iKnow® Guide to Sensing

Basics of Photoelectric Sensing

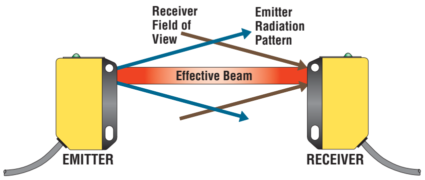
A photoelectric sensor is an optical control used in a variety of automated processes. It works by detecting a visible or invisible beam of light, and responding to a change in the received light intensity.

What is a PE Sensor?

Effective beam: "Working" part of a photoelectric beam.

Radiation pattern: Total area of sensing energy emission.

Field of view: Area of response.



Components of a Sensor

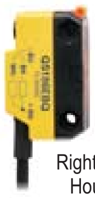
Emitter contains the light source, usually an LED, and an oscillator which modulates the LED at a high rate of speed. The emitter sends a modulated light beam to the receiver.

Receiver decodes the light beam and switches an output device that interfaces with the load.

Types of Sensors

Job Aid: Types of Sensors

1. **Self-contained sensors:** One-piece photoelectric sensors that contain both the optics and the electronics. These sensors perform their own modulation, demodulation, amplification and output switching.



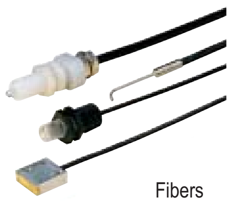
Right-Angle Housing

In-Line Housing

2. **Remote systems:** Sensing systems in which the amplification and the optical sensing are divided. The opto-elements contain only the optical components, allowing the sensing heads to be extremely small. The amplifier module contains the power input, amplification and output switching. This allows the sensitive electronics to be located away from the sensing event.

Opto-Elements Amplifier

3. **Fiber optic systems:** Sensing systems in which fiber optic cables are used with either remote or self-contained sensors. Fiber optic devices have no electrical circuitry and no moving parts, and can be used to safely pipe light into and out of hostile environments.



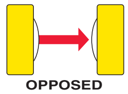
Fibers

Sensing Modes

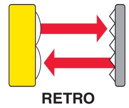
Sensing Modes

One way to tell sensors apart is by their **sensing mode**, the method in which a sensor sends and receives light. Photoelectric sensors are divided into three basic sensing modes: opposed, retroreflective and proximity.

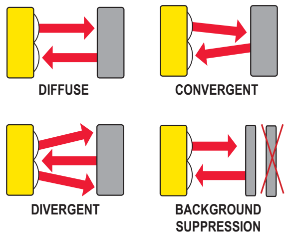
Opposed mode: The sensor's emitter and receiver are housed in two separate units. The emitter is placed opposite the receiver. An object is detected when it breaks the effective beam.



Retroreflective mode: The sensor contains both the emitter and receiver elements. The effective beam is established between the emitter, the retroreflector and the receiver. As with an opposed-mode sensor, an object is sensed when it interrupts or breaks the effective beam.



Proximity mode: These sensors contain both emitter and receiver elements. A proximity-mode sensor detects an object when emitted light is reflected off the object, back to the sensor.



Range

The range is the specified operating distance of a sensor or sensing system.

- **Opposed mode:** The distance from the emitter to the receiver.
- **Retroreflective mode:** The distance from the sensor to the retroreflector.
- **Proximity mode:** The distance from the sensor to the object being sensed.

Contrast

Understanding Contrast

Contrast is the ratio of the amount of light falling on a receiver in the "light" state, compared to the "dark" state. Increasing contrast in any sensing situation will increase the reliability of the sensing system.

Beam Pattern

Understanding Beam Patterns

A beam pattern is plotted on a 2-dimensional graph to illustrate how the sensor responds to its emitter or sensing target. Use the beam pattern to estimate placement of the sensing system with respect to adjacent objects.

Excess Gain

Understanding Excess Gain

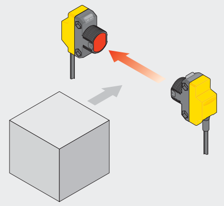
Excess gain is a measurement of the amount of light falling on a receiver, over and above the amount of light required to operate the sensor.

Sensing Modes

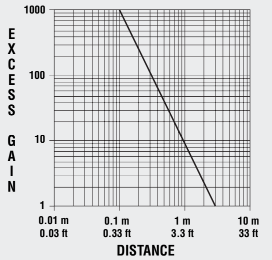
MORE INFO ONLINE Sensing Modes

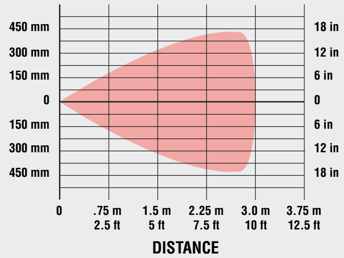
CONFIGURATION	FEATURES	EXCESS GAIN	BEAM PATTERN

OPPOSED

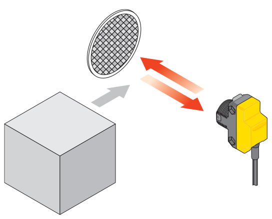


- Most reliable mode for opaque targets
- High excess gain results in long sensing range
- Good performance in contaminated environments
- High tolerance to misalignment

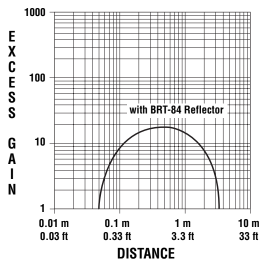


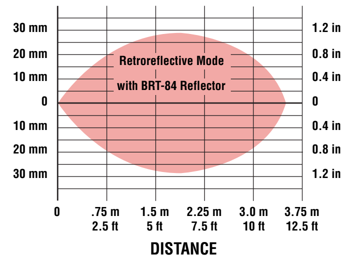


RETROREFLECTIVE

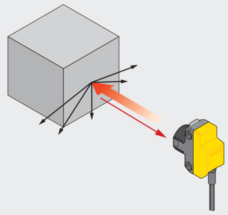


- Convenient when space is limited
- High excess gain results in long sensing range

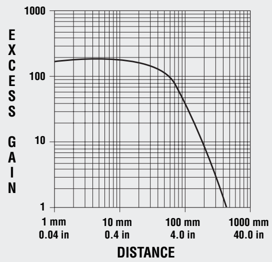


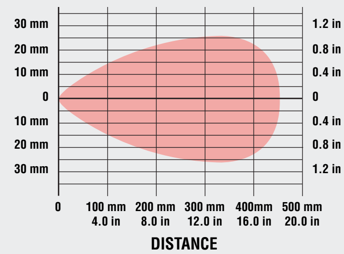


DIFFUSE

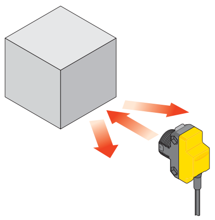


- Convenient when space is limited
- Used in applications requiring reflectivity monitoring

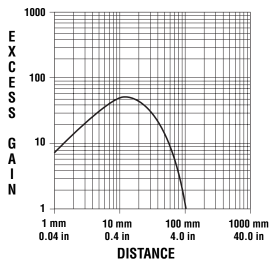


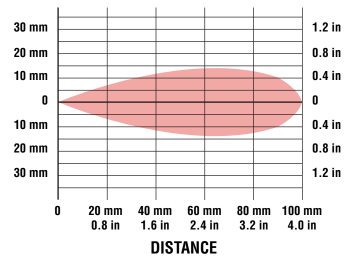


DIVERGENT

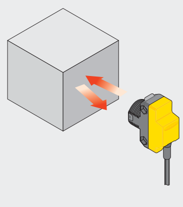


- Convenient when space is limited
- Good performance in detecting clear materials at close range
- Used in applications requiring reflectivity monitoring
- Reliable in detection of shiny or vibrating surfaces

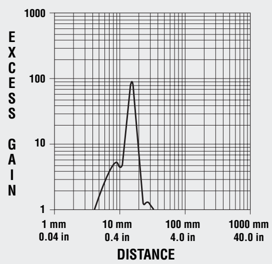


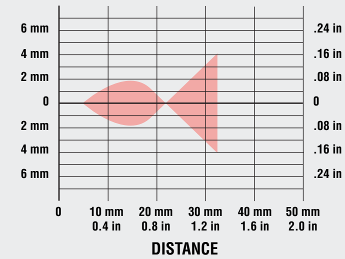


CONVERGENT

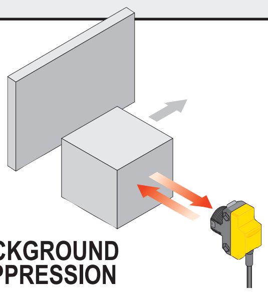


- Used for accurate positioning
- Excellent in small colormark or small object detection applications
- Used for accurate counting of radiused objects
- High excess gain allows detection of objects having low reflectivity

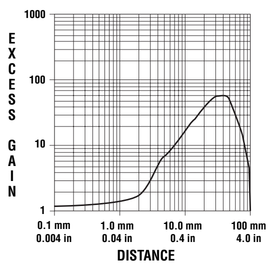




BACKGROUND SUPPRESSION



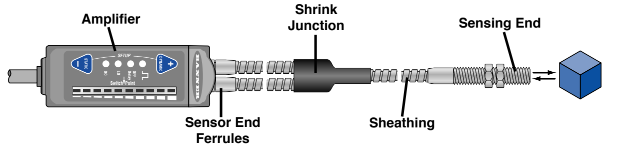
- Definite range limit used to ignore backgrounds
- High excess gain allows detection of objects having low reflectivity
- Good at detecting targets of varying reflectivity



Fiber Optics

MORE INFO ONLINE *Fiber Optics in Sensing*

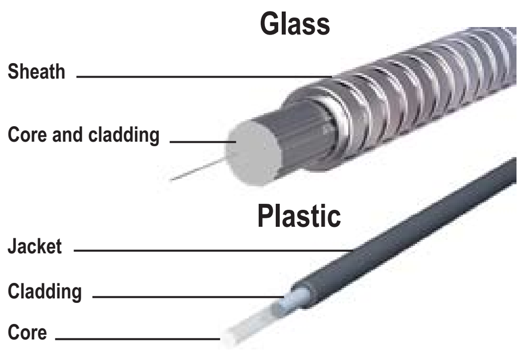
Fibers are transparent strands of optical quality glass or plastic that can be as thin as a strand of hair. In photoelectric sensing, these fibers are used to transmit and/or receive light from the LED of an attached sensor.



Fiber Optic Sensing System

Glass or Plastic Fibers

Fiber optics are available in **glass** or **plastic**. Glass fibers are arranged in bundles and plastic fibers are usually packaged as monofilaments.



Cross-section of fibers

Core – Thin glass or plastic center of the fiber through which light travels.

Cladding – Outer optical material surrounding the core that reflects light back into the core.

Jacket – Layer around plastic fiber to protect from damage and moisture.

Sheathing – Layer of stainless steel or PVC tubing to protect glass fiber bundles from damage.

Uses for Fibers

- **Tight sensing locations:** Size and flexibility of fibers allow positioning and mounting in tight spaces.
- **Vibration and shock:** Low mass fibers are able to withstand high levels of vibration and mechanical shock.
- **Extreme environments:** Fibers can be constructed to survive in corrosive or extreme moisture environments.
- **Explosion-proof design:** Fibers can safely pipe light into and out of hazardous areas.
- **High temperatures:** Glass fibers can tolerate extreme temperatures.
- **Custom sensing end design:** Fiber sensing heads can be "shaped" to the physical and optical requirements of a specific application.
- **Noise immunity:** A fiber is a passive mechanical part that is completely immune to electrical noise.

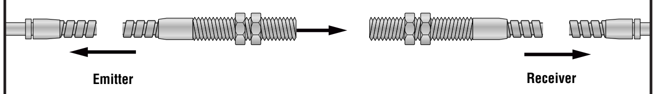
Fiber Optics & Sensing Modes

MORE INFO ONLINE *Job Aid: Types of Sensors*

The configuration of the fiber optic assembly and the type of amplifier used will determine the sensing mode.

Opposed-mode fiber assembly

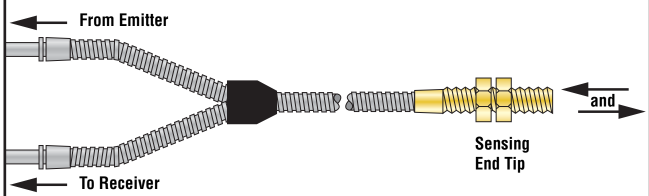
Guides light from an emitter to a sensing location, or from the sensing location back to the receiver. Opposed-mode fiber sensing requires two individual fiber optic cables.



Opposed Mode - Individual Fiber Optic Cable

Diffuse-mode fiber assembly

Conducts emitted light and the received light within one fiber optic assembly. This lets a single sensor both illuminate and view an object through the same fiber optic assembly.



Diffuse Mode - Bifurcated Fiber Optic Cable

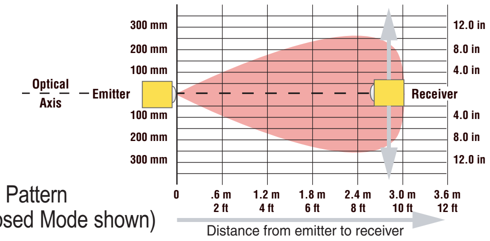
Considerations

- Larger bundle or core size leads to longer range and larger effective beam.
- Light signal attenuation occurs with longer fiber lengths.
- Optical fibers that have been ground and polished cannot be shortened, spliced or otherwise modified.
- Range and gain depend on both the amplifier and the fiber.
- Due to light transmission properties, plastic fibers are recommended for use only with visible light sensors.
- Glass fibers should not be subject to bending, pinching, repeated flexing, or high levels of radiation.

Beam Patterns

Understanding Beam Patterns

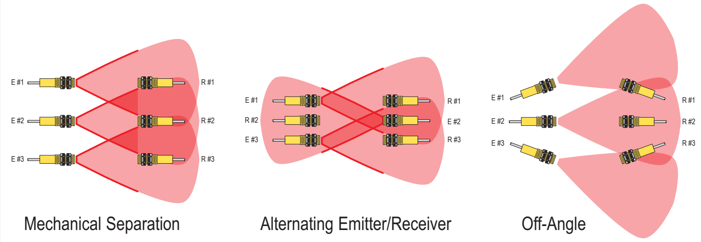
A beam pattern is plotted on a 2-dimensional graph to illustrate how the photoelectric receiver is designed to respond to its emitter. Maximum light energy occurs along the sensor's optical axis. The light energy decreases towards the beam pattern boundaries. The horizontal axis usually shows the range of the sensor.



Beam Pattern (Opposed Mode shown)

Uses for Beam Patterns

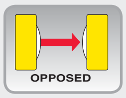
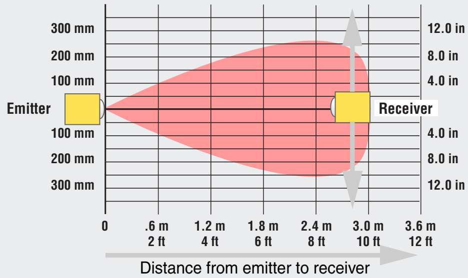
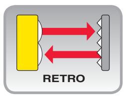
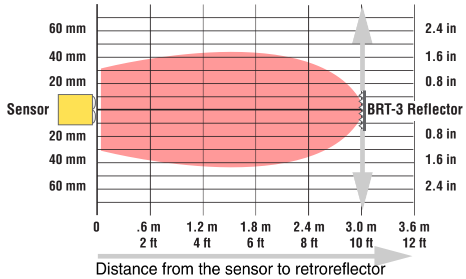
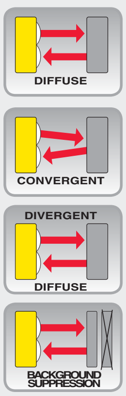
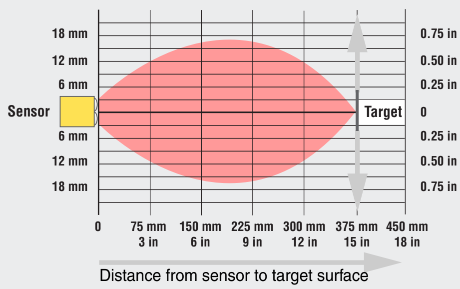
- Predict general radiation pattern given a specific target.
- Predict how multiple sensors can be mounted on a line without generating crosstalk.
- Provide accurate depiction of a light pattern a few feet from the sensor.



Using Beam Patterns to Avoid Optical Crosstalk

Reading a Beam Pattern

Job Aid: Understanding Beam Patterns

OPPOSED MODE 		**Uses:** To predict how closely adjacent, parallel opposed-mode sensor pairs can be placed to each other without generating optical crosstalk. **Horizontal:** Scale shows separation distance between the emitter and receiver. **Vertical:** The balloon-shaped plot defines the boundary of the receiver's response to the emitter. The receiver response is measured on either side of the optical axis.
RETROREFLECTIVE MODE 	 Retroreflective beam patterns are plotted using a model BRT-3 (75 mm) retroreflector (except where otherwise specified).	**Uses:** To show the area within which the sensor will respond to the retroreflector. The size of the beam pattern is proportional to the size and the reflective efficiency of the retroreflector. **Horizontal:** The scale shows the related distance between the retroreflective sensor and the retroreflector. **Vertical:** The scale depicts the farthest distance on either side of the sensor's optical axis where a retroreflector can establish a beam with the sensor. **Blind Spot:** If a beam pattern shows an area of no response at close range, it is indicating that the sensor has a "blind spot" area, where a retroreflector should not be located.
PROXIMITY MODE 	 Proximity-mode beam patterns are plotted using an 8 x 10 90% reflective white Kodak test card.	**Uses:** To show the boundary within which the edge of a light-colored diffuse surface will be detected as it moves past the sensor. The sensor's optical axis is represented as "0" on the vertical scale. **Horizontal:** The scale shows the distance from the sensor to the target's surface. **Vertical:** The scale shows the width of the sensor response measured on either side of the optical axis.

Excess Gain (EG)

Understanding Excess Gain

Excess gain is a measurement of the sensing light energy over and above the minimum amount required to operate the sensor's amplifier. This extra sensing energy is used to overcome signal attenuation caused by contaminants in the sensing environment.

Choose a sensor that will give you the optimal excess gain for your application. In most sensing situations, high excess gain relates directly to sensing reliability.

Measuring Excess Gain

$$\text{Excess Gain} = \frac{\text{Light energy falling on receiver element}}{\text{Sensor's amplifier threshold}}$$

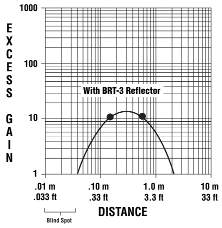
Threshold: The level of sensing energy required to cause the sensor's output to switch "on" or "off."

Excess gain of one (1x) is the measured voltage at the amplifier threshold level. Excess gain charts are useful when comparing sensors for an application, as direct measurement of amplifier voltage is often impractical.

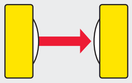
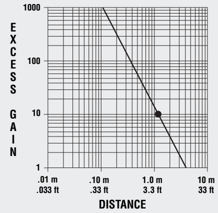
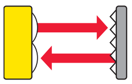
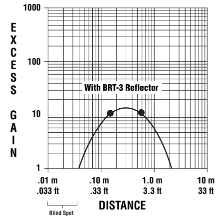
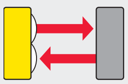
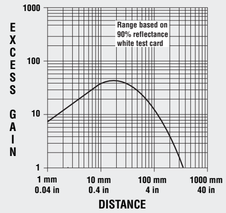
Excess Gain Curve

An excess gain curve is plotted on an X/Y axis. It shows the excess gain available for a particular sensor or sensing system as a function of distance. Excess gain curves are plotted for conditions of perfectly clean air and maximum receiver gain.

