic Transmitted Beam



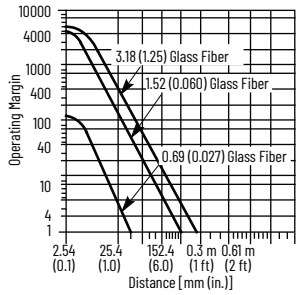
Small Aperture Fiber-optic Retroreflective



Large Aperture Fiber-optic Standard Diffuse



Large Aperture Fiber-optic Transmitted Beam



Large Aperture Fiber-optic Retroreflective

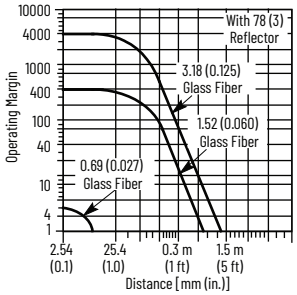
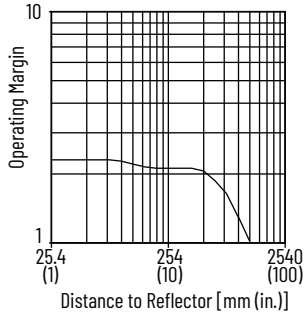
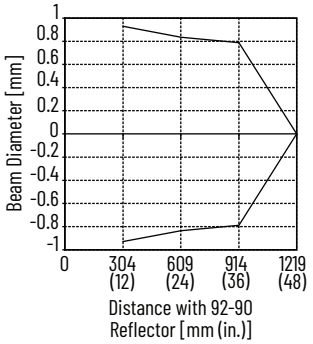


Table 24 - Clear Object Detection Versions

Response Curve



Beam Pattern



42JB VisiSight M20B Photoelectric Sensor

The VisiSight™ M20B family offers a wide range of sensing modes and an adjustment knob that simplifies sensitivity adjustment for maximum application flexibility.

The VisiSight sensor offers an industry standard 20 mm (0.79 in.) depth housing ideal for compact housing installations.

Features

- 360° highly visible operation status indicators
- Visible light source offered on select models for ease of alignment
- Industry standard 25.4 mm (1 in.) side mounting holes
- Embedded IO-Link 1.1 communication protocol with enhanced parameters
- Input to disable light source on transmitted beam emitter
- IP67 rated enclosure
- -40...+65 °C (-40...+149 °F) operating temperatures

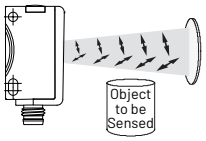
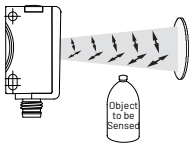
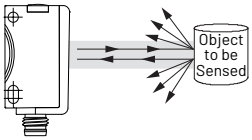
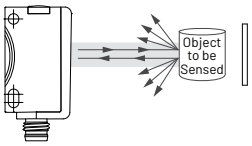
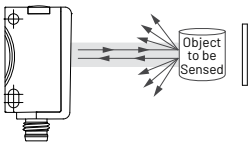
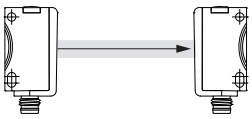
Available Models

- Polarized retroreflective
- Transmitted beam
- Background suppression
- Background reflection
- Diffuse
- Clear object detection

Specifications

Attribute	Value
Certifications	CE Marked for all applicable directives, cULus Listed, KCC, RCM, UKCA Marked for all applicable regulations
EMC Directive	EN 60947-5-2
Standards	UL 60947-5-2
Ambient light immunity	EN 60697-5-2:2007+A:2012
For declarations of conformity and certification details, visit rok.auto/certifications.	
Functional Safety Parameters	
MTTFd	860 a
User Interface	
Status indicators	Green and orange
Adjustments	Adjustment knob depending on catalog number
Optical	
Light-emitting diode (LED)	Visible red on all models
Electrical	
Operating voltage	10...30V DC
Current consumption	Less than 35 mA
Sensor protection	Reverse polarity and short circuit
Output	
Output type	PNP or NPN by catalog number
Output mode	Light and dark operate
Response Time	
Diffuse, max	0.5 ms
Transmitted beam, max	0.5 ms
Polarized retroreflective, max	0.5 ms
Clear object detection, max	0.5 ms
Background suppression, max	0.66 ms
Background reflection, max	0.66 ms
Load Current	
Resistive load	100 mA, max
Mechanical	
Housing material	ABS
Lens material	Acrylic
Environmental	
Enclosure rating	IP67
Operating temperature	-40...+65 °C (-40...+149 °F)

Product Selection

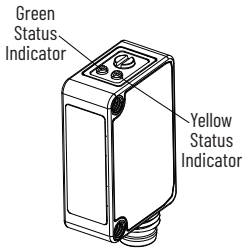
Sensing Mode	Light Source	Sensing Distance	Sensitivity Adjustment	Output Function	Output Type	Cat. No.
 Polarized Retroreflective	Visible red	6 m (19.7 ft) with Cat. No. 92-125 reflector	No adjustment knob	Complementary light and dark operate	NPN	42JB-P2MNB1-F4
					PNP	42JB-P2MPB1-F4
			Adjustment knob		NPN	42JB-P2MNA1-F4
					PNP	42JB-P2MPA1-F4
 Clear Object Detection	Visible red	3 m (9.8 ft) with Cat. No. 92-125 reflector	Adjustment knob	Complementary light and dark operate	NPN	42JB-C2MNA1-F4
					PNP	42JB-C2MPA1-F4
 Diffuse	Visible red	10 mm...1.5 m (0.4...59.1 in.)	Adjustment knob	Complementary light and dark operate	NPN	42JB-D2MNA1-F4
					PNP	42JB-D2MPA1-F4
 Background Suppression	Visible red	50 mm (2 in.)	No adjustment knob	Complementary light and dark operate	NPN	42JB-B2MNB1-F4
					PNP	42JB-B2MPB1-F4
	Visible red	100 mm (3.9 in.)			NPN	42JB-B2MNB2-F4
					PNP	42JB-B2MPB2-F4
		250 mm (9.8 in.)	Adjustment knob		NPN	42JB-B2MNA3-F4
					PNP	42JB-B2MPA3-F4
 Background Reflection	Visible red	250 mm (9.8 in.)	Adjustment knob	Complementary light and dark operate	NPN	42JB-N2MNA1-F4
					PNP	42JB-N2MPA1-F4
 Transmitted Beam	Visible red	25,000 mm (984.2 in.)	No adjustment knob - Freq 1	–	–	42JB-E2EZB1-F4
			Adjustment knob - Freq 1	Complementary light and dark operate	NPN	42JB-R2MNB1-F4
			Adjustment knob - Freq 1		PNP	42JB-R2MPB1-F4
			No adjustment knob - Freq 2	–	–	42JB-E2EZB2-F4
			Adjustment knob - Freq 2	Complementary light and dark operate	NPN	42JB-R2MNB2-F4
			Adjustment knob - Freq 2		PNP	42JB-R2MPB2-F4

IMPORTANT Connection Options [1]: The following suffixes describe the available connection options:

- P4: Describes an integral 4-pin DC pico (M8) quick-disconnect.
- F4: Describes a 4-pin DC micro (M12) quick-disconnect on a 150 mm (6 in.) length pigtail on DC models.
- A2: Describes a 2 m (6.6 ft) PVC cable.

(1) Additional connection options may be available. See the ProposalWorks™ tool for available options by sensing mode.

Status Indicators and User Interface



The following tables provide indicator status in the Run mode during operation. The sensor is always in Run mode except when being taught.

Table 25 - Standard I/O Operating Mode Indication

Color	Status	Description
Green	OFF	Power is OFF
	ON	Power is ON
	Flashing (6 Hz)	Unstable light: 0.8 X < margin < 1.5 X
	Flashing (1.4 Hz)	Output short circuit protection active
Orange	OFF	Output de-energized
	ON	Output energized

Table 26 - IO-Link Operation Mode Indication

Color	Status	Description
Green	OFF	Power is OFF
	Flashing (1 Hz)	Power is ON
Orange	OFF	Output de-energized
	ON	Output energized

The green status indicator can also serve as a setup alignment aid. As the sensor is adjusted:

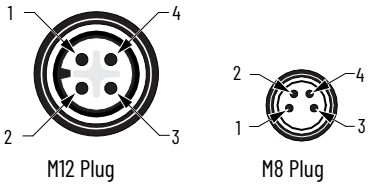
- A flashing green indicator shows that the sensor has detected a margin of 0.8 X
- A flashing green indicator and steady orange output indicator shows a margin greater than 1
- Steady green and orange indicators show a margin greater than 1.5. This status means that the sensor is receiving at least 1.5 times the signal strength back from the target that is required to trigger an output signal.

In general, it is desirable to have a higher margin to help overcome any deteriorating environmental conditions (dust build-up on the sensor lens). When aligning the sensor, the optimum performance can be obtained if this margin indicator is illuminated with the target in place.

Wiring

The quick-disconnect connector is shown in the following diagrams. The pin numbers correspond to plug connectors on the sensor.

Figure 96 - Micro (M12) Plug QD on Pigtail and Integral Pico (M8) Plug QD Pinout



Output Wiring

Figure 97 - PNP Complementary Models

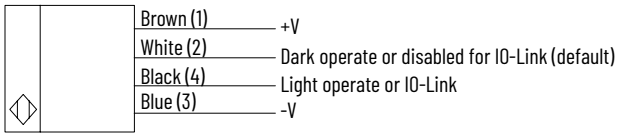
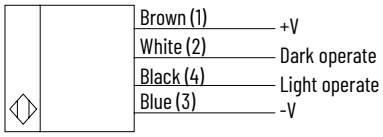
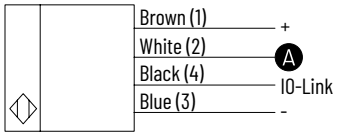


Figure 98 - NPN Complementary Models



Transmitted Beam Emitter



Item	Description
A	For normal operation, the black wire (Pin 4) needs no connection. To deactivate the light source, connect the black wire (Pin 4) to +V.

The IO-Link output Pin 4 (black) does not support the connection of multiple sensors in series (for example, one sensor powers the next sensor). The connection of multiple sensors in series can be achieved when using Pin 2 (white) outputs or by ordering a non-IO-Link catalog number.

Visit rok.auto/knowledgebase or contact your local Allen-Bradley distributor or Rockwell Automation sales office for specific ordering information.

Typical Response Curves

Diffuse

Figure 99 - 1.5 m (4.9 ft) Sensing Distance - Margin Curve

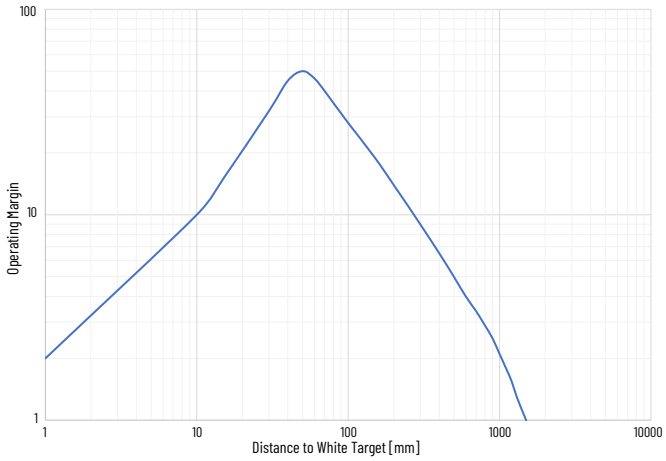
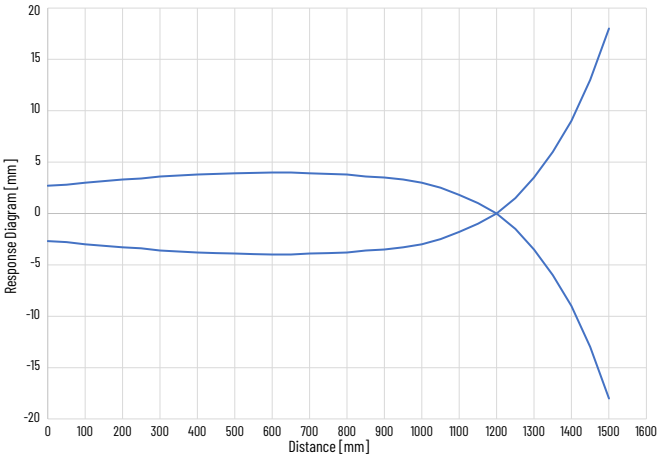


Figure 100 - 1.5 m (4.9 ft) Sensing Distance - Beam Pattern



Polarized Retroreflective

Figure 101 - 6 m (19.7 ft) Sensing Range - Margin Curve

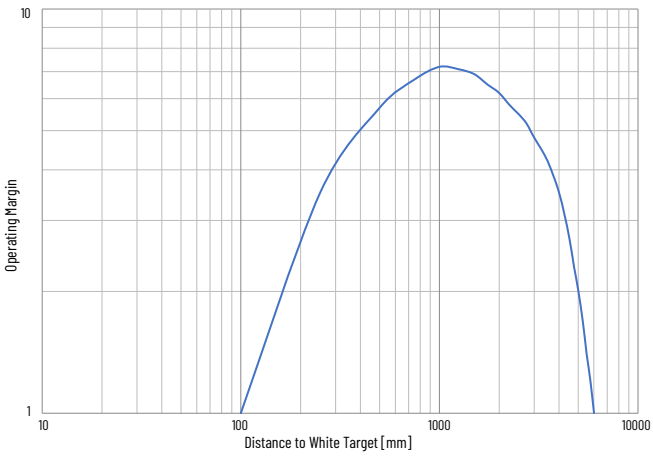
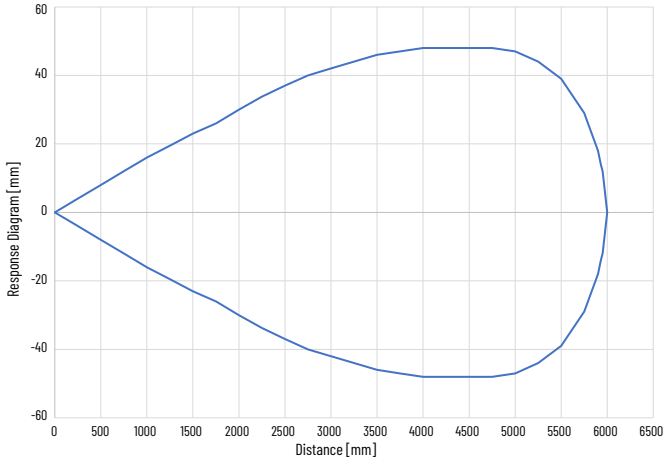