Excess Gain Curve



Reading an Excess Gain Curve

OPPOSED MODE 	The excess gain of an opposed-mode sensor pair is directly related to sensing distance. If the sensing distance is doubled, the excess gain is reduced by a factor of one-fourth, so the curve is always a straight line, when plotted on a log-log scale.		**Reading an Opposed Mode Curve** If an environment is moderately dirty (with 10x minimum excess gain required), sensors can be mounted up to approximately 1.2 meters apart.
RETROREFLECTIVE MODE 	The shape of a retroreflective excess gain curve is significantly influenced by the size of the retroreflector. The larger the retroreflector, the larger the shape and size of the curve.		**Reading a Retro Mode Curve** If an environment is moderately dirty (with 10x minimum excess gain required), a BRT-3 retroreflector can be mounted 0.15 to 0.5 meters away from the sensor for reliable sensing.
PROXIMITY MODE 	Excess gain for proximity-mode sensors is usually lower than that of other photoelectric sensing modes, because proximity modes depend on light reflected off the surface of a target. The curves are plotted using a Kodak 90% reflectance white test card as the reference material. Other materials are ranked compared to the test card in the table below.		**Reading a Proximity Mode Curve** Use the online Relative Reflectivity Chart to estimate the excess gain required. Multiply the excess gain required to sense the material by the excess gain level required for the environment.

Excess Gain Guidelines

Excess gain of one (1x) describes the measured sensing energy at the amplifier threshold level. These guidelines show how much excess gain is required to overcome environmental conditions.

EG	General Conditions
1.5x	**Clean air:** No dirt buildup on lenses or reflectors.
5x	**Slightly dirty**: Slight buildup of dust, dirt, oil, moisture, etc. on lenses or reflectors. Lenses are cleaned on a regular schedule.
10x	**Moderately dirty:** Obvious contamination of lenses or reflectors (but not obscured). Lenses cleaned occasionally or when necessary.
50x	**Very dirty:** Heavy contamination of lenses. Heavy fog, mist, dust, smoke, or oil film. Minimal cleaning of lenses.

Relative Reflectivity

Relative Reflectivity Chart

When using a proximity sensor, refer to the Relative Reflectivity chart to determine how reflectivity of different target surfaces will affect the excess gain requirements. Here are some sample targets.

Material	General Reflectivity	Minimum Excess Gain Required
Stainless steel, microfinish	400%	0.2
Natural aluminum, unfinished	140%	0.6
Kraft paper, cardboard	70%	1.3
Clear plastic bottle	40%	2.3
Tissue paper (1 ply)	35%	2.6
Rough wood pallet (clean)	20%	4.5

Contrast

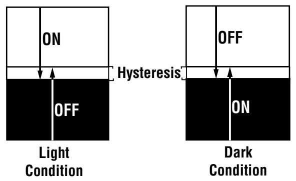
Sensing Contrast

GOOD
BETTER
BEST

Contrast is also referred to as the light-to-dark ratio. While most sensors do not allow direct measurement of light signals, contrast can be estimated. The higher the contrast ratio, the better and more accurately your sensor will detect its target.

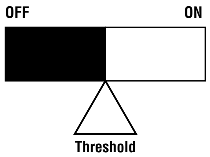
Contrast can be defined as:

$$\text{Contrast} = \frac{\text{Received light in the light condition}}{\text{Received light in the dark condition}}$$



Hysteresis: Difference of output switchpoint (threshold) from on-to-off, vs. off-to-on. Prevents output chatter.

Threshold: Point where output change-of-state occurs.

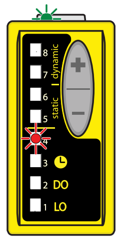


Contrast Guidelines

Follow these contrast guidelines to improve sensing reliability:

1. Choose a sensor or lensing option that will optimize contrast in any photoelectric sensing situation.
2. Adjust alignment and gain for maximum contrast during sensor installation.
3. If light and dark conditions are separated by 1/3 or more of the adjustment range of a sensor's sensitivity potentiometer, contrast is sufficient. Most Banner sensors intended for low-contrast applications are microprocessor-driven and will provide feedback of relative contrast.

Bargraph LED Number	Relative Contrast/ Recommendation
6 to 8	**Excellent:** Very stable operation.
4 to 5	**Good:** Minor sensing variables will not affect sensing reliability.
2 to 3	**Low:** Minor sensing variables will affect sensing reliability.
1	**Marginal:** Consider an alternate sensing scheme.

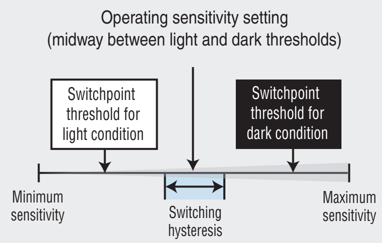
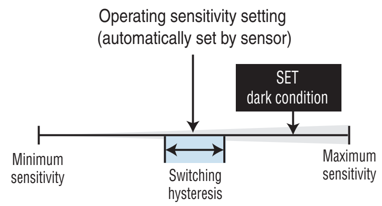
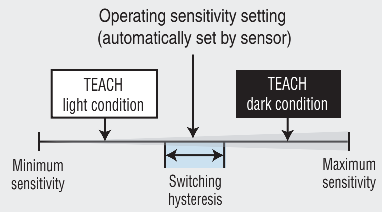


Bargraph sensors offer relative feedback in low-contrast applications.

Adjusting Sensitivity

Job Aid: Sensitivity Adjustment

Field-adjust the sensitivity of a sensor in order to maximize the contrast in an application.

TECHNIQUE	PROCESS	CONCEPT
Potentiometer Adjustment Manually adjust sensitivity with the potentiometer.	1. Adjust potentiometer to minimum. 2. Present the light and dark sensing conditions individually, turning the potentiometer slowly clockwise, until the alignment indicator just comes on. Note the settings. 3. Adjust the potentiometer to approximately midway between the two settings.	
SET Mode Adjustment Sensor's microprocessor automates sensitivity adjustment.	Present the dark sensing condition, and press the SET button. The sensor automatically sets the operating sensitivity below the switchpoint threshold for the dark condition.	
TEACH Mode Adjustment Sensor's microprocessor optimizes sensitivity adjustment between two user-set reference points.	1. Present the light sensing condition, and single-click the TEACH button. 2. Present the dark sensing condition, and (again) single-click the TEACH button. 3. The sensor automatically sets the operating sensitivity.	

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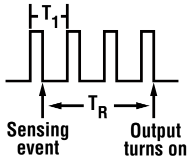
Response Time

Response Time

Response time is the maximum time required for the sensor to respond to a change in the input signal. It is the time from when the sensor sees its target to when it gives an output signal to the load. Response time is the time between the leading (or trailing) edge of the sensing event and the output's change of state.



T1 = Time of one light pulse
TR = Response time

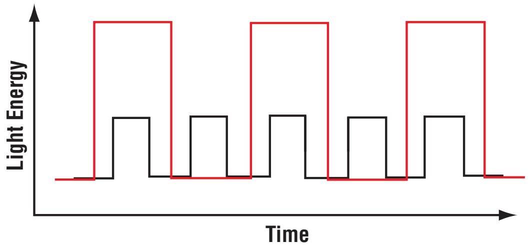
Importance

Response time can help determine how long a fast-moving object must stay in the sensor's field of view in order to be detected. It is especially important when your application requires detection of:

- High-speed events
- Small objects moving at high speeds
- Narrow gaps between objects
- Brief intervals between sensing events

Modulation

The speed of response of a modulated photoelectric sensor is limited by its frequency of modulation. There is a direct trade-off between sensor response time and sensing range (excess gain). High-speed sensors are modulated faster, thus yielding shorter range. If an LED is pulsed less often, it can be pulsed with a higher current, thereby producing more light energy.



Fast Response Yields Lower Excess Gain

Repeatability

The repeatability specification is used in applications where customers need to know the precise position of a moving part.

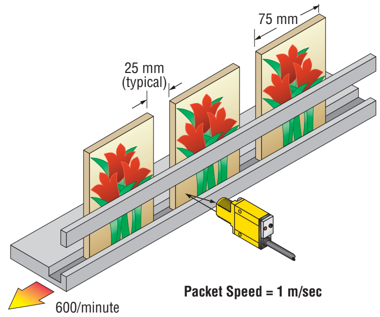
The sensor's output is allowed to switch only after a few modulated light pulses are counted. The response time before a modulated sensor turns on is equal to the time required for the sensor to count that number of pulses, and the sensor output changes state as soon as the sensor counts enough light pulses of the correct frequency.

Since the sensing event can occur at any time during a modulation cycle, the actual time between the sensing event and the sensor's output change can vary by up to one modulation cycle. This variation is the sensor's repeatability.

Calculating Response Time

You can determine a sensor's required response time when you know the size, speed and spacing of the objects to be detected.

$$\text{Response Time} = \frac{\text{Object width (or gap between objects)}}{\text{Object velocity}}$$



Calculate Response Time for Seed Packets with a Convergent Sensor

Application Example

To calculate the required sensor response time, the production line speed is first converted to the speed of, in this case, a seed packet.

When calculating the speed of the seed packet, take into account the space between the packets.

1. Determine how many packets are being processed per second: 600 packets/minute = 10 packets per second
2. Determine the distance of linear travel: 75 mm (packet width) + 25 mm (space between packets) = 100 mm
3. Calculate speed of packet = 100 mm/packet x 10 packets/sec

Packet Speed = 1 m/sec

Light condition: Sensing condition characterized by higher level of received sensing energy.

Knowing the speed of the object (1 m/sec), it is possible to calculate the time during which the sensor "sees" a packet of seeds.

$$\frac{\text{Object width (75 mm)}}{\text{Object velocity (1 m/sec)}} = .075 \text{ sec}$$

$$\text{Time of each packet passing the sensor} = 75 \text{ ms}$$

Calculating Light Condition

Dark condition: Sensing condition characterized by lower level of light energy (or none).

$$\frac{\text{Space width (25 mm)}}{\text{Object velocity (1 m/sec)}} = .025 \text{ sec}$$

$$\text{Time of each space passing the sensor} = 25 \text{ ms}$$

Calculating Dark Condition

In this application, the time between the packets is much less than the time during which the sensor "sees" a packet. As a result, the dark (or "off") time between packets is the more important consideration.

Outputs

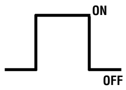
Outputs

The output circuit is the section of the sensor that interfaces to the external load. Output also refers to the useful energy delivered by the sensor.

Knowing the voltage and current requirements of the load is crucial to selecting the best sensor. Sensors with analog outputs always interface to circuits or devices which operate at low levels of dc voltage and current. Sensors with digital outputs interface to either ac or dc loads.

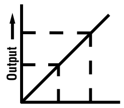
Digital/Analog Output

The output of a sensor is either digital or analog. A **digital**, or switched, output has only two states: "ON" and "OFF." On and off commonly refer to the status of the load that the sensor output is controlling.



Digital

An **analog** sensor is one that varies over a range of voltage (or current) and is proportional to some sensing parameter. Analog sensors provide a metered or gradual response.



Analog

Response Time

The response time of sensors with digital output depends largely on the sensor's output switching device. In general, sensors with solid-state outputs provide faster switching.

Sensors with electromechanical relays can only provide slow switching; the relay switching speed is the largest component of the specified sensor response time.

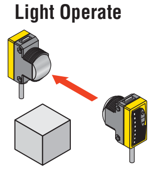
Light Operate/Dark Operate

Training Note: Light Operate/ Dark Operate

The sensor should be active when the application requires it. With digital photoelectric sensors, the input and the output are characterized by one of two sensing terms: Light Operate and Dark Operate.

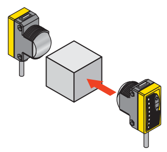
Light Operate (LO): A condition where a photoelectric sensor output energizes its load when the sensor "sees" a sufficient amount of its own modulated light.

Light Operate


The sensor "sees" light.

Dark Operate (DO): The complement of LO, where the sensor output energizes its load when it no longer "sees" the modulated light.

Dark Operate


The sensor "sees" dark.

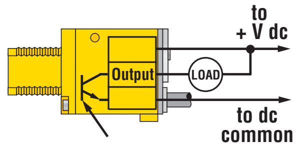
Contact Configuration Types

Solid-State Relays

Switching is accomplished by elements such as a transistor or SCR, without moving parts, heated filament or vacuum gaps.

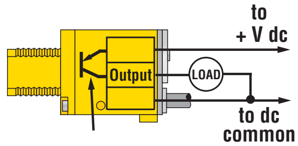
Complementary outputs: The dual-output configuration of a sensing device, where one output is Normally Open and the other is Normally Closed. In this case, both outputs have the same switchpoint, but only one output conducts at a time.

NPN output (sinking): Output switch configured with its collector open and its emitter connected to ground (dc common). The load is connected between the output (collector) and the positive of the dc supply.



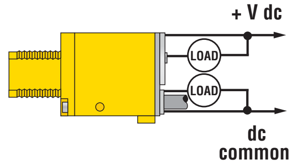
NPN Transistor

PNP output (sourcing): Output switch configured with its collector open and its emitter connected to the positive of the sensor supply voltage. The load is connected between the output (collector) and ground (dc common).



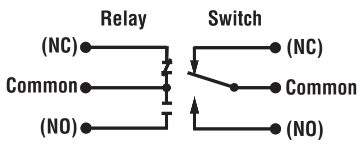
NPN Transistor

Bipolar outputs: The dual-output configuration of a dc sensing device, where one output switch is a sinking device (NPN) and the other output switch is a sourcing device (PNP). Both outputs have the same switchpoint.



Bipolar Output

E/M Relays



Used when a sensor provides direct control of a load that draws more current than can be handled by a solid-state relay. Double-throw contacts are used in interfaces that require complementary switching. E/M relays are useful when a string of sensor outputs are wired together in series for AND logic. Some E/M relay configurations include SPST, SPDT, DPST and DPDT.

Normally Open (NO): Designation for contacts of a switch or relay that are not connected when at rest. When activated, the contacts close (become connected).

Normally Closed (NC): Designation for contacts of a switch or relay that are connected when at rest. When activated, the contacts open (separate).

Vision Sensors

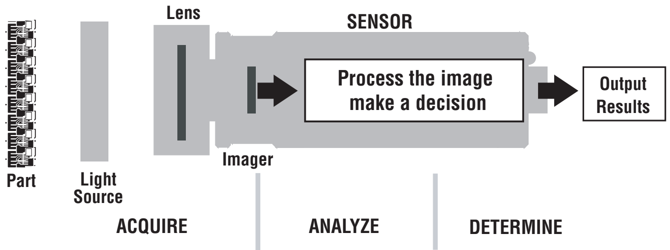
Vision sensing is electronic imaging, applied in a manufacturing setting for the purpose of control: Process control, machine tool control, robot control or quality control. Vision sensing is used to improve production processes and quality. Vision sensing is comprised of two major elements: A **hardware** element (camera, controller and lighting) and a **software** element (control system, graphical user interface and image algorithms).

Process

How A Vision Sensor Works

Visual inspection is a three-step process:

1. The sensor **acquires** an image of the part.
2. The microprocessor **analyzes** the image.
3. Another microprocessor **determines** if the inspection passes or fails, and reports the results to the manufacturing line. The part is then either passed to the next process, or it is rejected and removed.



Inspection

Digital Imaging

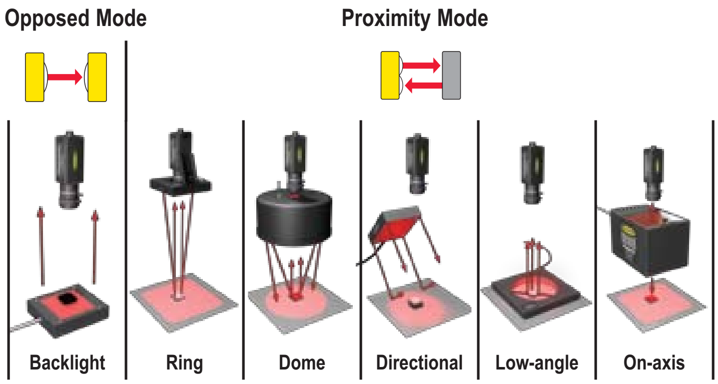
"Visual inspection" refers to the process of acquiring an image, analyzing that image based on set parameters and reporting the results. For some Banner vision sensors, inspections are set up using a remote PC. A digital camera captures images and the sensor software analyzes the images using vision tools to pass or fail the product.

Vision tools are specific software algorithms used to analyze an image. Each vision sensor uses a specific **tool set** to extract and isolate certain features within the image in order to determine whether a part passes or fails an inspection.

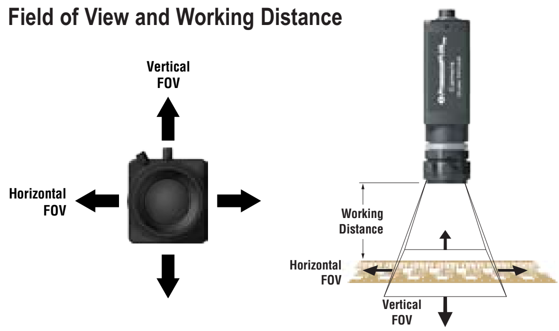
Parts

Choosing Lighting

1. **Light Source:** The light source is a critical component of any vision inspection system. Lighting is the most powerful tool for creating contrast to amplify the feature of interest, while minimizing other features of the part. Selecting the best light source depends on the shape, surface texture, color and opacity of the part.



2. **Lens:** The lens focuses the light onto the sensor's imager. The main consideration for selecting a lens is focal length. To determine the focal length, the field of view and working distance must be determined. The field of view is the area of the inspection captured on the sensor's imager. The working distance is the distance between the back of the lens and the target object.



3. **Sensor:** The sensor contains the imager, microprocessors and I/O.

   The **imager** has an array of tiny light-sensitive cells that converts the target into an image.

   Microprocessors analyze the image and make determinations about it based on user-determined tolerances and criteria.

   The sensor exports the inspection results through some type of **I/O**, e.g. Discrete or Ethernet.

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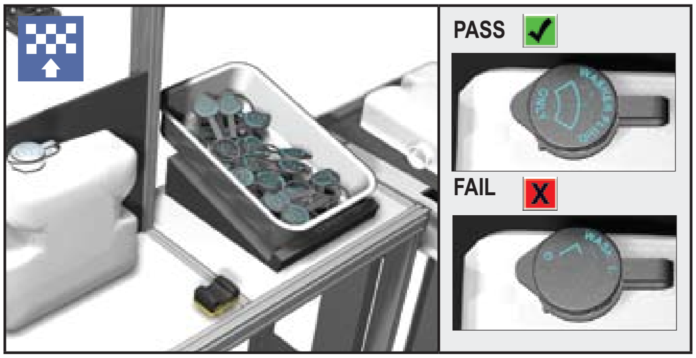
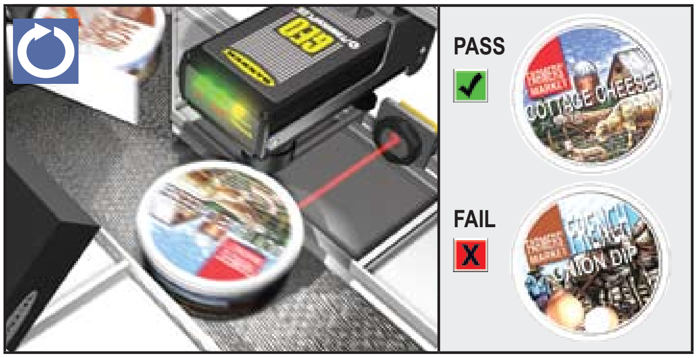
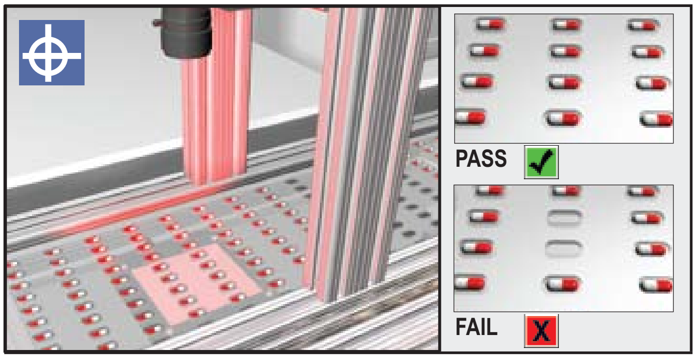
Applications Examples

MORE INFO ONLINE *Vision Applications*







ANALYSIS TOOLS measure and evaluate the results of the vision tools.