Figure 102 - 6 m (19.7 ft) Sensing Range - Beam Pattern



Background Suppression

Figure 103 - 50 mm (1.97 in.) Sensing Range - Margin Curves

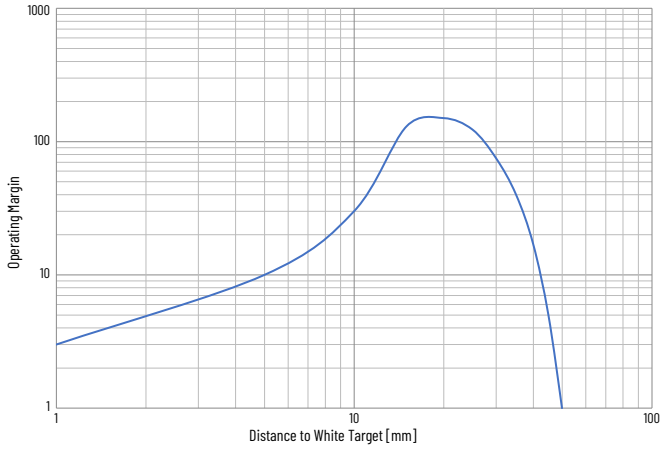


Figure 104 - 50 mm (1.97 in.) Sensing Range - Beam Pattern

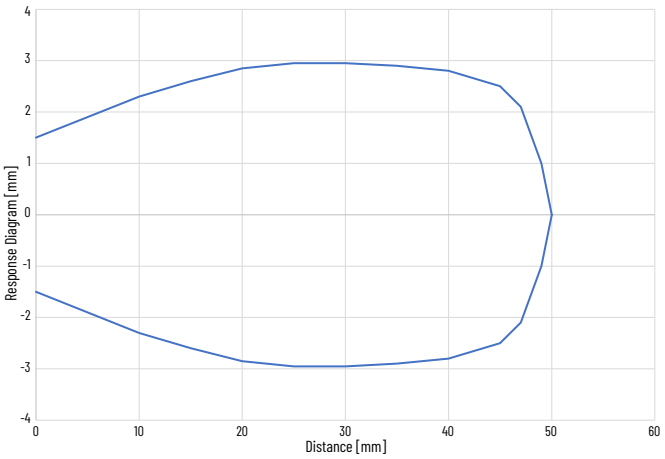


Figure 105 - 100 mm (3.94 in.) Sensing Range - Margin Curves

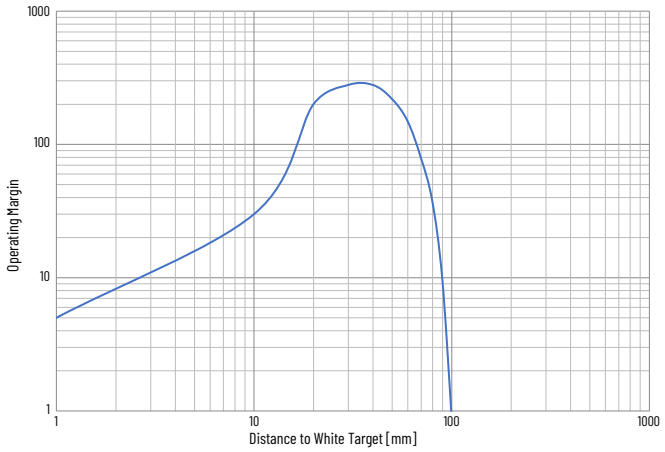


Figure 106 - 100 mm (3.94 in.) Sensing Range - Beam Pattern

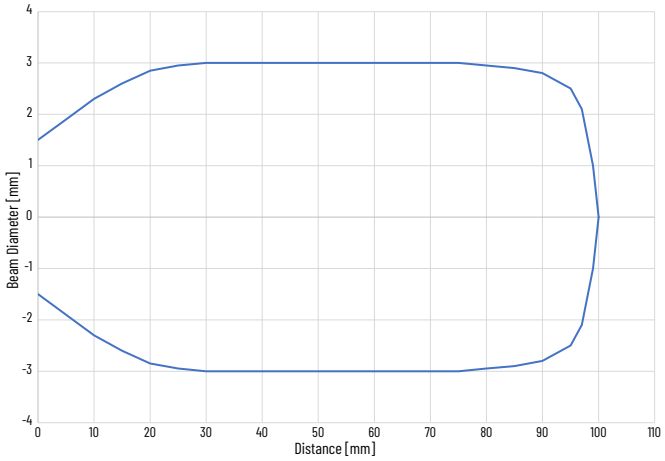


Figure 107 - 250 mm (9.84 in.) Sensing Range - Margin Curves

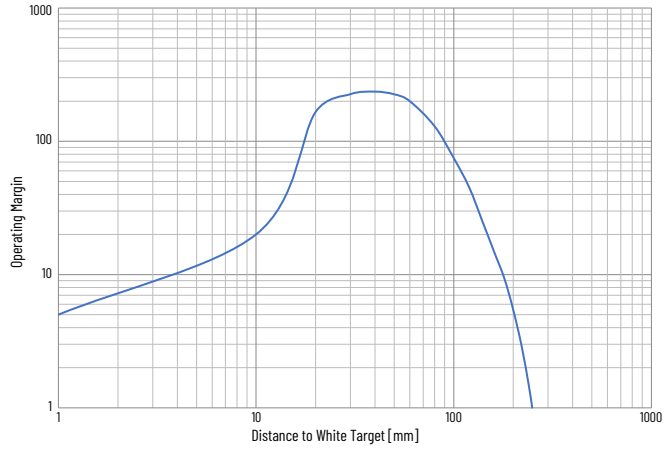
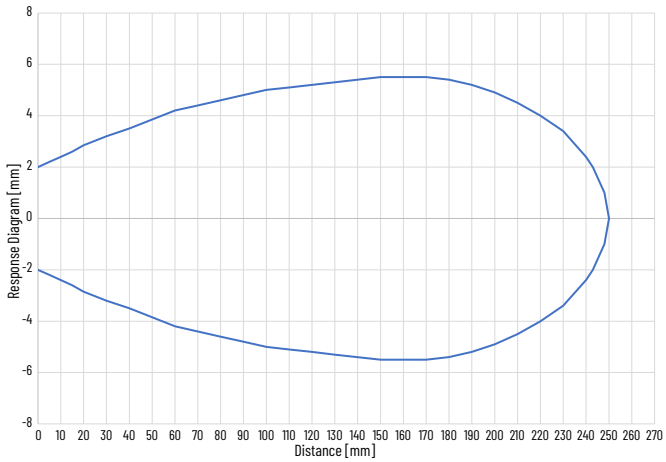