Measure: Measures distance and angles between two prescribed points, lines or curves

Math: Performs arithmetic functions on any tool or constant

Test: Evaluates results of selected vision and analysis tools to determine whether an inspection passes or fails; performs logical operations; and activates outputs

Communication: Sends images or results of selected location, vision and analysis tools over the Ethernet or RS-232 serial communication ports to industrial Ethernet or PC networks

Vision Tools

MORE INFO ONLINE *Vision Tools*

Vision tools are software algorithms used to analyze an image. A vision sensor uses a set of tools to create an inspection. Using one or several tools, a user can extract and isolate certain features of an image in order to determine whether a part passes or fails an inspection. Several inspections involving different vision tools can be performed on a single image.

LOCATION TOOLS compensate for translational and rotational movement.

Locate: Determines translation and rotation by detecting relative movement of edges

Pattern Find: Determines translation and rotation by detecting relative movement of a pattern

GEO Find: Determines translation and rotation movement of a part up to 360° by detecting relative movement of a pattern

VISION TOOLS analyze the image.

Color Match: Inspects for matching hue and intensity

Average Color: Tests or communicates color content values sensed in a selected area

Average Gray Scale: Determines the gray scale intensity value of an area

Blob: Determines the presence, connectivity, size, shape and location of selected features

Edge: Determines the presence, number, classification and location of edges

Object: Determines the presence, number, classification, size and location of objects

Pattern Count: Determines the presence, number and location of pattern(s)

GEO Count: Detects the presence and location of a target pattern in any orientation

Bar Code: Finds, decodes and grades 2D and 1D linear bar codes

Bead Tool: Monitors a track of material for width, consistency and location

OCR/OCV: Reads and verifies optical characters

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Vision Lighting

MORE INFO ONLINE *Choosing Lighting*

A vision sensor captures and then analyzes an electronic image. The quality of the images depends on the image's contrast. Dedicated lighting can guarantee constant, consistent light conditions that can be manipulated to create a high-contrast image.

Here are some factors to consider when choosing lighting:

1. Lighting geometry
2. Techniques
3. Optical properties of the part

Lighting Geometry

MORE INFO ONLINE *Lighting Geometry*

The geometry of propagation refers to how light energy leaves the source. Light can come from a point, diffuse, or collimated source.

When you understand how to manipulate lighting geometry, you can:

- Eliminate glare
- Eliminate hot spots
- Minimize unimportant features

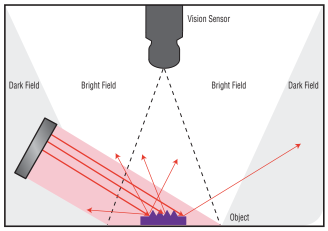
Diffuse Source **Collimated Source** **Point Source**

Lighting Techniques

Lighting techniques refer to how the light source is mounted in relation to the target object and the sensor.

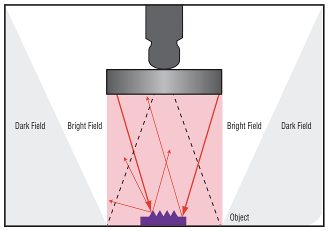
Dark-Field: Illuminate objects with indirect light.

- Casts shadows
- Highlights height changes
- Textured surfaces are bright



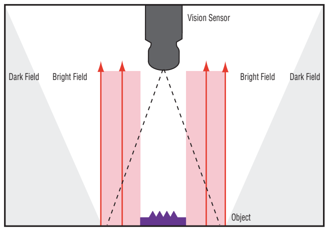
Bright-Field: Illuminate objects with direct light.

- Detect color change
- Smooth surfaces are bright



Backlight: Transmit light from behind the object.

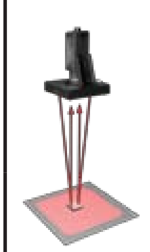
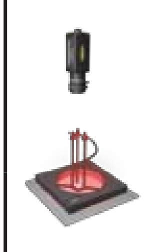
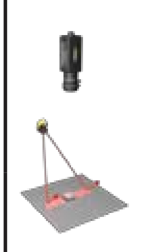
- Highlights outlines and profiles
- Highest contrast



Optical Properties of a Target

MORE INFO ONLINE *Lighting Techniques*

Optical properties of a part can be used in conjunction with lighting to highlight features.

		Backlight	Directional	Ring	Low-Angle	Diffused	On-axis	Structured
The main goal of lighting in a vision application is to create contrast between the part and the background.								
Optical Properties	**Example Parts**							
Shape	Notches Stampings Embossing	Highlights outlines and profiles	Casts shadows to highlight height changes	—	Height changes are bright Flat surfaces are dark	Lowers contrast between shapes	Flat surfaces are bright Height changes are dark	Highlights changes in height on part
Surface Texture	Polished metal Sandpaper	—	Textured surfaces are bright Smooth surfaces are dark	—	Diffuse surfaces are brighter than reflective	Lowers contrast between reflective and textured surfaces	Reflective surface are brighter than diffuse	—
Color	Wires Printing Plastic UV Coatings	—	Based on target color	Based on target color	—	Based on target color	Based on target color	—
Translucency	Drilled hole Plastics	Solid parts block light, clear parts transmit light	—	—	—	—	—	—

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Vision Lenses

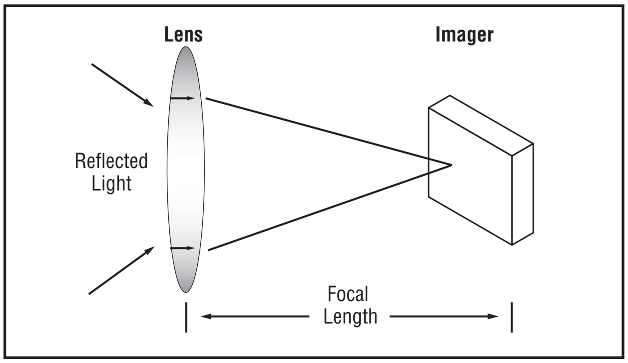
MORE INFO ONLINE Choosing A Lens

The sensor's lens focuses the reflected light onto the imager chip. The quality of the lens will influence the quality of the image.

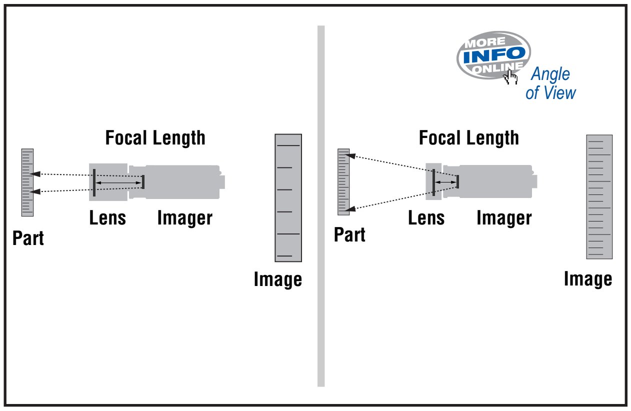
Lenses have one main function: To create a 2-D image of the scene, focusing the entire field-of-view (FOV) on the imager chip.

Lens Basics

Focal Length: The distance from the lens to the camera's imager. It is specified in millimeters. Focal length determines the relationship between working distance and the angle of view. Shorter focal length results in wider FOV.



Angle of View: Angle of view indicates how much of the visual scene can be captured by the lens. It is determined by the focal length of the lens and how far away the camera is from the target.



Working Distance: The distance from the camera to the target object under inspection.

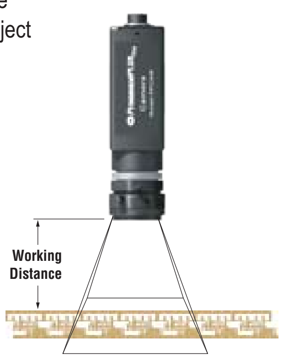
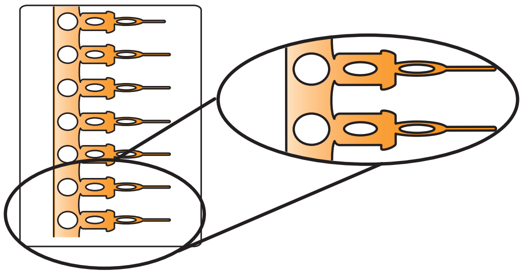


Image Quality

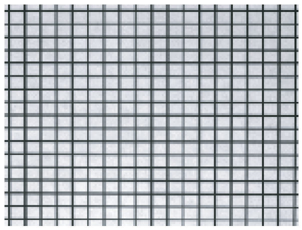
A camera that captures a high quality image assures the most accurate information for later analysis. To insure a high image quality, choose a lens that:

- Magnifies the feature of interest to fill the FOV
- Captures required FOV without adding distortion to the image
- Optimizes your FOV based on working distance
- Focuses entire scene of inspection

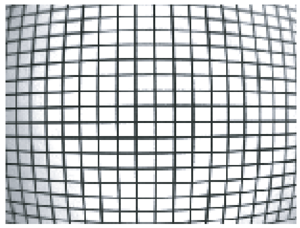
Resolution: The ability of a vision sensor to differentiate between two features that are close together. If the features blur together, a higher resolution lens is required.



Distortion: The lens can influence image quality by how it collects and focuses light on the imager chip. Different lenses have different degrees of optical distortion, or undesired change in the shape of an image.

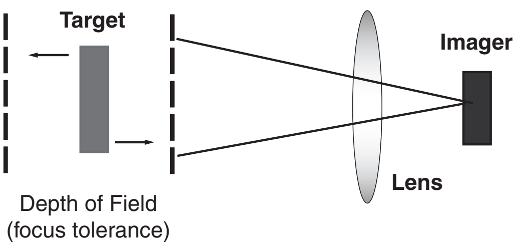


25 mm Lens



4 mm Lens

Depth of Field: The in-focus range of a vision system that includes the areas which remain in focus behind and in front of the target.



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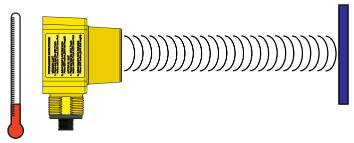
Ultrasonic Sensors

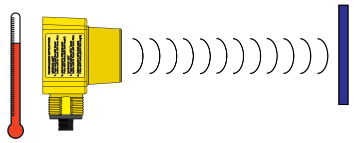
Ultrasonic sensors emit a pulse of energy which travels at the speed of sound. A portion of this energy is reflected off of a target and travels back to the sensor. The sensor measures the total time required for the energy to reach the target and return to the sensor and calculates the distance from the sensor to the target.

Temperature Effect

The speed of sound depends on chemical composition, pressure and temperature of the gas in which it is traveling. In most ultrasonic applications, the composition and pressure of the gas are relatively fixed, while the temperature is not. The speed of sound increases roughly 1% per 10° F (6° C) temperature increase.



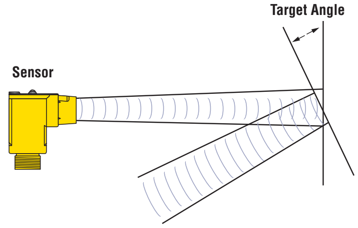
Cold Environment



Warm Environment

Target Angle

A flat target that is perpendicular to the beam axis will reflect the most sound energy back to the sensor. As the target angle increases, the amount of energy received by the sensor decreases. For most ultrasonic sensors, the target angle should be 10˚ or less.

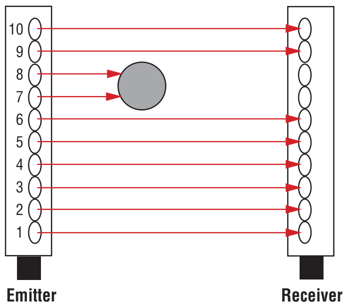


Air Currents

Air currents due to wind, fans, pneumatic equipment or other sources can deflect or disturb the path of the ultrasonic energy, so a sensor may fail to recognize the correct location of the target.

Measuring Light Screens

Banner light screens have a vertical array of photoelectric emitters and receivers: The emitters in one housing, the receivers in another. An object placed between the emitter and receiver will block the emitted light from reaching the corresponding receivers.



Synchronous Scanning

Identifies which of the beams is blocked, by enabling one emitter channel to pulse light while simultaneously directing its corresponding receiver to look for a signal. The system records which beam channels are blocked and which are clear, and then outputs a signal, either analog or discrete.

Sensor Response Time

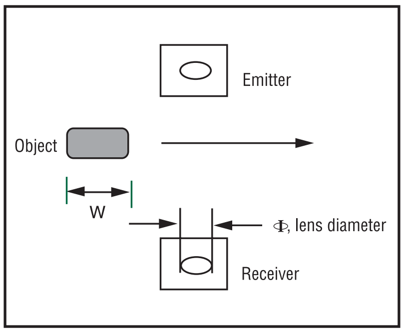
The time required for an array system to “see” an object varies depending on which channel is blocked, when the object blocks a particular channel and when that particular channel is scanned. The result is that the minimum response time is equal to 1 ms; the maximum response time is equal to twice the scan time. The scan time, in turn, varies according to array length and scanning mode, and is specified in the product literature. the lens diameter and the maximum response time of the system.

Minimum Object Detection

The minimum object detection size is a function of the lens diameter for an individual channel and the spacing between channels. The minimum object detection size is defined as the smallest diameter rod that can be detected reliably.

Maximum Part Speed

The maximum speed of a passing part is a function of the part size, the lens diameter and the maximum response time of the system.



Measuring Modes

Banner’s measuring light screens can be configured, with a simple Windows setup program, for several measuring modes for both analog and discrete outputs. For example, the output can be based on the:

- First beam blocked
- Last beam blocked
- Total number of beams blocked
- First beam made
- Last beam made
- Total number of beams made
- Center beam of several blocked beams
- Number of transitions from blocked to made
- Highest number of contiguous beams blocked

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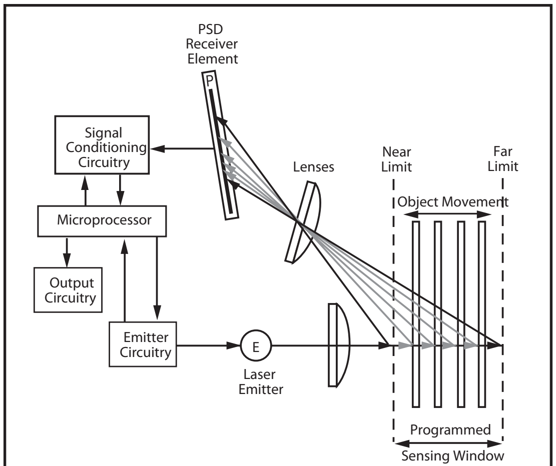
Light Gauging Sensors

Light gauging sensors utilize either "Time of Flight" or triangulation technology to detect the presence and position of targets.

Time of Flight: Measurement of the amount of time that emitted light takes to travel to the target and return to the sensor. This technology is used in long-range sensing applications.

Triangulation: An emitter transmits visible light through a lens, towards a target. The beam bounces off the target, returning some light to the sensor's Position Sensitive Device (PSD) receiver element. The target's distance from the receiver determines the angle at which the light travels to the receiver element. This angle, in turn, determines where the received light will fall along the PSD receiver element. The position of the light on the PSD receiver element is processed through analog and/or digital electronics to calculate the appropriate output value.



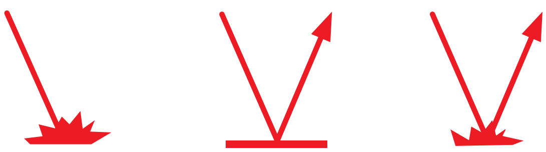
Triangulation Technology

Surface Reflectivity and Texture

Triangulation sensors depend on the diffuse reflections of light from the target. A diffuse reflection is one in which the light tends to scatter equally in all directions from the target. If the target surface is mirror-like, then light will tend to reflect in only one direction (If this target is not perpendicular to the sensor, the light will be reflected away from the sensor).

Triangulation sensors also require a non-porous, opaque surface for accurate operation. Measurement errors will result from semi-transparent targets such as clear plastic, or from porous materials such as foam.

Best | **Worst** | **Typical**



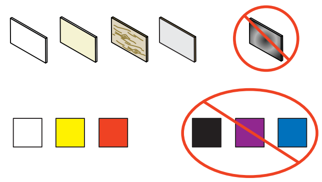
Diffuse targets (e.g., matte finish white ceramic) reflect light consistently in all directions

Specular targets (e.g., a mirror) reflect light in only one direction

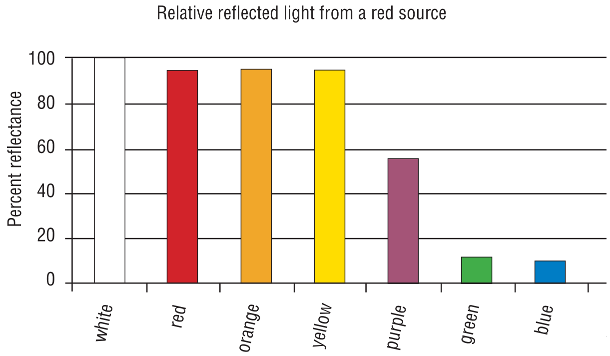
Mixed targets (most objects) display traits of both diffuse and specular targets

Color Effects

The color of the object being measured can affect the resolution and accuracy of the readings. White, red, yellow and orange targets will reflect more light than green, blue or black targets. The resolution for dark targets may be up to four times less that for white targets.

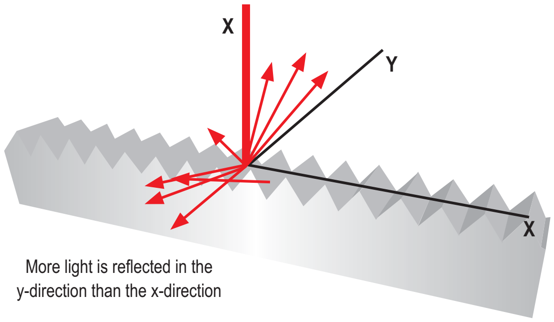


The graph below shows the relative amount of received light that is reflected from various target colors, using visible red light. The resolution is roughly affected according to the square of the received light. For example, reducing the amount of light by a factor of nine will degrade the resolution by a factor of three.



Metal Surfaces

Bare metal surfaces do not exhibit consistent reflectivity across their surfaces. As a result, the repeatability from one point on a metal surface to another, even at the same distance from the sensor, will degrade. This effect varies from metal to metal and is dependent upon surface finish.



More light is reflected in the y-direction than the x-direction

Total Expected Measurement Error

Keep in mind that the overall expected accuracy of an analog sensor is the combination of several performance parameters, not simply the sensor's resolution. Linearity and temperature effect can also affect accuracy.

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Temperature Gauging Sensors

Q&A: T-GAGE

Temperature Gauging sensors activate an output when they detect objects that are either hotter or colder than the ambient condition. These passive, non-contact sensors use a thermopile as a receiver element to detect infrared light energy emitted by target objects. The information is measured and analyzed by the sensor, and depending on the thermal contrast, an output is given.

Range

The sensing range is determined by the sensor's field of view and the size of the target object.

Thermal Contrast

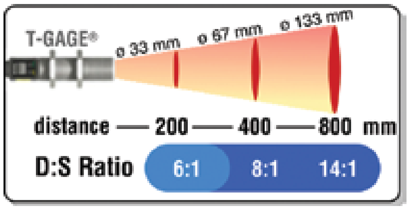
The difference between the ambient temperature and the temperature of the target object. High thermal contrast increases switching accuracy.

Field of View

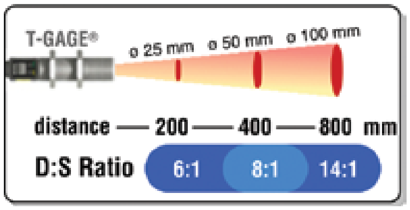
The field of view (FOV) is the area of response, based on the sensor's lens design. The temperature information collected by the sensor will be an average of everything in the sensor's field of view. To increase thermal contrast and reliability of the output, the target object must fill as much of the field of view as possible. If the target object does not fill the sensor's field of view, the sensor will average the temperature of everything in the field of view, thereby reducing the reliability of the output.

D:S Ratio

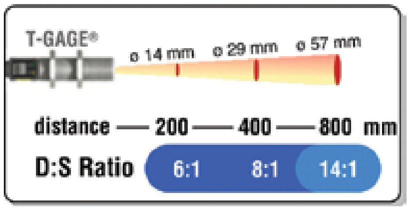
Spot size refers to the area where the temperature data is taken. Spot size can be calculated at any distance from the target by using the distance-to-spot ratio.



D:S ratio is inversely related to viewing angle. A sensor with a small viewing angle will have a large D:S ratio.



For a sensor with an 8:1 ratio, the sensor's spot size is a 1" diameter circle at a distance of 8". As you go out further from the sensor face, the spot size will be larger.



The sensor's distance-to-spot size ratio can be adjusted by lensing the thermopile. This might be necessary depending on the size of the target and the range at which it must be sensed.

Magnetic Sensors

Q&A: M-GAGE

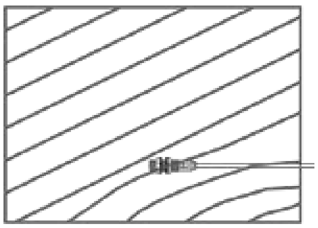
Magnetic devices are passive, non-contact magnetic receivers that detect 3-dimensional changes in the Earth's natural magnetic field caused by the presence of large ferrous objects.

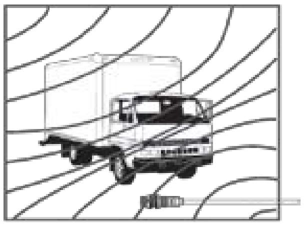
Range

The sensor range depends on three variables:

1. The local magnetic environment (including nearby ferrous material)
2. The magnetic properties of the object to be sensed
3. Sensor settings

The strong disturbance of a large ferrous object decreases as distance from the sensor increases, and the magnitude and shape of the disturbance is dependent on the object's shape and content.





Sensing Area

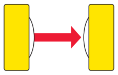
Magnetic sensors are omni-directional; they can detect ambient magnetic field in all directions. They can be used in close proximity to each other without interaction since they are passive devices and individually learn their environment.

Environmental Considerations

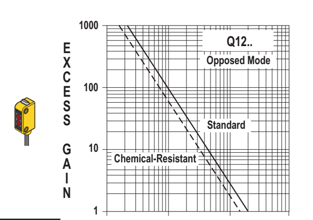
Environment	Typical Industries & Applications	Recommendations
Normal Temperature	All non-abusive applications from -20° to +55° C	• All sensor types; choice depends on range, excess gain and electrical and performance requirements.
High Temperatures	• Metal processing • Painting applications • Paper manufacturing • Outdoor applications	• Glass fiber optics: Use when above +100° C; max. to 480° C. • Plastic fiber optics: Use polycarbonate fibers up to +125° C. • Remote sensors: Use up to +100° C.
Low Temperatures	• Meat processing • Food processing • Chemical processing • Outdoor applications	• Glass fiber optics: Use below -40° C; min. to -140° C. • Remote sensors: -40° C to +100° C.
Moisture	• Food processing • Car washes • Pharmaceuticals • Bottling plants • Outdoor applications	• Sensors with NEMA 6 ratings represent the best moisture seals and can resist occasional and prolonged (NEMA 6P) submersion. • NEMA 4 and 6 ratings: Can withstand low-pressure washdown. • NEMA tests do not take into account the elevated pressures and temperatures of solutions used to wash equipment in food processing applications. • See NEMA and IP enclosure ratings chart online. • Condensation can be eliminated by using unlensed fiber optics.
Corrosive Agents	• Semiconductors • Chemical • Lumber • Pulp/paper • Amusement parks (UV light)	**Solvents/Alkalis** • Stainless steel sensor housings. • Glass fiber optic assemblies in stainless steel sheathing. • Fiber optic assemblies without epoxy (available by special order). **Bases** • Fiber optic assemblies with PVC jackets. **Acids** • Thermoplastic polyester housings; see chart online. • Teflon® sheathing; protect the sensing tip from direct contact with concentrated acids. • Polyethylene jacket of standard plastic fiber optic cables resists acids, but can degrade with prolonged contact.
Dirt, Dust, Fog	• Lumber • Ceramics ovens • Paper • Steel • Mining	**High Excess Gain** • Excess gain data should be carefully evaluated. • Opposed-mode sensors with excess gain above 1000x. **Lens Size** • Smaller lens concentrates the beam for greater penetrating ability. • Larger lenses will yield greater range, but will disperse available sensing energy. **Inductive Proximity Sensors** • For metal targets and short sensing ranges.
Vibration & Shock	• Metal (stamping) • Printing (presses) • Packaging	• Lightweight sensing components; smaller sensors. • Anti-vibration mounts placed between the sensor and mounting bracket. • Glass or plastic fiber optic assemblies can withstand more than 100 Gs of acceleration. • Glass fibers cannot tolerate repeated flexing. Use plastic, hi-flex or coiled fibers. • Remote sensors can withstand up to 15 Gs of acceleration. • One-piece self-contained sensors with epoxy-encapsulated circuitry withstand up to 10 Gs of acceleration.
Hazardous Areas	• Chemicals/Gas/Oil/Refinery • Grain elevators • Airbag manufacturers	• Special sensing equipment must be installed, using measures to avoid sources of ignition. • See chart defining Hazardous Location Classifications online. • NAMUR photoelectric sensors. • Glass and plastic fiber optics. (Plastic fiber optics are preferred, as it is easier to seal around the fiber bundle at the barrier between the hazardous and safe environment).