Figure 108 - 250 mm (9.84 in.) Sensing Range - Beam Pattern



Background Reflection

Figure 109 - 250 mm (9.84 in.) Sensing Range - Margin Curves

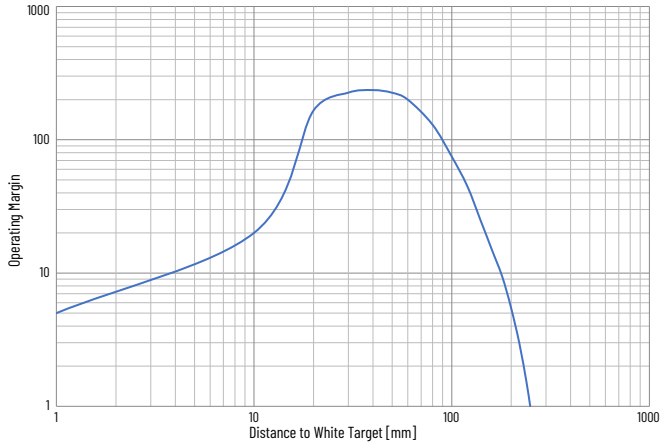
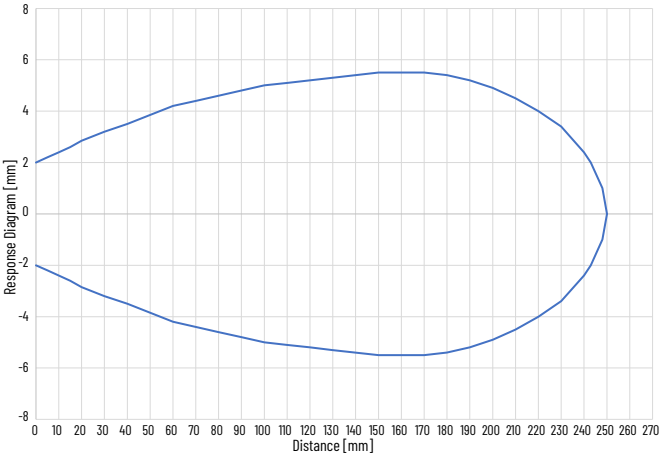
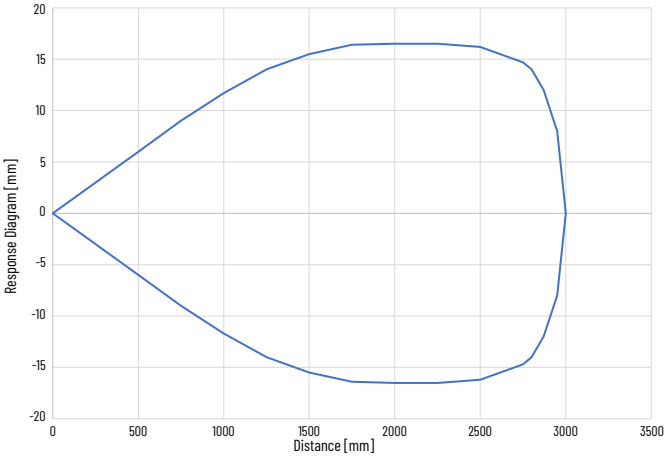


Figure 110 - 250 mm (9.84 in.) Sensing Range - Beam Patterns



Clear Object Detection

Figure 111 - 3 m (9.8 ft) Sensing Range - Beam Patterns



Transmitted Beam

Figure 112 - 25 m (82 ft) Sensing Range - Margin Curves

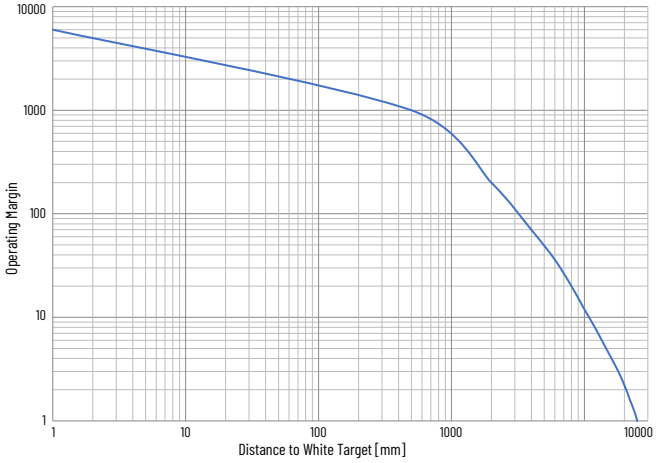
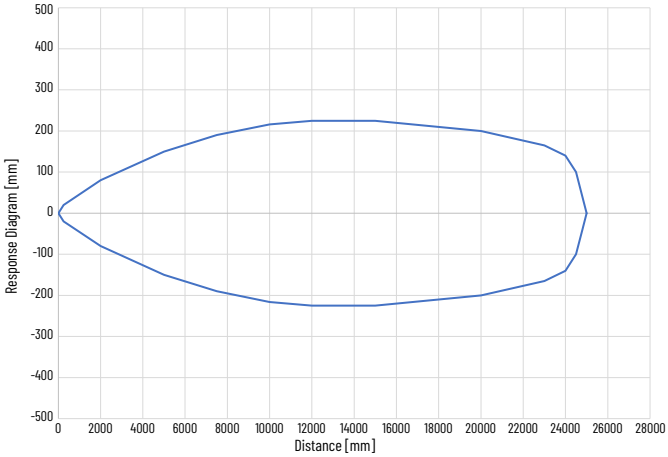
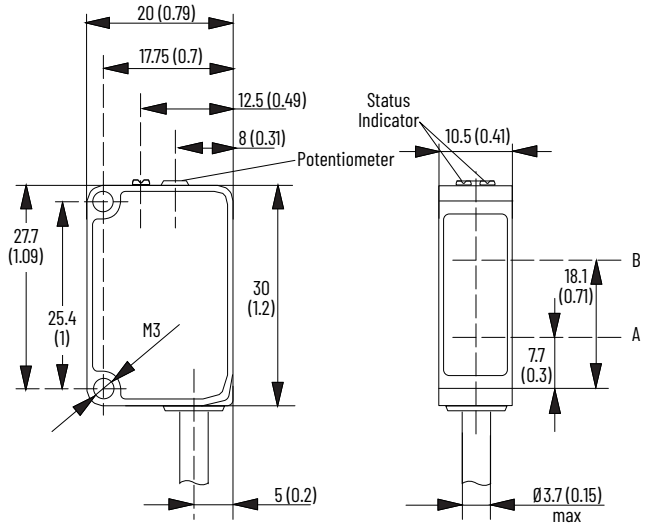


Figure 113 - 25 m (82 ft) Sensing Range - Beam Pattern



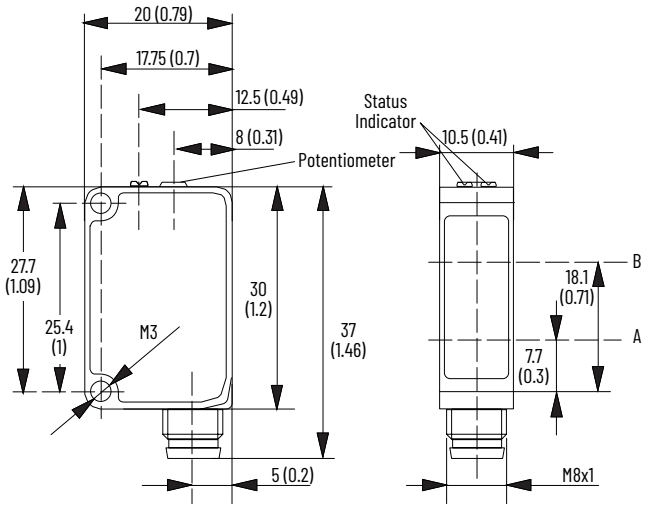
Approximate Dimensions

Figure 114 - 2 m (6.6 ft) Cable Models [mm (in.)]



Item	Description
A	Emitter axis
B	Receiver axis

Figure 115 - Integral M8 Pico QD Models [mm (in.)]



Item	Description
A	Emitter axis
B	Receiver axis

Table 27 - Emitter and Receiver Axis Position

Sensing Mode	A [mm (in.)]	B [mm (in.)]
Diffuse	7.7 (0.3)	18.1 (0.71)
Background suppression	7.7 (0.3)	18.1 (0.71)
Background reflection	7.7 (0.3)	18.1 (0.71)
Polarized retroreflective	7.7 (0.3)	18.1 (0.71)
Clear object detection	7.7 (0.3)	18.1 (0.71)
Transmitted beam emitter	16.3 (0.64)	
Transmitted beam receiver	16.3 (0.64)	

Accessories

Description		Cat. No.
DC micro (M12) QD cordset, straight, 4-pin, 2 m (6.6 ft)		889D-F4AC-2
DC pico (M8) QD cordset, straight, 4-pin, 2 m (6.6 ft)		889P-F4AB-2
DC pico (M8) QD cordset, right angle, 4-pin, 2 m (6.6 ft)		889P-R4AB-2
Mounting bracket	Stainless steel, L-shaped	60-BJS-L1
		60-BJS-L2
		60-BJT-L2
	Stainless steel, dovetail	60-BKTL-SS
	Plastic, swivel/tilt	60-2619
	Replacement, stainless steel, for replacing larger (50 x 50 mm) sensors	60-BJT-RCS
	Protective, stainless steel, U-shaped	60-BJT-U1
	Protective, stainless steel, horizontal and vertical	60-BJT-H1

Description		Cat. No.
Reflector	Corner cube, 76 mm (3 in.) diameter	92-124
	Corner cube, 84 mm (3.3 in.) diameter	92-125
	Corner cube, 32 mm (1.5 in.) diameter	92-47
	Corner cube, 100 x 100 mm (4 x 4 in.)	92-108
	Corner cube, 51 x 61 mm (2 x 2.5 in.)	92-109
	Micro cube, 51 x 61 mm (2 x 2.5 in.) for laser and clear object models	92-118

42KL MiniSight 18 mm (0.71 in.) Compact Rectangular Sensor

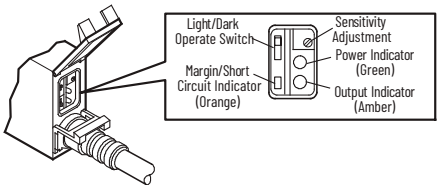
Features

- Compact rectangular size with standard 18 mm (0.71 in.) mounting nose
- Visible indicators for power, output, and 2.5X margin/short circuit
- Short circuit protection in all versions, including two-wire universal voltage versions
- False pulse protection
- Switch selectable light or dark operation
- Access to sensor adjustments through a captive cover that does not require tools for access
- Eight sensing modes are available
- Rated to withstand high temperature 1200 psi washdowns
- 300 µs high-speed DC versions
- No tools are required to attach fiber-optic cables to either glass or plastic fiber-optic sensors

Specifications

Attribute	42KL MiniSight 18 mm (0.71 in.) Compact Rectangular Sensor
Environmental	
Certifications	UL, CSA, and CE Marked for all applicable directives
Operating Environment	NEMA 4X, 6P, IP67, 1200 psi (8270 kPa) washdown
Operating Temperature	-20…+70 °C (-4…+158 °F)
Vibration	10…55 Hz, 1 mm amplitude, meets or exceeds IEC 60947-5-2
Shock	30 g with 1 ms pulse duration, meets or exceeds IEC 60947-5-2
Relative Humidity	5…95%
Optical	
Sensing Modes	Retroreflective, polarized retroreflective, diffuse, wide angle diffuse, fixed focus diffuse, transmitted beam, fiber-optic
Sensing Range	See Product Selection on page 63
Field of View	See Product Selection on page 63
Light Source	Visible red LED (660 nm), infrared LED (880 nm)
LED Indicators	See User Interface
Adjustments	Multi-turn potentiometer
Electrical	
Voltage	10.8…30V DC, 21.6…250V AC/DC
Current Consumption	30 mA max (DC)
Sensor Protection	Overload, short circuit, reverse polarity, false pulse
Outputs	
Response Time	See Product Selection on page 63
Output Type	PNP and NPN (DC), MOSFET (AC/DC)
Output Mode	Light operate or dark operate selectable
Output Current	100 mA @ 30V DC max
Output Leakage Current	0.1 mA max (DC), 1.7 mA (AC/DC)
Mechanical	
Housing Material	Noryl 190X
Lens Material	Acrylic
Connection Types	2 m (6.6 ft) cable (24 AWG), 4-pin DC micro (M12) QD, 3-pin AC micro (M12)
Supplied Accessories	75012-097-01 18 mm (0.71 in.) locknut
Optional Accessories	See Cordsets and Accessories on page 65

User Interface



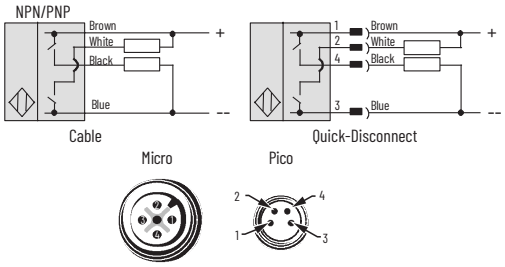
The power indicator turns off when the output indicator is on. The catalog number for the rear snap cover is 60-2679.

Wiring Diagrams

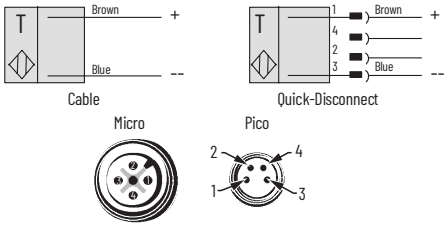
For Rockwell Automation programmable controller compatible interface, see the PHOTOSWITCH Photoelectric Sensors and Programmable Controller Interface Manual, publication 42-2.0.

IMPORTANT Quick-disconnect wiring codes that are shown are valid for Rockwell Automation cables only.