Opposed Mode

○ = Infrared LED
● = Visible Red LED


OPPOSED

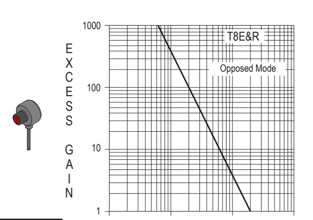
WORLD-BEAM® Q12



EGCO-1

Range: 2 m	LED: ●	Pg. 47

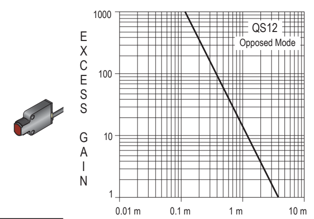
T8



EGCO-2

Range: 2 m	LED: ●	Pg. 50

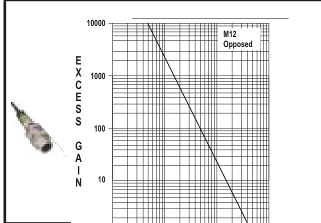
MINI-BEAM® 2 QS12



EGCO-3

Range: 4 m	LED: ●	Pg. 53

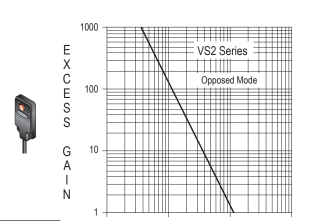
M12



EGCO-4

Range: 5 m	LED: ●	Pg. 56

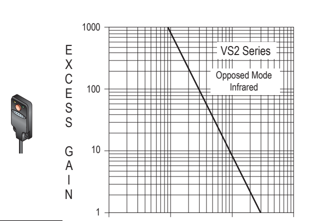
VS2



EGCO-5

Range: 1.2 m	LED: ●	Pg. 62

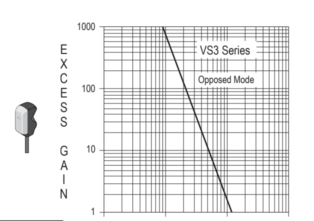
VS2



EGCO-6

Range: 3 m	LED: ○	Pg. 62

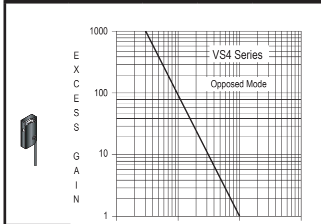
VS3



EGCO-7

Range: 1.2 m	LED: ●	Pg. 65

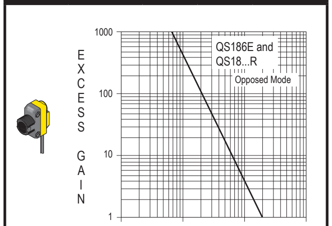
VS4



EGCO-8

Range: 1 m	LED: ●	Pg. 68

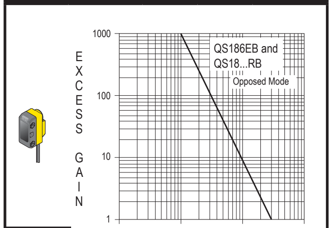
WORLD-BEAM® QS18



EGCO-9

Range: 20 m	LED: ○	Pg. 71

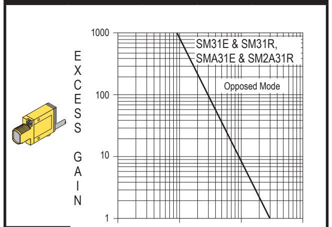
WORLD-BEAM® QS18



EGCO-10

Range: 3 m	LED: ○	Pg. 71

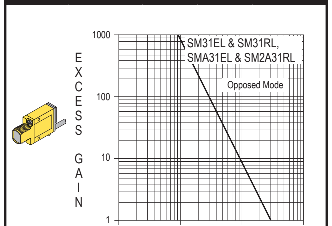
MINI-BEAM®



EGCO-11

Range: 3 m	LED: ○	Pg. 80

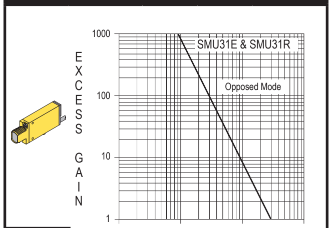
MINI-BEAM®



EGCO-12

Range: 30 m	LED: ○	Pg. 80

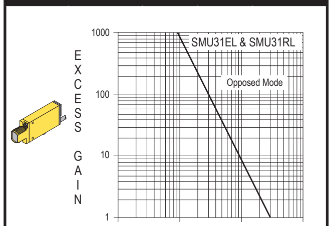
MINI-BEAM® Universal



EGCO-13

Range: 3 m	LED: ○	Pg. 88

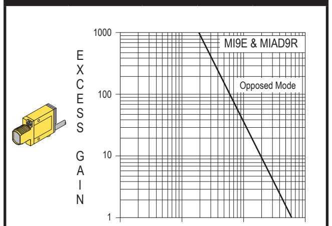
MINI-BEAM® Universal



EGCO-14

Range: 30 m	LED: ○	Pg. 88

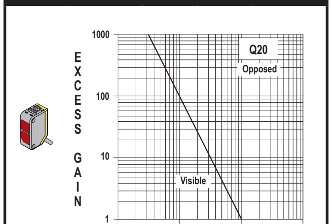
MINI-BEAM® NAMUR



EGCO-15

Range: 6 m	LED: ○	Pg. 90

WORLD-BEAM® Q20

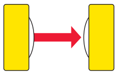


EGCO-16

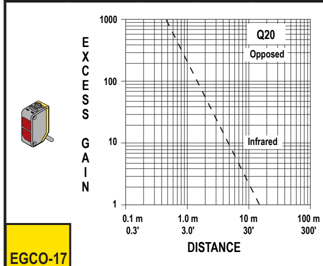
Range: 10 m	LED: ●	Pg. 93

Opposed Mode

○ = Infrared LED



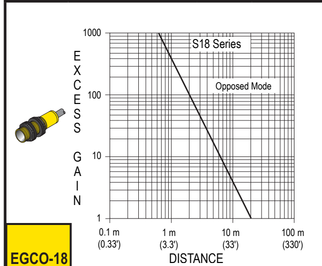
WORLD-BEAM® Q20



EGCO-17

Range: 15 m	LED: ○	Pg. 93

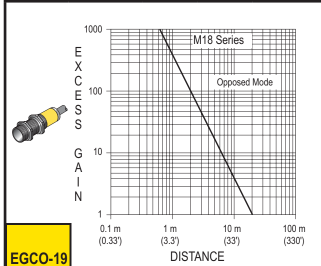
S18



EGCO-18

Range: 20 m	LED: ○	Pg. 96

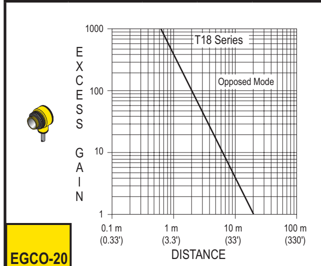
M18



EGCO-19

Range: 20 m	LED: ○	Pg. 97

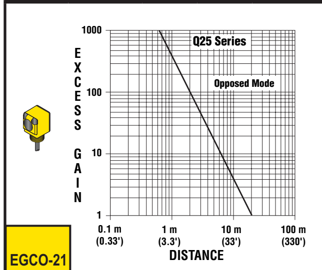
T18



EGCO-20

Range: 20 m	LED: ○	Pg. 102

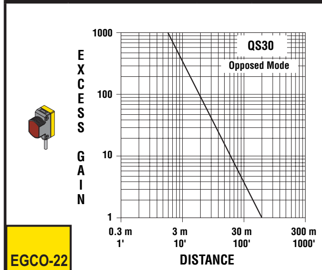
Q25



EGCO-21

Range: 20 m	LED: ○	Pg. 107

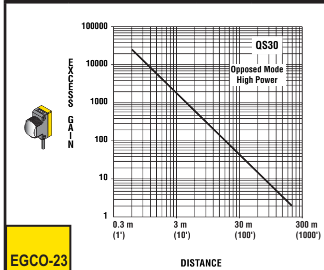
WORLD-BEAM® QS30



EGCO-22

Range: 60 m	LED: ○	Pg. 113

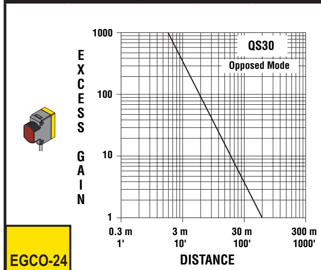
WORLD-BEAM® QS30 High Power



EGCO-23

Range: 213 m	LED: ○	Pg. 113

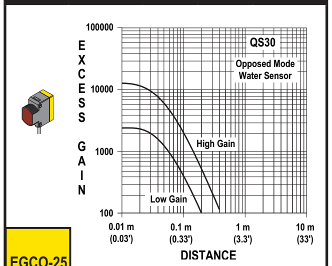
WORLD-BEAM® QS30 Universal Voltage



EGCO-24

Range: 60 m	LED: ○	Pg. 119

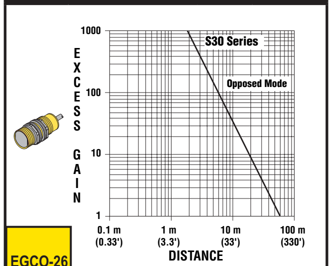
WORLD-BEAM® QS30 High-Power Water



EGCO-25

Range: 4 m	LED: ○	Pg. 113

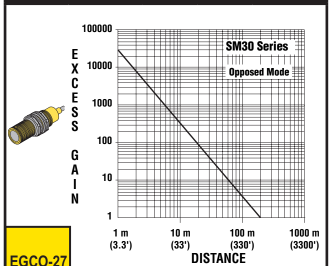
S30



EGCO-26

Range: 60 m	LED: ○	Pg. 122

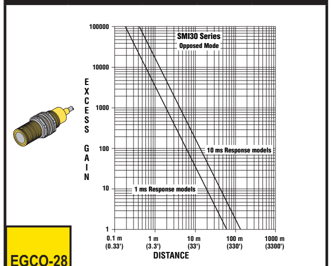
SM30



EGCO-27

Range: 200 m	LED: ○	Pg. 126

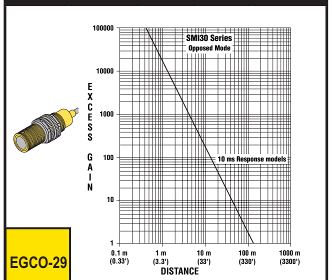
SMI30 - Frequency A



EGCO-28

Range: 140 m	LED: ○	Pg. 128

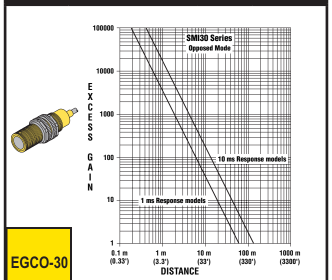
SMI30 - Frequency B



EGCO-29

Range: 140 m	LED: ○	Pg. 128

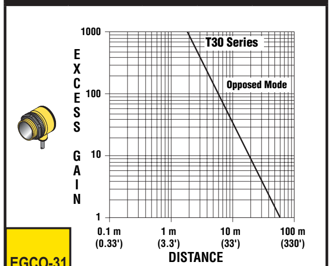
SMI30 - Frequency C



EGCO-30

Range: 140 m	LED: ○	Pg. 128

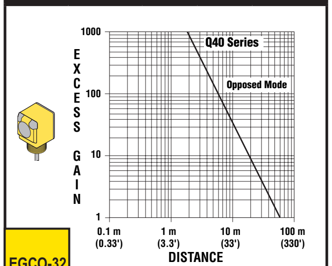
T30



EGCO-31

Range: 60 m	LED: ○	Pg. 130

Q40

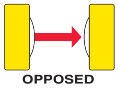


EGCO-32

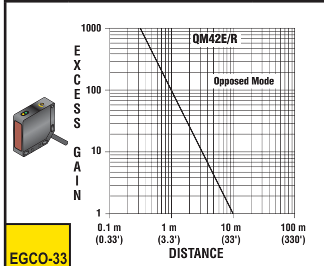
Range: 60 m	LED: ○	Pg. 134

Opposed Mode

○ = Infrared LED



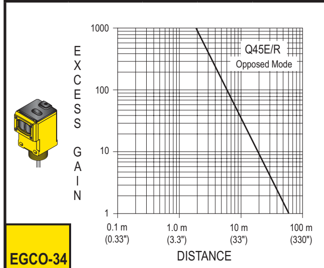
QM42



EGCO-33

Range: 10 m	LED: ○	Pg. 141

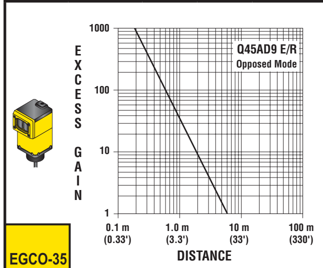
Q45



EGCO-34

Range: 60 m	LED: ○	Pg. 147

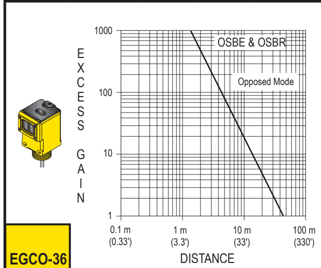
Q45 NAMUR



EGCO-35

Range: 6 m	LED: ○	Pg. 157

OMNI-BEAM™

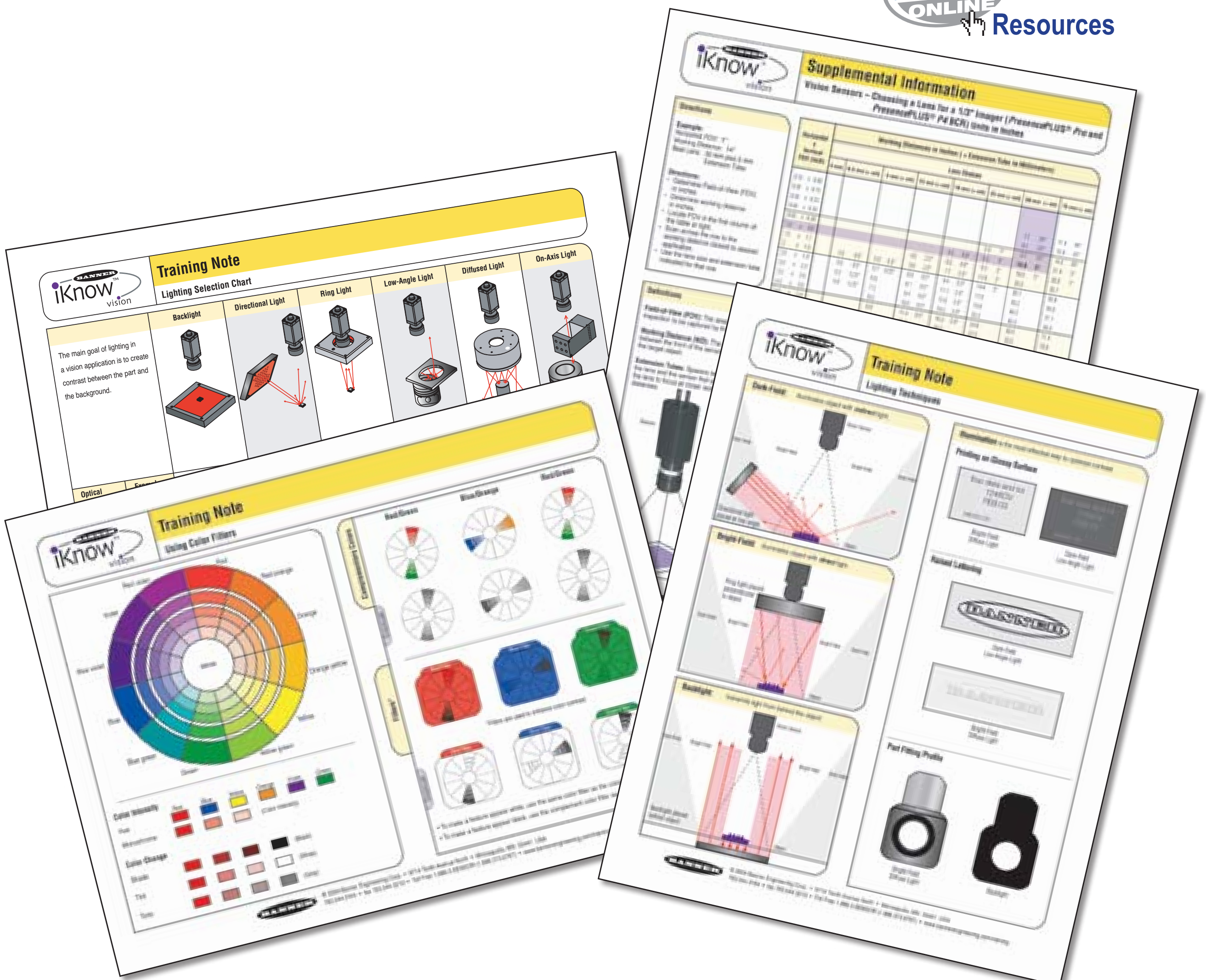


EGCO-36

Range: 45 m	LED: ○	Pg. 160

Find more job aids online.

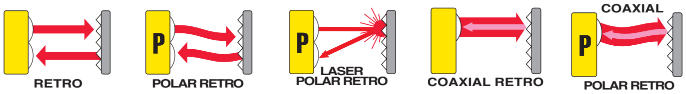
MORE INFO ONLINE
Resources



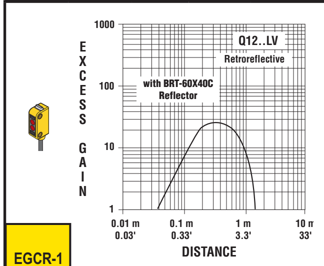
iKNOW®
PERFORMANCE CURVES
HOOKUP DIAGRAMS
GLOSSARY
INTERNATIONAL REPS

Retroreflective Mode

● = Visible Red LED
P = Visible Red LED Polarized
LP = Visible Red Laser LED Polarized



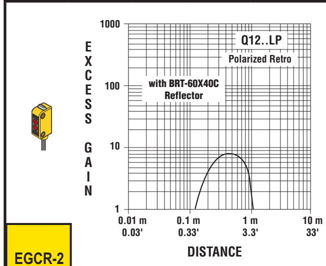
WORLD-BEAM® Q12



EGCR-1

Range: 1.5 m	LED: ●	Pg. 47

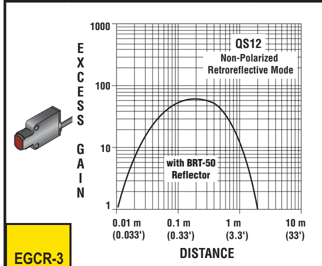
WORLD-BEAM® Q12



EGCR-2

Range: 1 m	LED: P	Pg. 47

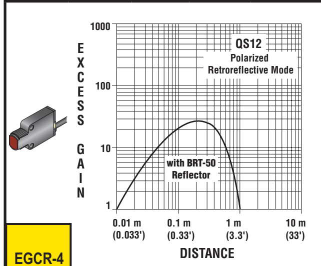
MINI-BEAM®2 QS12



EGCR-3

Range: 2 m	LED: ●	Pg. 53

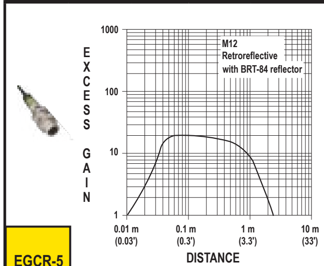
MINI-BEAM®2 QS12



EGCR-4

Range: 1 m	LED: P	Pg. 53

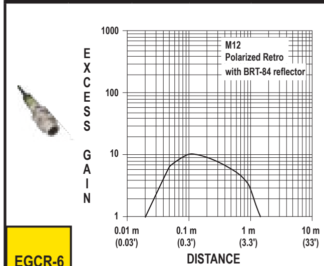
M12



EGCR-5

Range: 2.5 m	LED: ●	Pg. 56

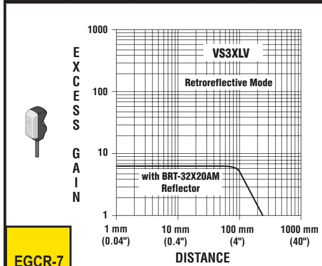
M12



EGCR-6

Range: 1.5 m	LED: P	Pg. 56

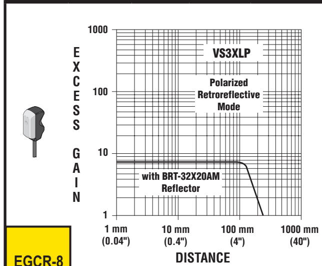
VS3



EGCR-7

Range:250 mm	LED: ●	Pg. 65

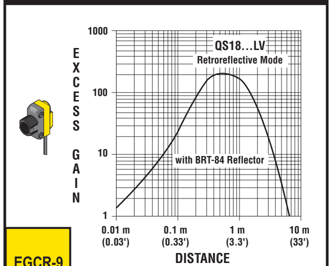
VS3



EGCR-8

Range:250 mm	LED: P	Pg. 65

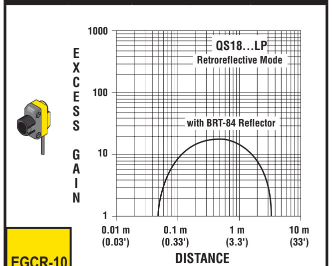
WORLD-BEAM® QS18



EGCR-9

Range: 6.5 m	LED: ●	Pg. 72

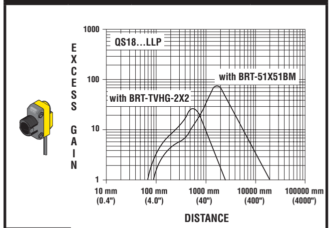
WORLD-BEAM® QS18



EGCR-10

Range: 3.5 m	LED: P	Pg. 72

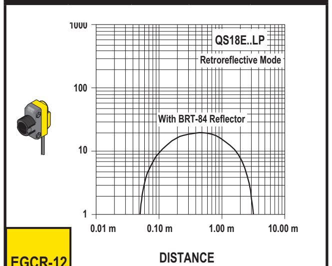
WORLD-BEAM® QS18 Class 1 Laser



EGCR-11

Range: 10 m	LED: LP	Pg. 72

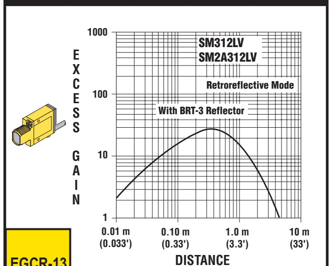
WORLD-BEAM® QS18 *Expert*™



EGCR-12

Range: 3.5 m	LED: P	Pg. 76

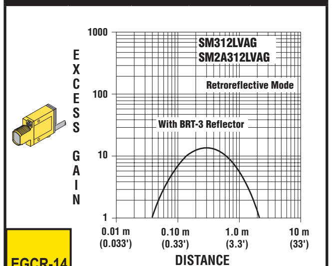
MINI-BEAM®



EGCR-13

Range: 5 m	LED: ●	Pg. 80

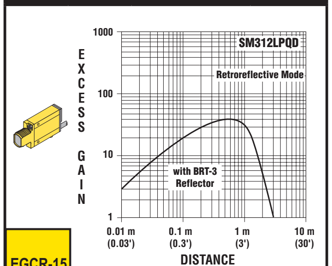
MINI-BEAM®



EGCR-14

Range: 2 m	LED: P	Pg. 80

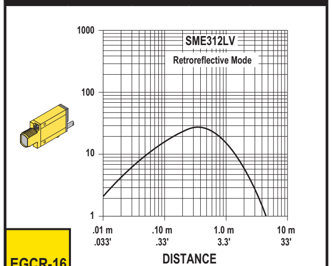
MINI-BEAM®



EGCR-15

Range: 3 m	LED: P	Pg. 80

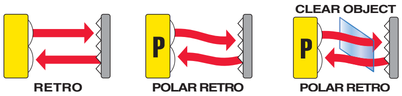
MINI-BEAM® *Expert*™



EGCR-16

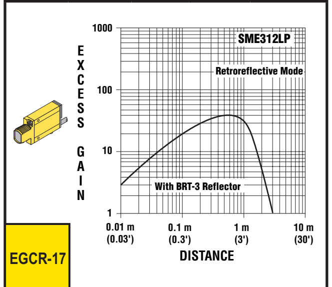
Range: 5 m	LED: ●	Pg. 85

Retroreflective Mode



○ = Infrared LED
● = Visible Red LED
P = Visible Red LED Polarized
■ = Visible Red Clear Object Detection Polarized

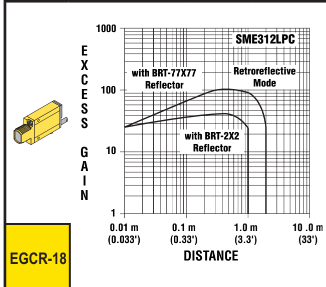
MINI-BEAM® *Expert*™



EGCR-17

Range: 3 m | LED: P | Pg. 85

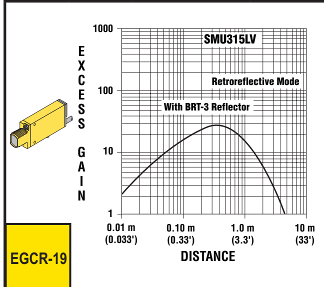
MINI-BEAM® *Expert*™



EGCR-18

Range: 1 m | LED: ■ | Pg. 85

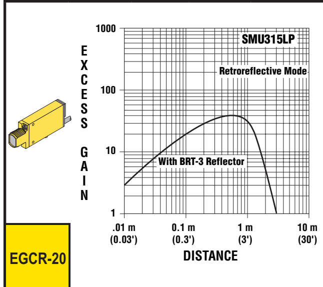
MINI-BEAM® Universal



EGCR-19

Range: 5 m | LED: ● | Pg. 88

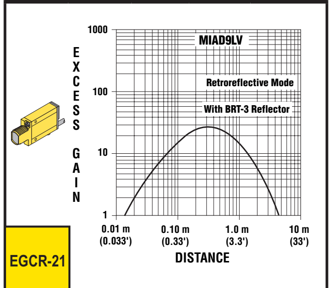
MINI-BEAM® Universal



EGCR-20

Range: 3 m | LED: P | Pg. 88

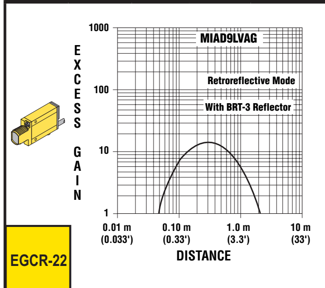
MINI-BEAM® NAMUR



EGCR-21

Range: 5 m | LED: ● | Pg. 90

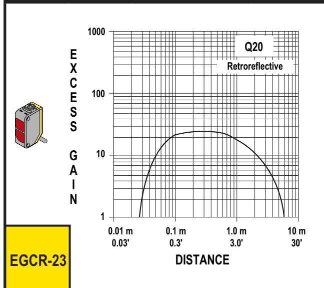
MINI-BEAM® NAMUR



EGCR-22

Range: 2 m | LED: P | Pg. 90

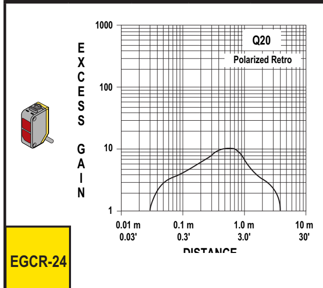
WORLD-BEAM® Q20



EGCR-23

Range: 6 m | LED: ● | Pg. 93

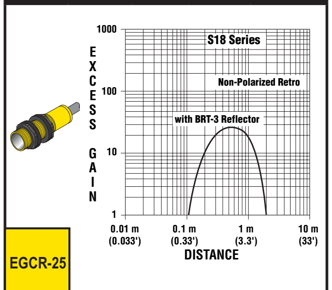
WORLD-BEAM® Q20



EGCR-24

Range: 4 m | LED: P | Pg. 93

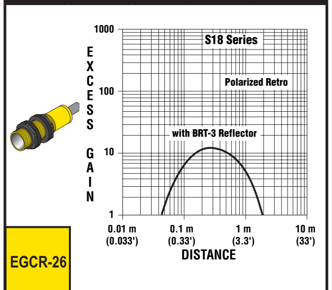
S18



EGCR-25

Range: 2 m | LED: ○ | Pg. 96

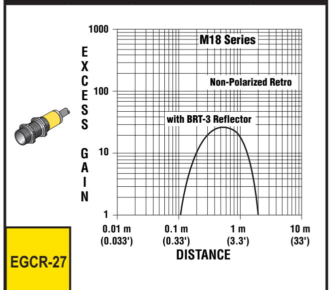
S18



EGCR-26

Range: 2 m | LED: P | Pg. 96

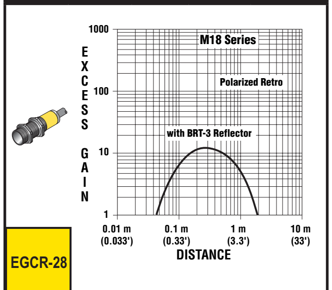
M18



EGCR-27

Range: 2 m | LED: ○ | Pg. 97

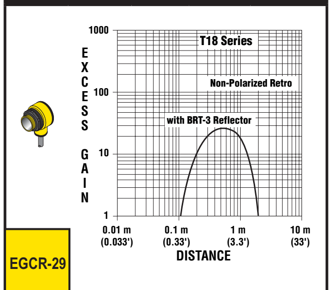
M18



EGCR-28

Range: 2 m | LED: P | Pg. 97

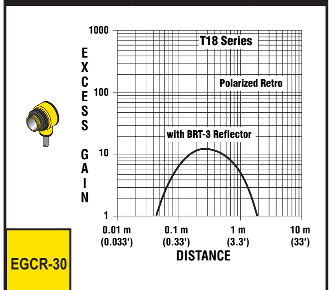
T18



EGCR-29

Range: 2 m | LED: ○ | Pg. 102

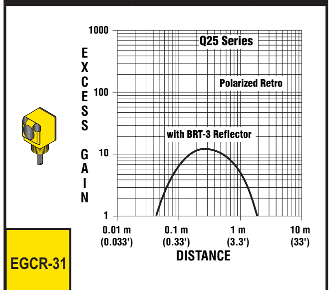
T18



EGCR-30

Range: 2 m | LED: P | Pg. 102

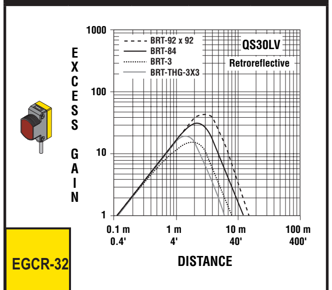
Q25



EGCR-31

Range: 2 m | LED: P | Pg. 107

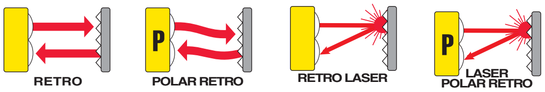
WORLD-BEAM® QS30



EGCR-32

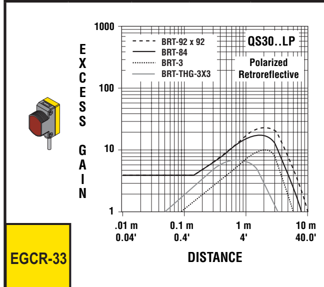
Range: 12 m | LED: ● | Pg. 114

Retroreflective Mode



● = Visible Red LED
P = Visible Red LED Polarized
✸ = Visible Red Laser LED
LP = Visible Red Laser LED Polarized