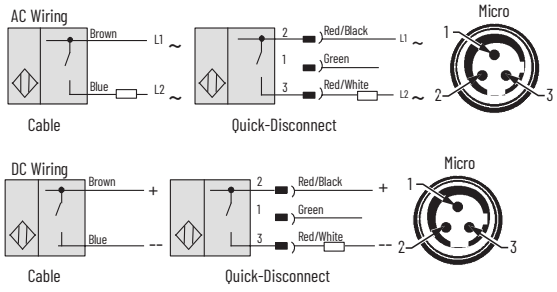
11…30V DC Sensors



Transmitted Beam Source

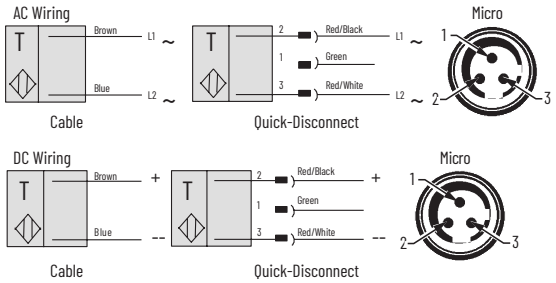


22…250V AC/DC Sensors



Load can be switched to Pin 2 or brown.

Transmitted Beam Source



Approximate Dimensions

Figure 116 - DC Sensors [mm (in.)]

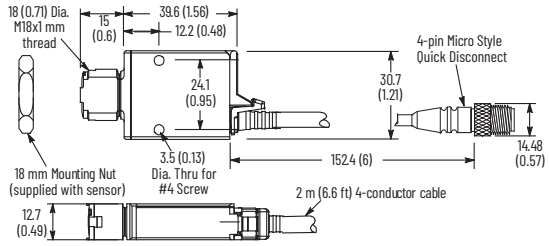


Figure 117 - AC/DC Sensors [mm (in.)]

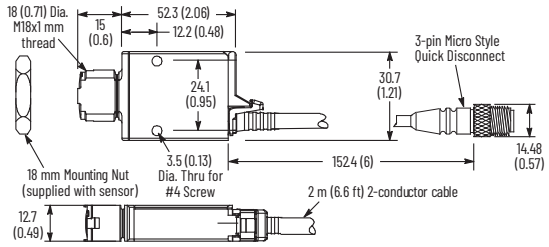


Figure 118 - Infrared Glass Fiber-optic Sensors [mm (in.)]

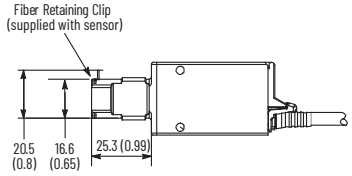
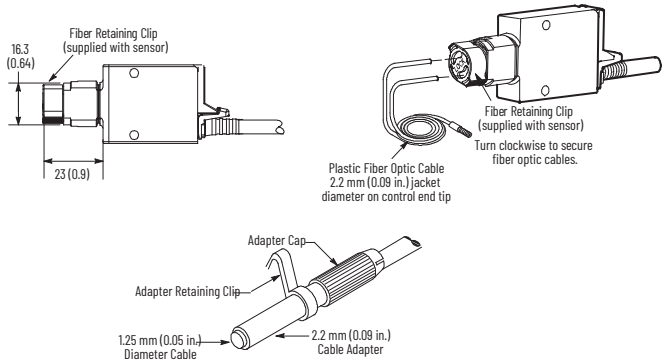


Figure 119 - Visible Red Plastic Fiber-optic Sensors [mm (in.)]



- Special glass fiber-optic cables are also available with 2.2 mm (0.09 in.) diameter control end tips.
- Catalog number 61-6731 adapters are required for smaller fiber-optic cables with jacket diameters of 1.25 mm (0.05 in.).

Typical Response Curves and Beam Patterns

Table 28 - Retroreflective

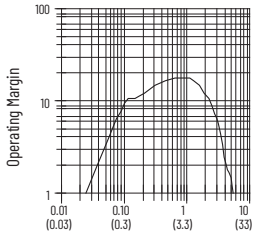
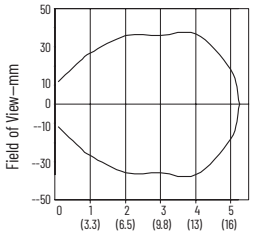
Typical Response Curve	Beam Pattern
	

Table 29 - Polarized Retroreflective

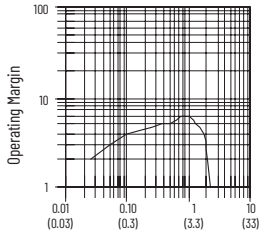
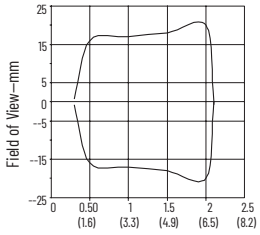
Typical Response Curve	Beam Pattern
	

Table 30 - Standard Diffuse

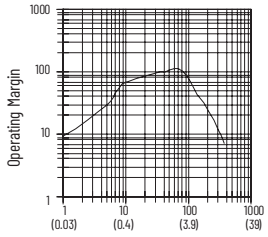
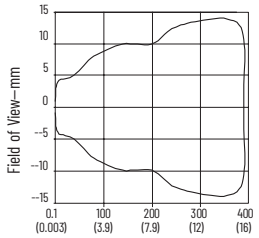
Typical Response Curve	Beam Pattern
	

Table 31 - Wide Angle Diffuse

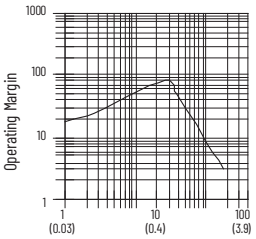
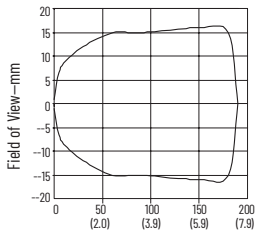
Typical Response Curve	Beam Pattern
	

Table 32 - Fixed Focus Diffuse — 16 mm Red LED

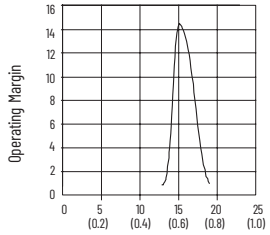
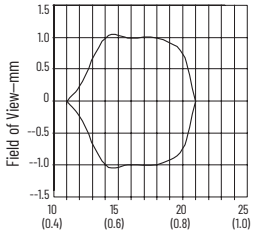
Typical Response Curve	Beam Pattern
	

Table 33 - Fixed Focus Diffuse — 16 mm Green LED

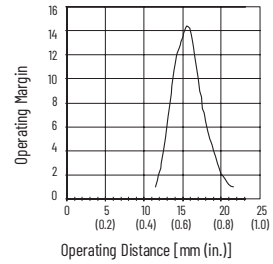
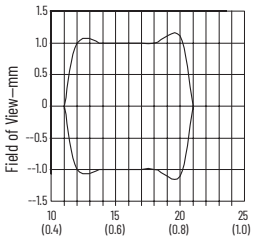
Typical Response Curve	Beam Pattern
	

Table 34 - Fixed Focus Diffuse — 43 mm (1.7 in.) Red LED

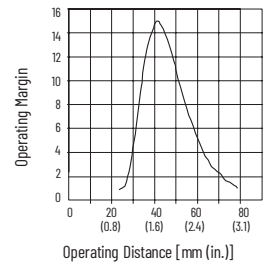
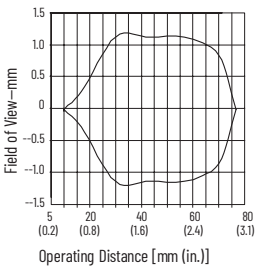
Typical Response Curve	Beam Pattern
	

Table 35 - Transmitted Beam

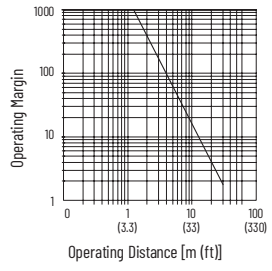
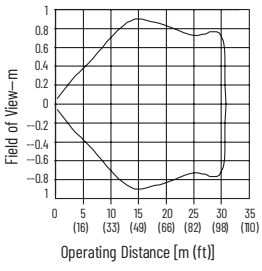
Typical Response Curve	Beam Pattern
	

Table 36 - Large Aperture Fiber-optic — Retroreflective (with 3 in. dia. reflector)

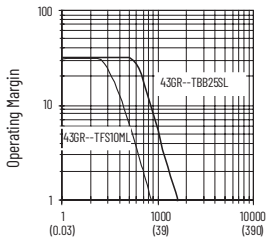
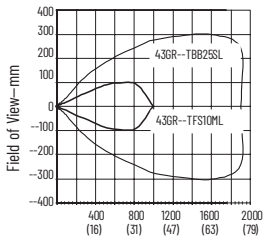
Typical Response Curve	Beam Pattern
	

Table 37 - Large Aperture Fiber-optic — Diffuse

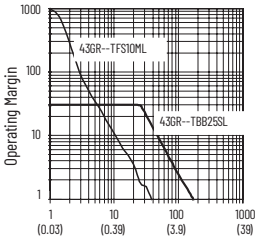
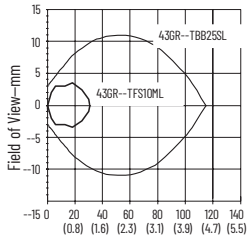
Typical Response Curve	Beam Pattern
	

Table 38 - Large Aperture Fiber-optic — Transmitted Beam

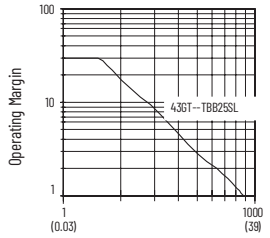
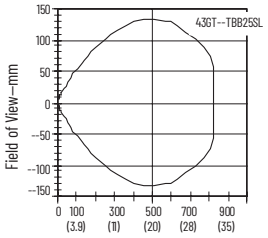
Typical Response Curve	Beam Pattern
	

Table 39 - Small Aperture Fiber-optic — Retroreflective (with 3 in. dia. reflector)

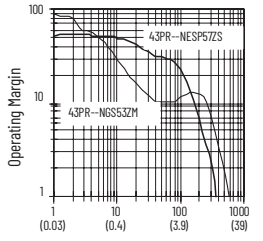
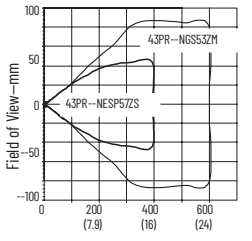
Typical Response Curve	Beam Pattern
	

Table 40 - Small Aperture Fiber-optic — Diffuse

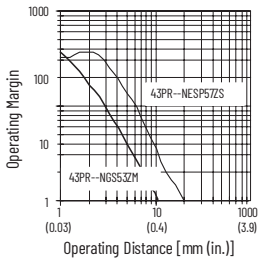
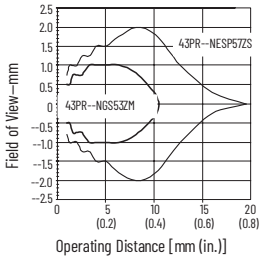
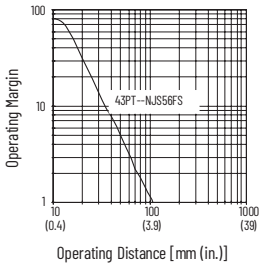
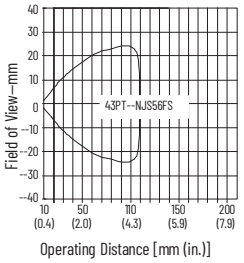
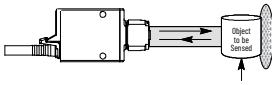
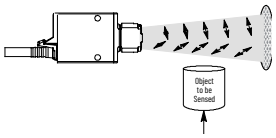
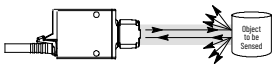
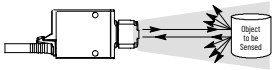
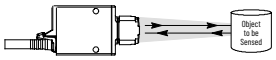
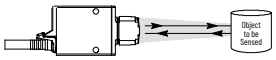
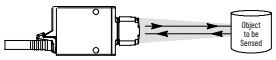
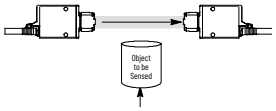
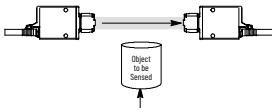
Typical Response Curve	Beam Pattern
	

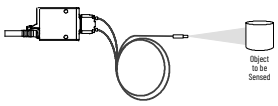
Table 41 - Small Aperture Fiber-optic — Transmitted Beam

Typical Response Curve	Beam Pattern
	

Product Selection

Sensing Mode	Operating Voltage Supply Current	Sensing Distance	Output Energized	Output Type Capacity Response Time	Connection Type	Cat. No.
 Retroreflective Field of View: 1.5° Emitter LED: Visible red 660 nm	10.8...30V DC 35 mA	25 mm...5 m (0.98 in...16.4 ft)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-U2LB-A2
					4-pin DC micro	42KL-U2LB-F4
					4-pin pico QD	42KL-U2LB-Y4
		25 mm...2.5 m (0.98 in....8.2 ft)		NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-U2LBQ-A2
					4-pin DC micro	42KL-U2LBQ-F4
					4-pin pico QD	42KL-U2LBQ-Y4
	21.6...250V AC/DC	25 mm...5 m (0.98 in...16.4 ft)		Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-U2TC-A2
					3-pin AC micro	42KL-U2TC-G3
 Polarized Retroreflective Field of View: 1.5° Emitter LED: Visible red 660 nm	10.8...30V DC 35 mA	25 mm...2 m (0.98 in...6.6 ft)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-P2LB-A2
					4-pin DC micro	42KL-P2LB-F4
					4-pin pico QD	42KL-P2LB-Y4
		25 mm...1 m (0.98 in...3.3 ft)		NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-P2LBQ-A2
					4-pin DC micro	42KL-P2LBQ-F4
					4-pin pico QD	42KL-P2LBQ-Y4
	21.6...250V AC/DC	25 mm...2 m (0.98 in...6.6 ft)		Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-P2TC-A2
					3-pin AC micro	42KL-P2TC-G3
 Standard Diffuse Field of View: 5° Emitter LED: Infrared 880 nm	10.8...30V DC 35 mA	1...380 mm (0.04...15 in.)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-D1LB-A2
					4-pin DC micro	42KL-D1LB-F4
					4-pin pico QD	42KL-D1LB-Y4
		1...190 mm (0.04...7.5 in.)		NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-D1LBQ-A2
					4-pin DC micro	42KL-D1LBQ-F4
					4-pin pico QD	42KL-D1LBQ-Y4
	21.6...250V AC/DC	1...380 mm (0.04...15 in.)		Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-D1TC-A2
					3-pin AC micro	42KL-D1TC-G3
 Wide Angle Diffuse Field of View: 18° Emitter LED: Infrared 880 nm	10.8...30V DC 35 mA	1...180 mm (0.04...7.0 in.)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-W1LB-A2
					4-pin DC micro	42KL-W1LB-F4
					4-pin pico QD	42KL-W1LB-Y4
		1...90 mm (0.04...3.5 in.)		NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-W1LBQ-A2
					4-pin DC micro	42KL-W1LBQ-F4
					4-pin pico QD	42KL-W1LBQ-Y4
	21.6...250V AC/DC			Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-W1TC-A2
					3-pin AC micro	42KL-W1TC-G3