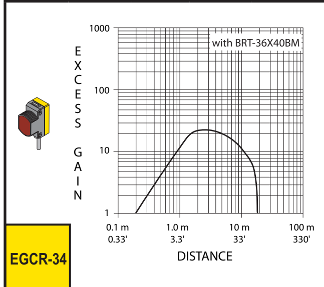
WORLD-BEAM® QS30



EGCR-33

Range: 8 m | **LED:** P | Pg. 114

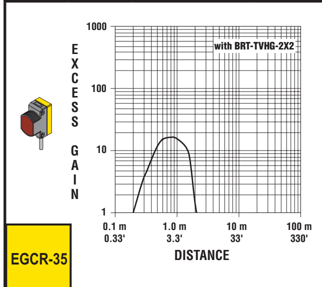
WORLD-BEAM® QS30 Class 1 Laser



EGCR-34

Range: 18 m | **LED:** LP | Pg. 116

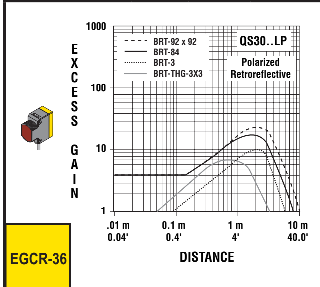
WORLD-BEAM® QS30 Class 1 Laser



EGCR-35

Range: 2 m | **LED:** LP | Pg. 116

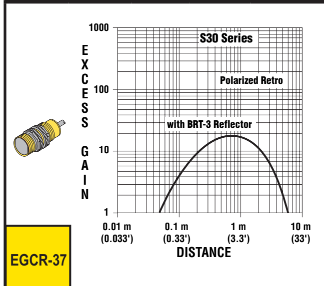
WORLD-BEAM® QS30 Universal



EGCR-36

Range: 8 m | **LED:** P | Pg. 119

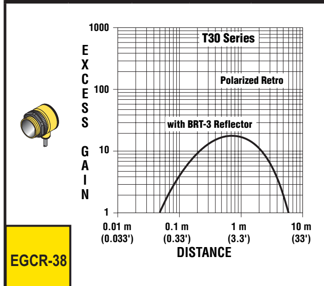
S30



EGCR-37

Range: 6 m | **LED:** P | Pg. 122

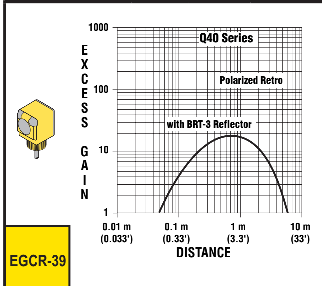
T30



EGCR-38

Range: 6 m | **LED:** P | Pg. 130

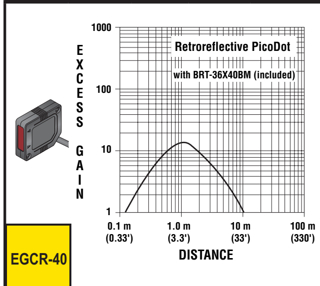
Q40



EGCR-39

Range: 6 m | **LED:** P | Pg. 134

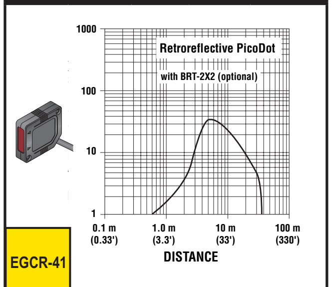
PicoDot®



EGCR-40

Range: 10.6 m | **LED:** LP | Pg. 138

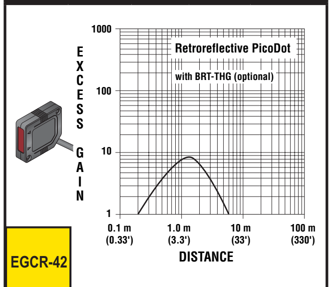
PicoDot®



EGCR-41

Range: 39.6 m | **LED:** LP | Pg. 138

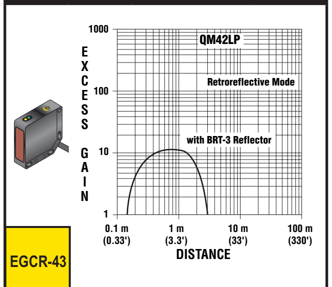
PicoDot®



EGCR-42

Range: 6 m | **LED:** LP | Pg. 138

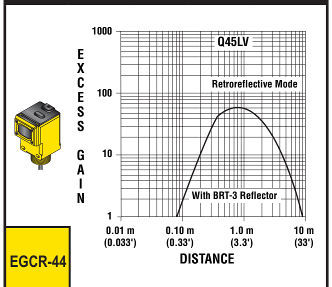
QM42



EGCR-43

Range: 3 m | **LED:** P | Pg. 141

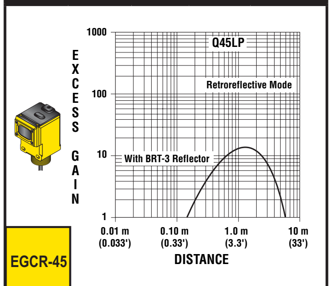
Q45



EGCR-44

Range: 9 m | **LED:** ● | Pg. 147

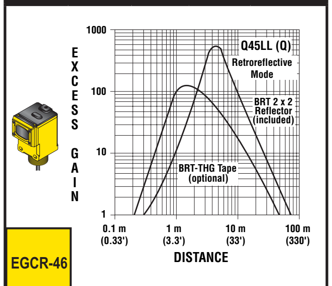
Q45



EGCR-45

Range: 6.0 m | **LED:** P | Pg. 147

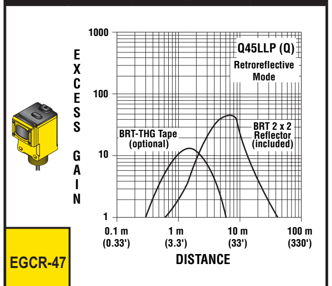
Q45 Class 2 Laser



EGCR-46

Range: 70 m | **LED:** ✸ | Pg. 147

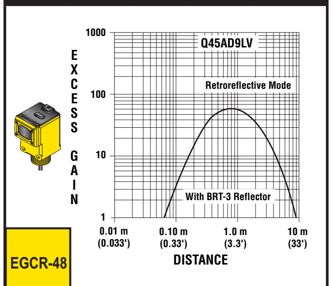
Q45 Class 2 Laser



EGCR-47

Range: 40 m | **LED:** LP | Pg. 147

Q45 NAMUR

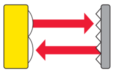


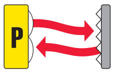
EGCR-48

Range: 9 m | **LED:** ● | Pg. 157

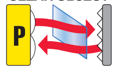
Retroreflective Mode

● = Visible Red LED
P = Visible Red LED Polarized
■ = Visible Red Clear Object Detection Polarized

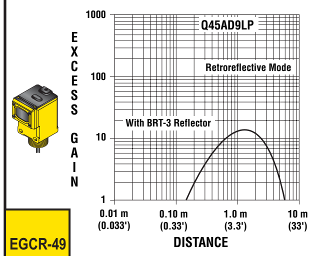

RETRO


POLAR RETRO


LASER POLAR RETRO

CLEAR OBJECT

POLAR RETRO

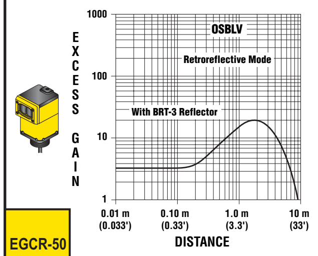
Q45 NAMUR



EGCR-49

Range: 6 m	LED: P	Pg. 157

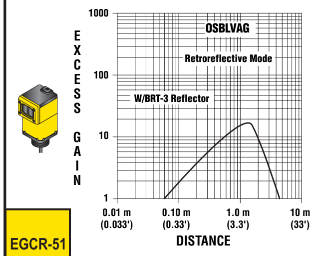
OMNI-BEAM™



EGCR-50

Range: 9 m	LED: ●	Pg. 160

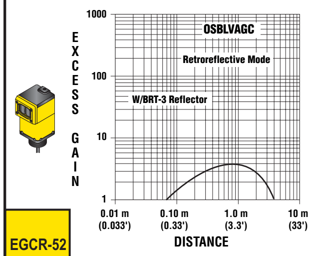
OMNI-BEAM™



EGCR-51

Range: 4.5 m	LED: P	Pg. 160

OMNI-BEAM™

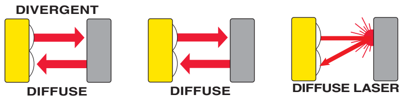


EGCR-52

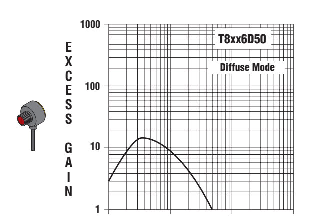
Range: 4 m	LED: ■	Pg. 160

Diffuse Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED
✸ = Visible Red Laser LED



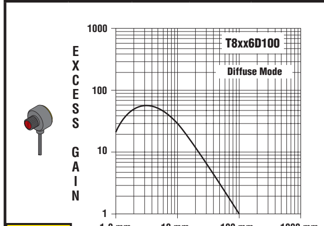
T8



EGCD-1

Range: 50 m | **LED:** ● | Pg. 50

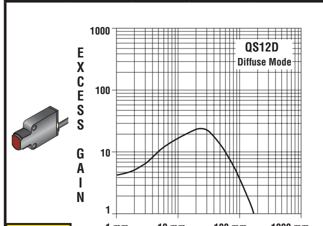
T8



EGCD-2

Range: 100 mm | **LED:** ● | Pg. 50

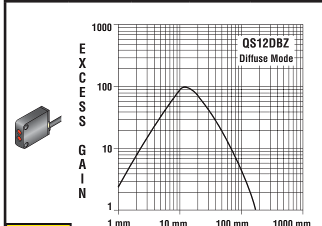
MINI-BEAM® 2 QS12



EGCD-3

Range: 180 mm | **LED:** ● | Pg. 53

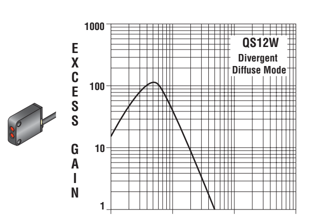
MINI-BEAM® 2 QS12



EGCD-4

Range: 180 mm | **LED:** ● | Pg. 53

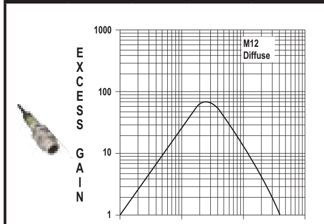
MINI-BEAM® 2 QS12



EGCD-5

Range: 50 mm | **LED:** ● | Pg. 53

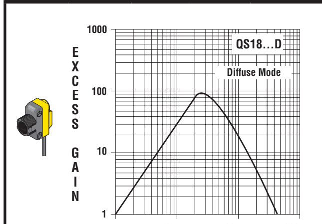
M12



EGCD-6

Range: 400 mm | **LED:** ● | Pg. 56

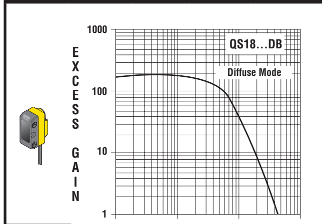
WORLD-BEAM® QS18



EGCD-7

Range: 450 m | **LED:** ○ | Pg. 73

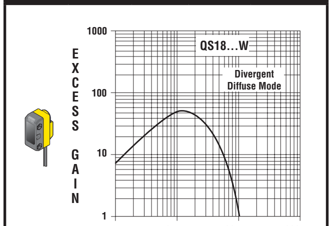
WORLD-BEAM® QS18



EGCD-8

Range: 450 mm | **LED:** ○ | Pg. 73

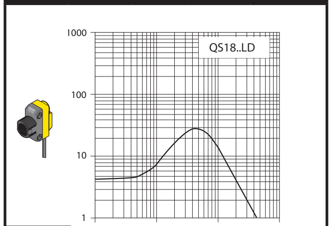
WORLD-BEAM® QS18



EGCD-9

Range: 100 mm | **LED:** ○ | Pg. 73

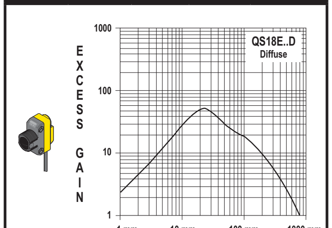
WORLD-BEAM® QS18 Class 1 Laser



EGCD-10

Range: 300 mm | **LED:** ✸ | Pg. 73

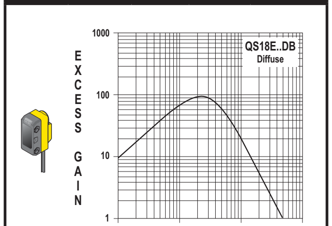
WORLD-BEAM® QS18 *Expert*™



EGCD-11

Range: 800 mm | **LED:** ○ | Pg. 76

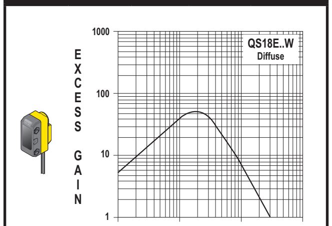
WORLD-BEAM® QS18 *Expert*™



EGCD-12

Range: 500 mm | **LED:** ○ | Pg. 76

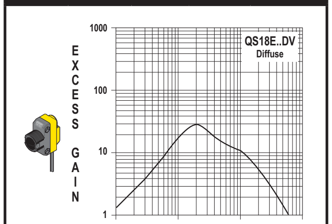
WORLD-BEAM® QS18 *Expert*™



EGCD-13

Range: 300 mm | **LED:** ○ | Pg. 77

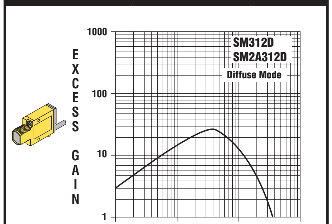
WORLD-BEAM® QS18 *Expert*™



EGCD-14

Range: 600 mm | **LED:** ● | Pg. 77

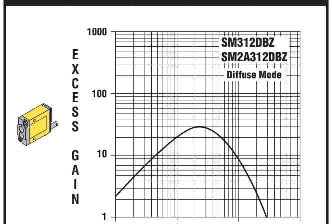
MINI-BEAM®



EGCD-15

Range: 380 mm | **LED:** ○ | Pg. 80

MINI-BEAM®



EGCD-16

Range: 300 mm | **LED:** ○ | Pg. 80

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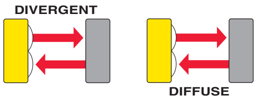
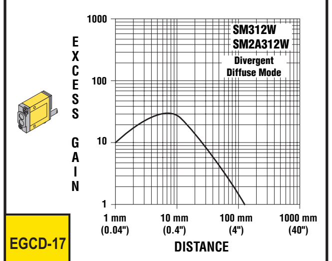
HOOKUP DIAGRAMS
GLOSSARY
INTERNATIONAL REPS

Diffuse Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



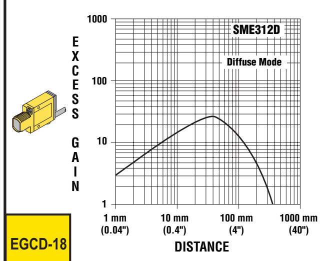
MINI-BEAM®



EGCD-17

Range: 130 mm | **LED:** ○ | Pg. 80

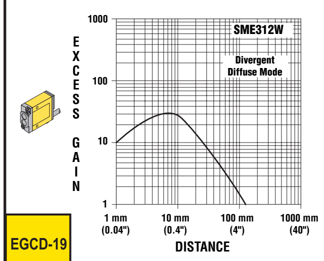
MINI-BEAM® *Expert*™



EGCD-18

Range: 380 mm | **LED:** ○ | Pg. 85

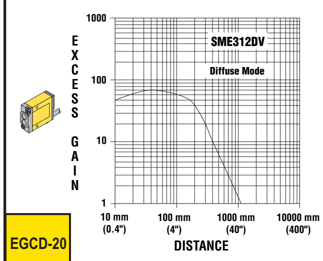
MINI-BEAM® *Expert*™



EGCD-19

Range: 130 mm | **LED:** ○ | Pg. 85

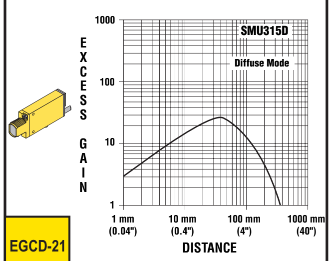
MINI-BEAM® *Expert*™



EGCD-20

Range: 1100 mm | **LED:** ● | Pg. 85

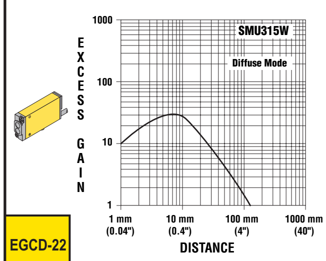
MINI-BEAM® Universal



EGCD-21

Range: 380 mm | **LED:** ○ | Pg. 88

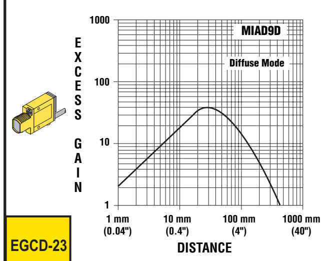
MINI-BEAM® Universal



EGCD-22

Range: 130 mm | **LED:** ○ | Pg. 88

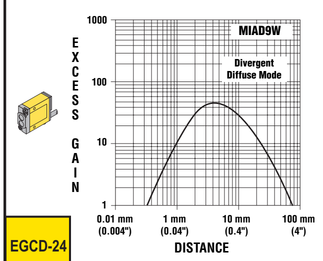
MINI-BEAM® NAMUR



EGCD-23

Range: 380 mm | **LED:** ○ | Pg. 90

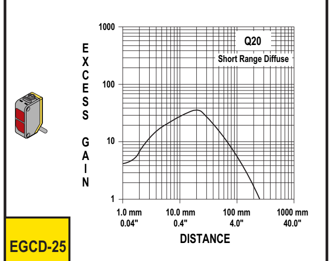
MINI-BEAM® NAMUR



EGCD-24

Range: 75 mm | **LED:** ○ | Pg. 90

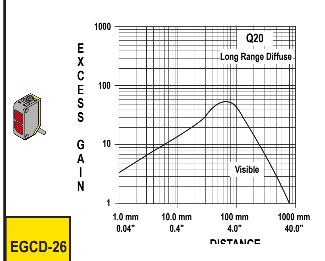
WORLD-BEAM® Q20



EGCD-25

Range: 250 mm | **LED:** ● | Pg. 93

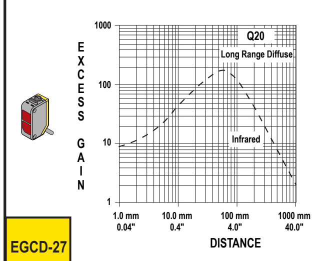
WORLD-BEAM® Q20



EGCD-26

Range: 800 mm | **LED:** ● | Pg. 93

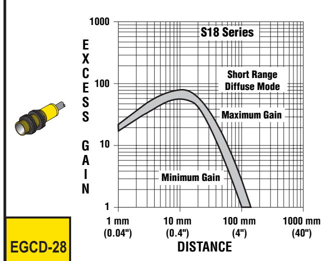
WORLD-BEAM® Q20



EGCD-27

Range: 1500 mm | **LED:** ○ | Pg. 93

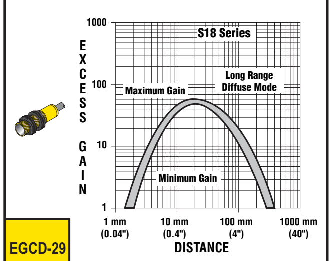
S18



EGCD-28

Range: 100 mm | **LED:** ○ | Pg. 96

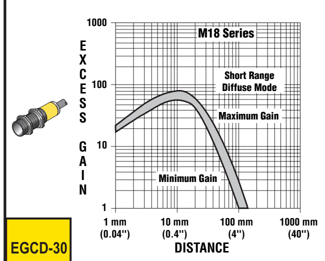
S18



EGCD-29

Range: 300 mm | **LED:** ○ | Pg. 96

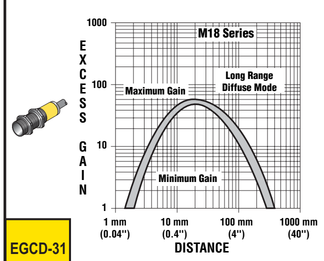
M18



EGCD-30

Range: 100 mm | **LED:** ○ | Pg. 97

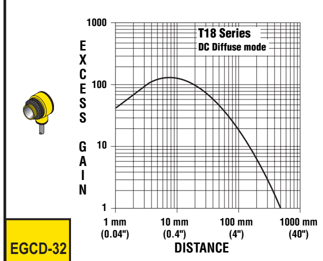
M18



EGCD-31

Range: 300 mm | **LED:** ○ | Pg. 97

T18

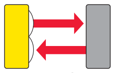


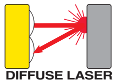
EGCD-32

Range: 500 mm | **LED:** ○ | Pg. 102

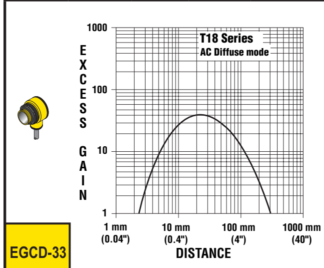
Diffuse Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED
✸ = Visible Red Laser LED