Sensing Mode	Operating Voltage Supply Current	Sensing Distance	Output Energized	Output Type Capacity Response Time	Connection Type	Cat. No.
 Fixed Focus Diffuse Emitter LED: Visible red 660 nm	10.8...30V DC 35 mA	16 mm (0.63 in.)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-F2LBS-A2
					4-pin DC micro	42KL-F2LBS-F4
					4-pin pico QD	42KL-F2LBS-Y4
				NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-F2LBSQ-A2
					4-pin DC micro	42KL-F2LBSQ-F4
					4-pin pico QD	42KL-F2LBSQ-Y4
	21.6...250V AC/DC			Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-F2TCS-A2
					3-pin AC micro	42KL-F2TCS-G3
 Fixed Focus Diffuse Emitter LED: Visible green 525 nm	10.8...30V DC 35 mA			NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-F3LBS-A2
					4-pin DC micro	42KL-F3LBS-F4
					4-pin pico QD	42KL-F3LBS-Y4
				NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-F3LBSQ-A2
					4-pin DC micro	42KL-F3LBSQ-F4
					4-pin pico QD	42KL-F3LBSQ-Y4
 Fixed Focus Diffuse Emitter LED: Visible red 660 nm		43 mm (1.7 in.)		NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-F2LBL-A2
					4-pin DC micro	42KL-F2LBL-F4
					4-pin pico QD	42KL-F2LBL-Y4
				NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-F2LBLQ-A2
					4-pin DC micro	42KL-F2LBLQ-F4
					4-pin pico QD	42KL-F2LBLQ-Y4
	21.6...250V AC/DC			Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-F2TCL-A2
					3-pin AC micro	42KL-F2TCL-G3
 Transmitted Beam Light Source Field of View: 7° Emitter LED: Infrared 880 nm	10.8...30V DC 35 mA	1...30 m (98 ft)	–	–	2 m (6.6 ft) 300V cable	42KL-E1EZB-A2
					4-pin DC micro	42KL-E1EZB-F4
					4-pin pico QD	42KL-E1EZB-Y4
	21.6...250V AC/DC 5 mA		–	–	2 m (6.6 ft) 300V cable	42KL-E1QZB-A2
					3-pin AC micro	42KL-E1QZB-G3
	10.8...30V DC 35 mA	1...10 m (33 ft)	–	–	2 m (6.6 ft) 300V cable	42KL-E1EZBQ-A2
					4-pin DC micro	42KL-E1EZBQ-F4
					4-pin pico QD	42KL-E1EZBQ-Y4
 Transmitted Beam Receiver Field of View: 7° Emitter LED: Infrared 880 nm	10.8...30V DC 25 mA	30 m (98 ft)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-RLB-A2
					4-pin DC micro	42KL-RLB-F4
					4-pin pico QD	42KL-RLB-Y4
	21.6...250V AC/DC			Power MOSFET 2-wire 100 mA 16 ms	2 m (6.6 ft) 300V cable	42KL-RTC-A2
					3-pin AC micro	42KL-RTC-G3
	10.8...30V DC 25 mA	10 m (33 ft)	Light/dark selectable	NPN/PNP 100 mA 900 µs	2 m (6.6 ft) 300V cable	42KL-RLBQ-A2
					4-pin DC micro	42KL-RLBQ-F4
					4-pin pico QD	42KL-RLBQ-Y4
 Large Aperture Fiber-optic Field of View: Depends on the fiber-optic cable selected Emitter LED: Infrared 880 nm	10.8...30V DC 35 mA	Depends on the fiber-optic cable selected (1)	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-G1LB-A2
					4-pin DC micro	42KL-G1LB-F4
					4-pin pico QD	42KL-G1LB-Y4
				NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-G1LBQ-A2
					4-pin DC micro	42KL-G1LBQ-F4
					4-pin pico QD	42KL-G1LBQ-Y4
	21.6...250V AC/DC			Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-G1TC-A2
					3-pin AC micro	42KL-G1TC-G3

Sensing Mode	Operating Voltage Supply Current	Sensing Distance	Output Energized	Output Type Capacity Response Time	Connection Type	Cat. No.
 Small Aperture Plastic Fiber-optic Field of View: Depends on the fiber-optic cable selected Emitter LED: Visible red 660 nm	10.8...30V DC 35 mA	Depends on the fiber-optic cable selected	Light/dark selectable	NPN/PNP 100 mA 1 ms	2 m (6.6 ft) 300V cable	42KL-L2LB-A2
					4-pin DC micro	42KL-L2LB-F4
					4-pin pico QD	42KL-L2LB-Y4
				NPN/PNP 100 mA 300 µs	2 m (6.6 ft) 300V cable	42KL-L2LBQ-A2
					4-pin DC micro	42KL-L2LBQ-F4
					4-pin pico QD	42KL-L2LBQ-Y4
	21.6...250V AC/DC 15 mA			Power MOSFET 2-wire 100 mA 8.3 ms	2 m (6.6 ft) 300V cable	42KL-L2TC-A2
					3-pin AC micro	42KL-L2TC-G3

(1) For fiber-optic selection, see the Fiber Optic Cables Technical Data, publication FIBERS-TD001.

Cordsets and Accessories

Description	Cat. No.
DC Micro QD Cordset, Straight, 4-pin, 2 m (6.6 ft)	889D-F4AC-2
AC Micro QD Cordset, Straight, 3-pin, 2 m (6.6 ft)	889R-F3AEA-2
Pico QD Cordset, Straight, 4-pin, 2 m (6.6 ft)	889P-F4AB-2
76 mm (3 in.) Diameter Reflector	92-39
32 mm (1.25 in.) Diameter Reflector	92-47

Table 42 - Transmitted Beam—Maximum Operating Distance with Apertures

Aperture Slot Size	Maximum Range		Cat. No.
	Standard Speed	High Speed	
1 mm	2.1 m (6.9 ft)	0.7 m (2.3 ft)	60-2673
2 mm	10.5 m (34.5 ft)	3.5 m (11.4 ft)	60-2674
4 mm	18.6 m (61.0 ft)	6.1 m (20.1 ft)	60-2675
1, 2, 4 mm kit	–	–	60-2676

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Literature Library	Find installation instructions, manuals, brochures, and technical data publications.	rok.auto/literature
Product Compatibility and Download Center (PCDC)	Download firmware, associated files (such as AOP, EDS, and DTM), and access product release notes.	rok.auto/pcdc

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