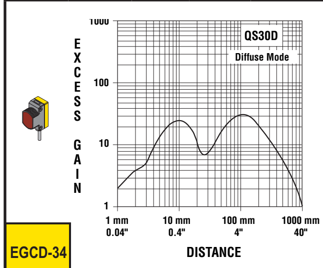
T18



EGCD-33

Range: 300 mm	LED: ○	Pg. 104

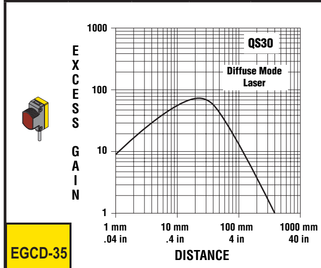
WORLD-BEAM® QS30



EGCD-34

Range: 1 m	LED: ○	Pg. 114

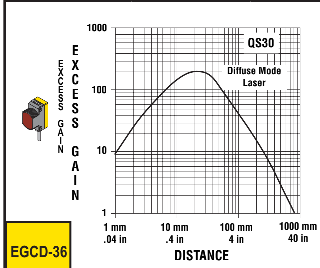
WORLD-BEAM® QS30 Class 1 Laser



EGCD-35

Range: 400 mm	LED: ✸	Pg. 116

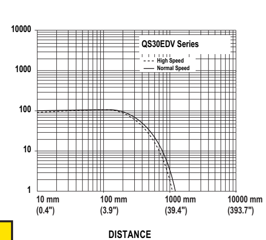
WORLD-BEAM® QS30 Class 2 Laser



EGCD-36

Range: 800 mm	LED: ✸	Pg. 116

WORLD-BEAM® QS30 *Expert*™ Visible Red LED

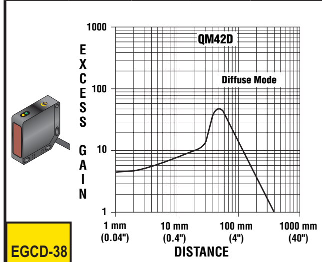


EGCD-37

*Normal mode: 1100 mm;
High-Speed mode: 1400 mm

Range: 1400 mm*	LED: ●	Pg. 116

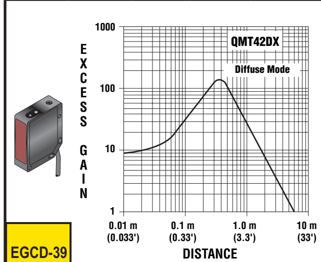
QM42



EGCD-38

Range: 400 mm	LED: ○	Pg. 141

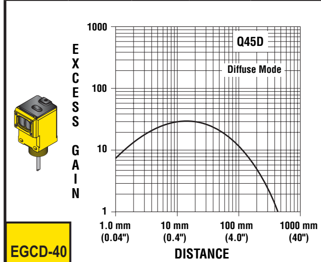
QMT42



EGCD-39

Range: 6 mm	LED: ○	Pg. 141

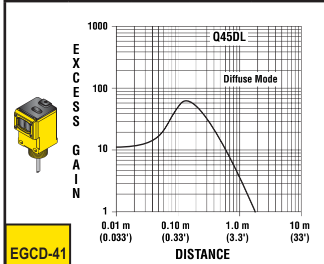
Q45



EGCD-40

Range: 450 mm	LED: ○	Pg. 148

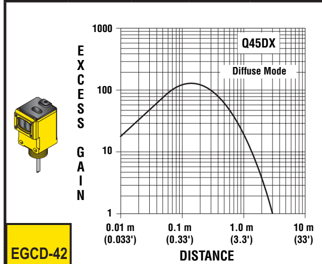
Q45



EGCD-41

Range: 1.8 mm	LED: ○	Pg. 148

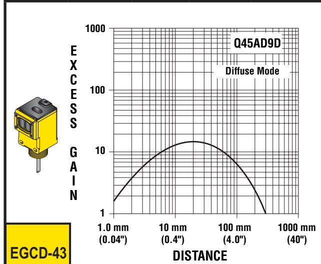
Q45



EGCD-42

Range: 3 mm	LED: ○	Pg. 148

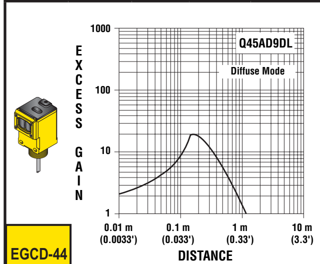
Q45 NAMUR



EGCD-43

Range: 300 mm	LED: ○	Pg. 157

Q45 NAMUR



EGCD-44

Range: 1 mm	LED: ○	Pg. 157

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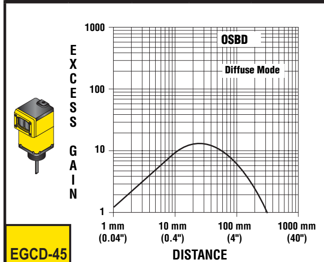
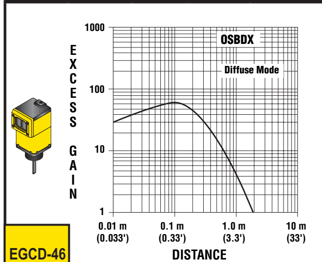


EGCD-45

Range: 300 mm	LED: ○	Pg. 160

OMNI-BEAM™

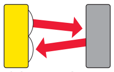


EGCD-46

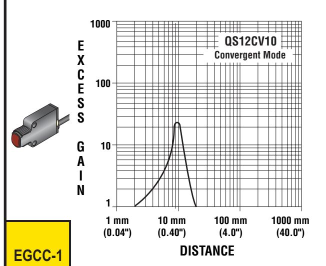
Range: 2 m	LED: ○	Pg. 160

Convergent Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



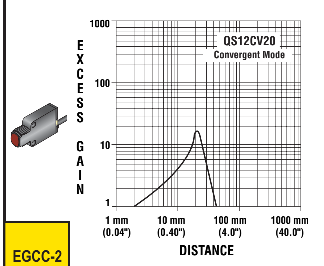
MINI-BEAM®2 QS12



EGCC-1

Range: 10 mm	LED: ●	Pg. 53

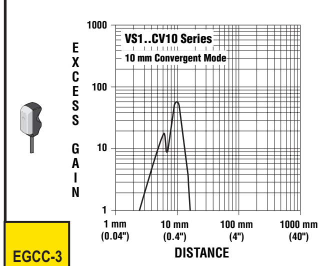
MINI-BEAM®2 QS12



EGCC-2

Range: 20 mm	LED: ●	Pg. 53

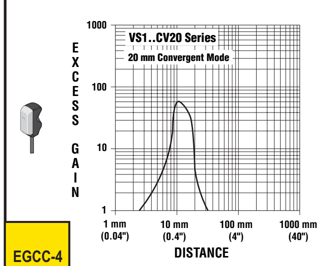
VS1



EGCC-3

Range: 10 mm	LED: ●	Pg. 59

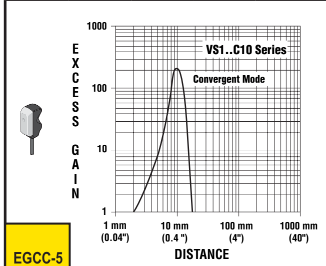
VS1



EGCC-4

Range: 20 mm	LED: ●	Pg. 59

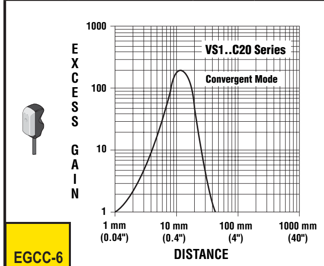
VS1



EGCC-5

Range: 10 mm	LED: ○	Pg. 59

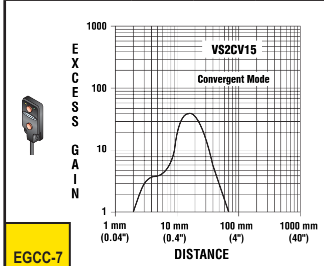
VS1



EGCC-6

Range: 20 mm	LED: ○	Pg. 59

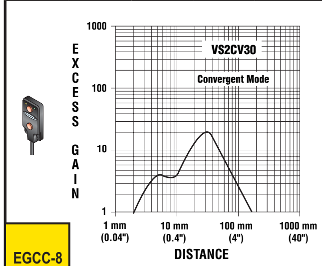
VS2



EGCC-7

Range: 15 mm	LED: ●	Pg. 62

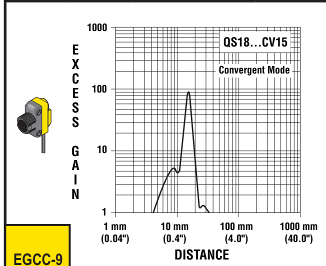
VS2



EGCC-8

Range: 30 mm	LED: ●	Pg. 62

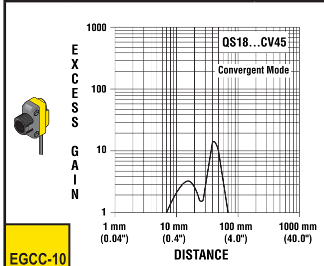
WORLD-BEAM® QS18



EGCC-9

Range: 16 mm	LED: ●	Pg. 72

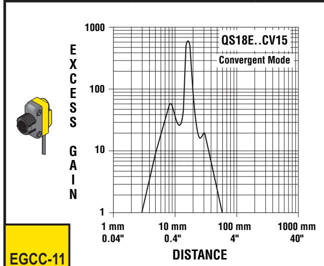
WORLD-BEAM® QS18



EGCC-10

Range: 43 mm	LED: ●	Pg. 72

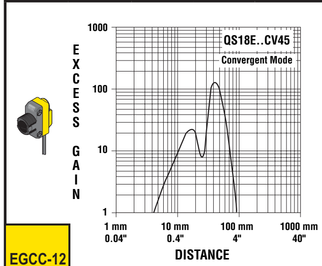
WORLD-BEAM® QS18 *Expert*™



EGCC-11

Range: 16 mm	LED: ●	Pg. 76

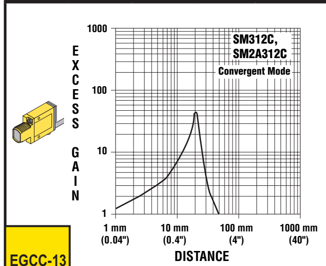
WORLD-BEAM® QS18 *Expert*™



EGCC-12

Range: 43 mm	LED: ●	Pg. 76

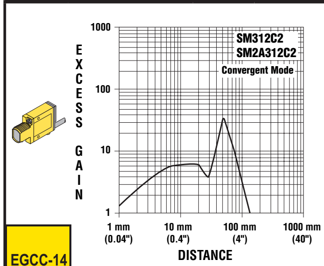
MINI-BEAM®



EGCC-13

Range: 16 mm	LED: ○	Pg. 80

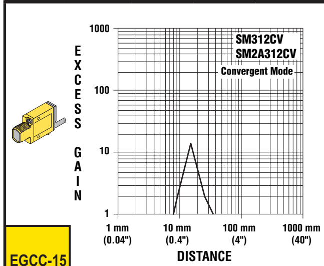
MINI-BEAM®



EGCC-14

Range: 43 mm	LED: ○	Pg. 80

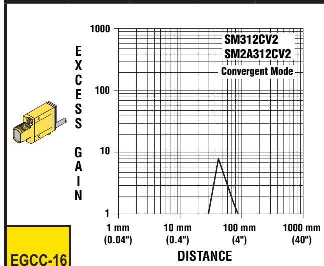
MINI-BEAM®



EGCC-15

Range: 16 mm	LED: ●	Pg. 80

MINI-BEAM®



EGCC-16

Range: 43 mm	LED: ●	Pg. 80

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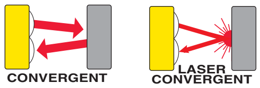
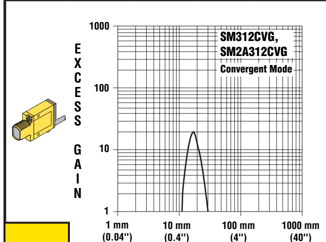
Convergent Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
● = Visible Green LED
● = Visible Blue LED
○ = Visible White LED
✸ = Visible Red Laser LED



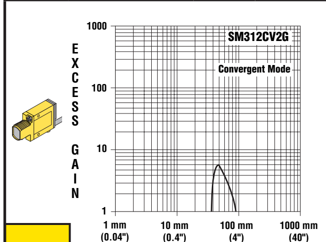
MINI-BEAM®



EGCC-17

Range: 16 mm | LED: ● (green) | Pg. 80

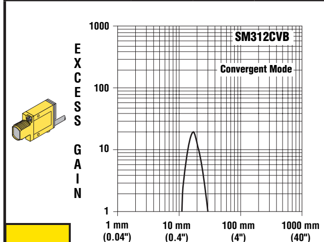
MINI-BEAM®



EGCC-18

Range: 49 mm | LED: ● (green) | Pg. 80

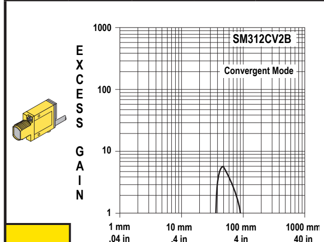
MINI-BEAM®



EGCC-19

Range: 16 mm | LED: ● (blue) | Pg. 80

MINI-BEAM®



EGCC-20

Range: 49 mm | LED: ● (blue) | Pg. 80

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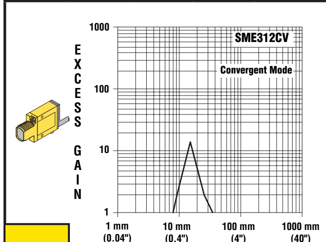
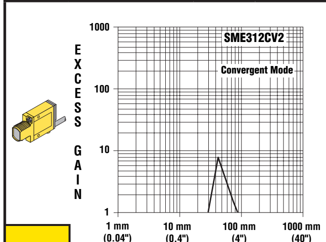


EGCC-21

Range: 16 mm | LED: ● (red) | Pg. 86

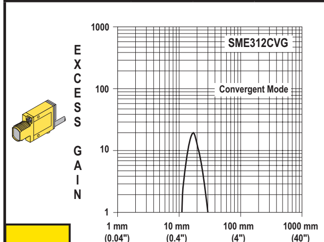
MINI-BEAM® *Expert*™



EGCC-22

Range: 43 mm | LED: ● (red) | Pg. 86

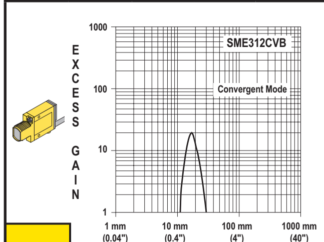
MINI-BEAM® *Expert*™



EGCC-23

Range: 16 mm | LED: ● (green) | Pg. 86

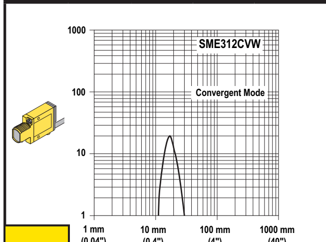
MINI-BEAM® *Expert*™



EGCC-24

Range: 16 mm | LED: ● (blue) | Pg. 86

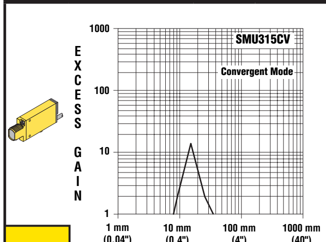
MINI-BEAM® *Expert*™



EGCC-25

Range: 16 mm | LED: ○ | Pg. 86

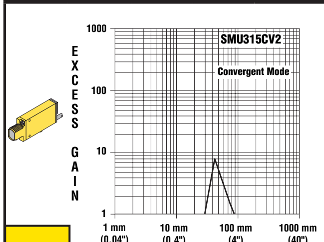
MINI-BEAM® Universal



EGCC-26

Range: 16 mm | LED: ● (red) | Pg. 88

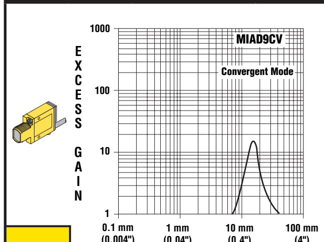
MINI-BEAM® Universal



EGCC-27

Range: 43 mm | LED: ● (red) | Pg. 88

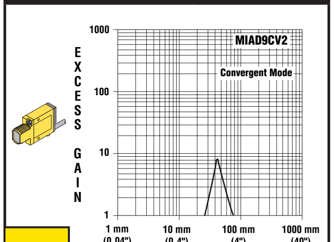
MINI-BEAM® NAMUR



EGCC-28

Range: 16 mm | LED: ● (red) | Pg. 90

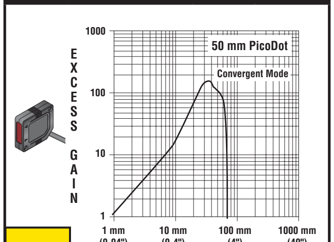
MINI-BEAM® NAMUR



EGCC-29

Range: 43 mm | LED: ● (red) | Pg. 90

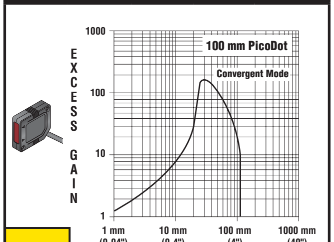
PicoDot® Class 2 Laser



EGCC-30

Range: 50 mm | LED: ✸ | Pg. 138

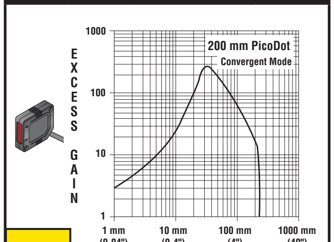
PicoDot® Class 2 Laser



EGCC-31

Range: 102 mm | LED: ✸ | Pg. 138

PicoDot® Class 2 Laser

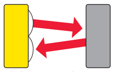


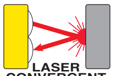
EGCC-32

Range: 203 mm | LED: ✸ | Pg. 138

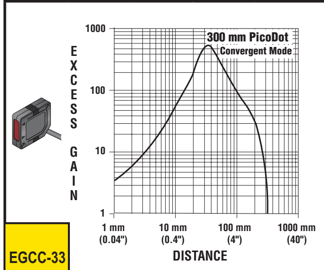
Convergent Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
● = Visible Green LED
● = Visible Blue LED
✸ = Visible Red Laser LED


CONVERGENT


LASER CONVERGENT

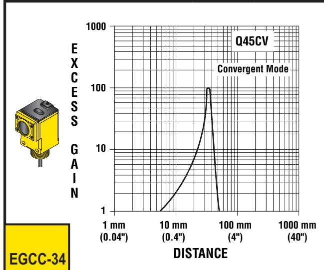
PicoDot® Class 2 Laser



EGCC-33

Range: 305 mm	LED: ✸	Pg. 138

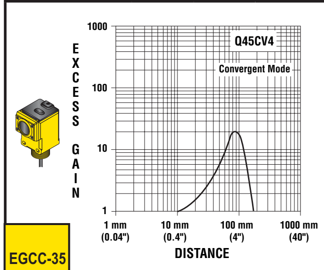
Q45



EGCC-34

Range: 38 mm	LED: ●	Pg. 148

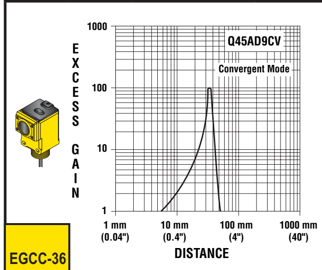
Q45



EGCC-35

Range: 100 mm	LED: ●	Pg. 148

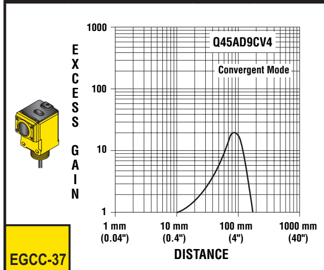
Q45 NAMUR



EGCC-36

Range: 38 mm	LED: ●	Pg. 157

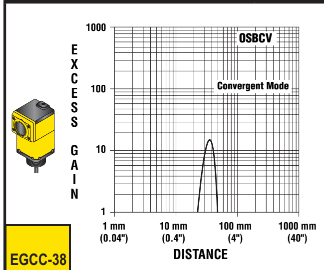
Q45 NAMUR



EGCC-37

Range: 100 mm	LED: ●	Pg. 157

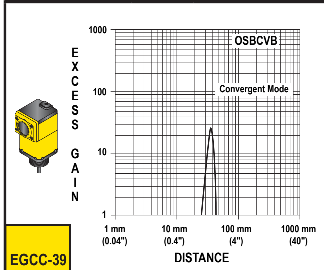
OMNI-BEAM™



EGCC-38

Range: 38 mm	LED: ●	Pg. 161

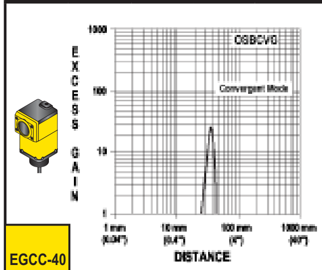
OMNI-BEAM™



EGCC-39

Range: 38 mm	LED: ●	Pg. 161

OMNI-BEAM™



EGCC-40

Range: 38 mm	LED: ●	Pg. 161

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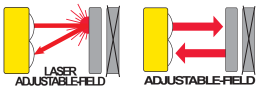
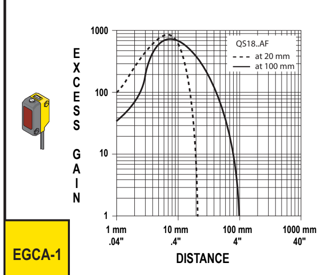
Adjustable-Field Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED
✸ = Visible Red Laser LED



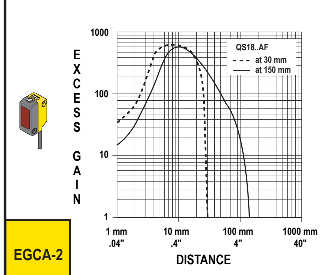
WORLD-BEAM® QS18



EGCA-1

Cutoff Min: 20 mm	LED: ●	Pg. 73
Cutoff Max: 100 mm		

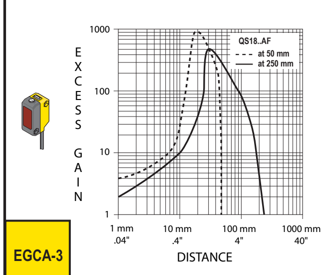
WORLD-BEAM® QS18 Class 1 Laser



EGCA-2

Cutoff Min: 30 mm	LED: ✸	Pg. 73
Cutoff Max: 150 mm		

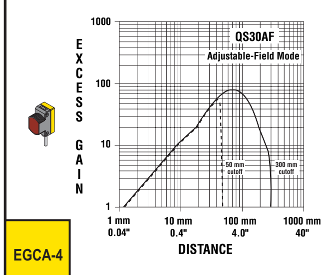
WORLD-BEAM® QS18 Class 2 Laser



EGCA-3

Cutoff Min: 50 mm	LED: ✸	Pg. 73
Cutoff Max: 250 mm		

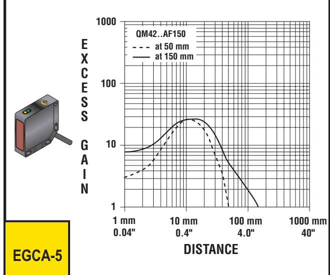
WORLD-BEAM® QS30



EGCA-4

Cutoff Min: 50 mm	LED: ●	Pg. 116
Cutoff Max: 300 mm		

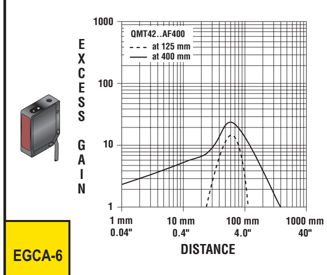
QM42



EGCA-5

Cutoff Min: 50 mm	LED: ●	Pg. 142
Cutoff Max: 150 mm		

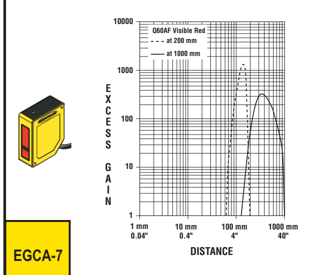
QMT42



EGCA-6

Cutoff Min: 125 mm	LED: ●	Pg. 142
Cutoff Max: 400 mm		

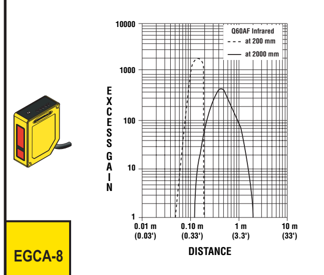
Q60 Visible Red



EGCA-7

Cutoff Min: 200 mm	LED: ●	Pg. 166
Cutoff Max: 1000 mm		

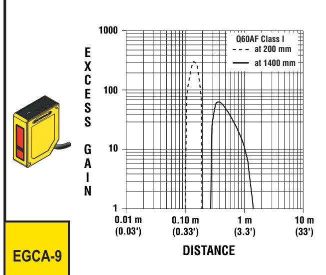
Q60 Infrared



EGCA-8

Cutoff Min: 200 mm	LED: ○	Pg. 166
Cutoff Max: 2000 mm		

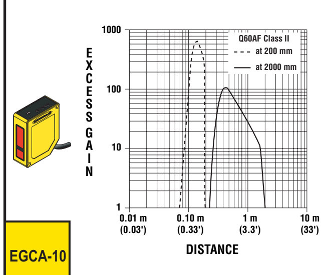
Q60 Class 1 Laser



EGCA-9

Cutoff Min: 200 mm	LED: ✸	Pg. 166
Cutoff Max: 1400 mm		

Q60 Class 2 Laser

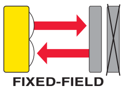


EGCA-10

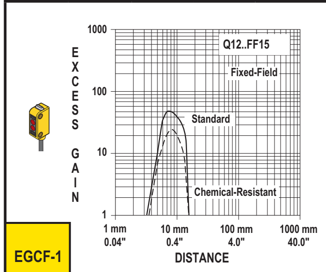
Cutoff Min: 300 mm	LED: ✸	Pg. 166
Cutoff Max: 2000 mm		

Fixed-Field Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



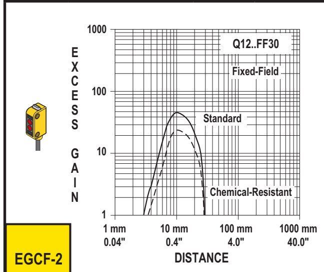
WORLD-BEAM® Q12



EGCF-1

Cutoff: 15 mm	LED: ●	Pg. 47

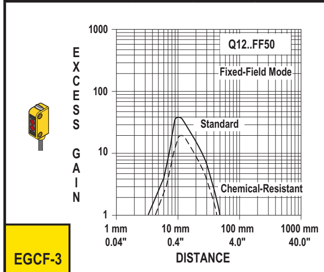
WORLD-BEAM® Q12



EGCF-2

Cutoff: 30 mm	LED: ●	Pg. 48

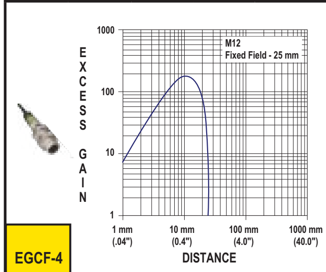
WORLD-BEAM® Q12



EGCF-3

Cutoff: 50 mm	LED: ●	Pg. 48

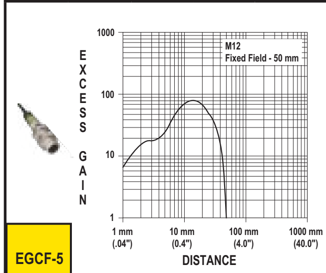
M12



EGCF-4

Cutoff: 25 mm	LED: ●	Pg. 56

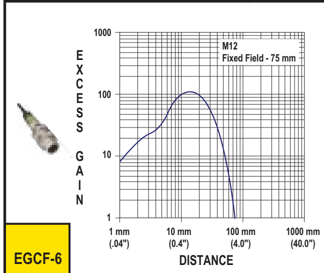
M12



EGCF-5

Cutoff: 50 mm	LED: ●	Pg. 56

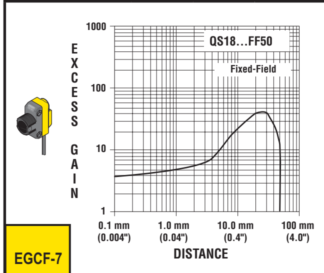
M12



EGCF-6

Cutoff: 75 mm	LED: ●	Pg. 56

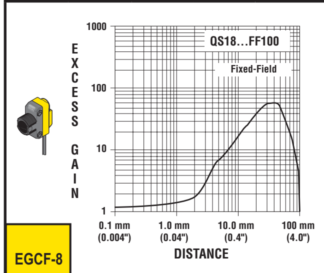
WORLD-BEAM® QS18



EGCF-7

Cutoff: 50 mm	LED: ●	Pg. 73

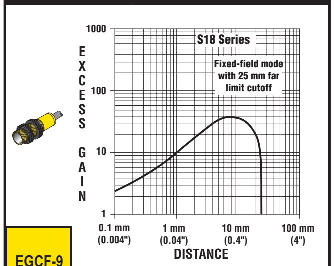
WORLD-BEAM® QS18



EGCF-8

Cutoff: 100 mm	LED: ●	Pg. 74

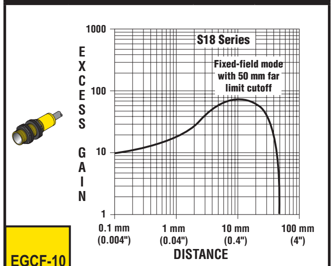
S18



EGCF-9

Cutoff: 25 mm	LED: ○	Pg. 96

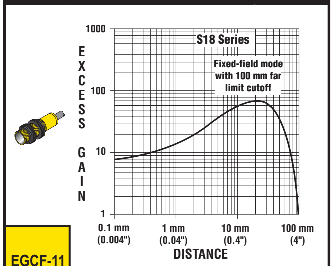
S18



EGCF-10

Cutoff: 50 mm	LED: ○	Pg. 96

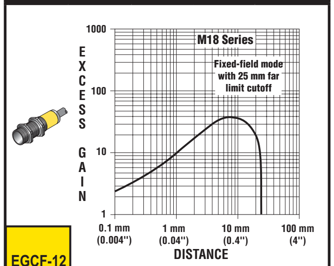
S18



EGCF-11

Cutoff: 100 mm	LED: ○	Pg. 96

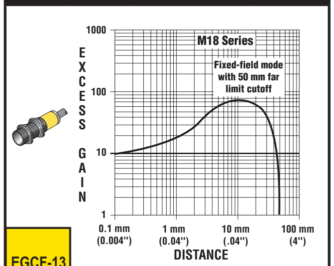
M18



EGCF-12

Cutoff: 25 mm	LED: ○	Pg. 97

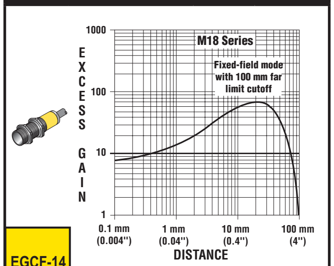
M18



EGCF-13

Cutoff: 50 m	LED: ○	Pg. 97

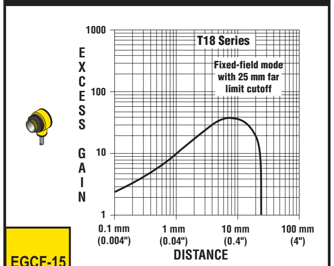
M18



EGCF-14

Cutoff: 100 mm	LED: ○	Pg. 97

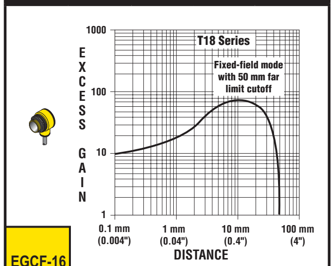
T18



EGCF-15

Cutoff: 25 mm	LED: ○	Pg. 102

T18

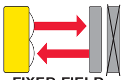


EGCF-16

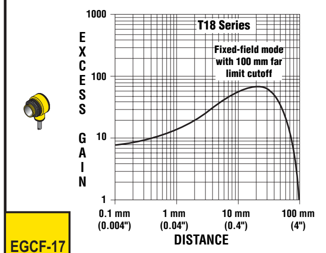
Cutoff: 50 mm	LED: ○	Pg. 102

Fixed-Field Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



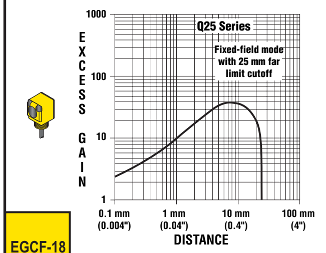
T18



EGCF-17

Cutoff: 100 mm | LED: ○ | Pg. 102

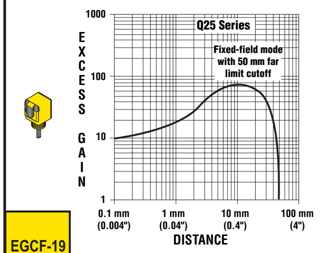
Q25



EGCF-18

Cutoff: 25 mm | LED: ○ | Pg. 107

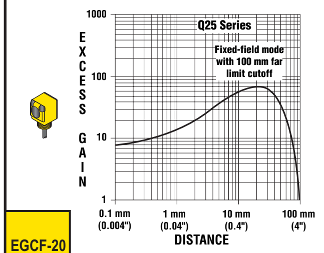
Q25



EGCF-19

Cutoff: 50 mm | LED: ○ | Pg. 107

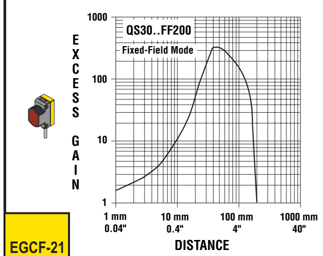
Q25



EGCF-20

Cutoff: 100 mm | LED: ○ | Pg. 107

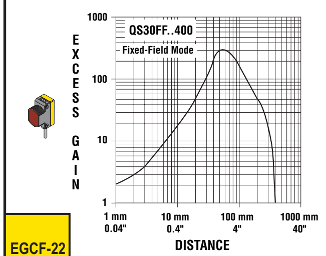
WORLD-BEAM® QS30



EGCF-21

Cutoff: 200 mm | LED: ● | Pg. 114

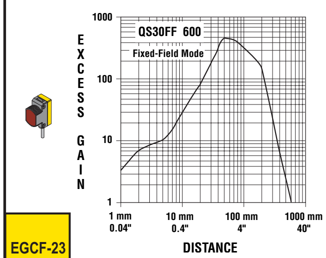
WORLD-BEAM® QS30



EGCF-22

Cutoff: 400 mm | LED: ● | Pg. 114

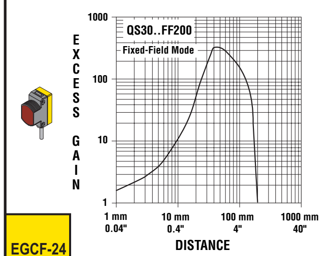
WORLD-BEAM® QS30



EGCF-23

Cutoff: 600 mm | LED: ● | Pg. 114

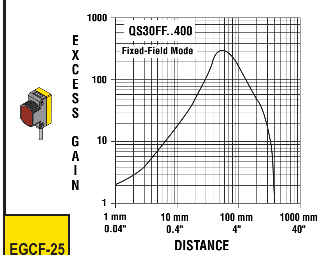
WORLD-BEAM® QS30 Universal



EGCF-24

Cutoff: 200 mm | LED: ● | Pg. 119

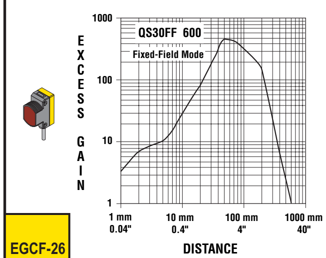
WORLD-BEAM® QS30 Universal



EGCF-25

Cutoff: 400 mm | LED: ● | Pg. 119

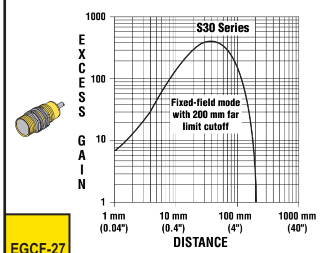
WORLD-BEAM® QS30 Universal



EGCF-26

Cutoff: 600 mm | LED: ● | Pg. 119

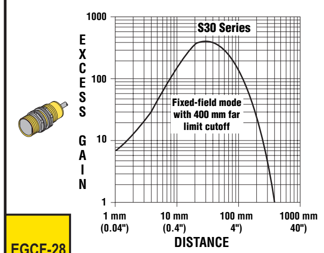
S30



EGCF-27

Cutoff: 200 mm | LED: ○ | Pg. 122

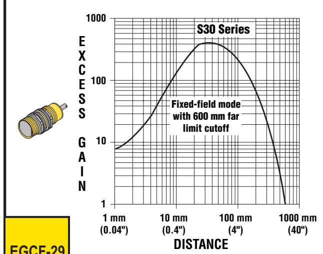
S30



EGCF-28

Cutoff: 400 mm | LED: ○ | Pg. 122

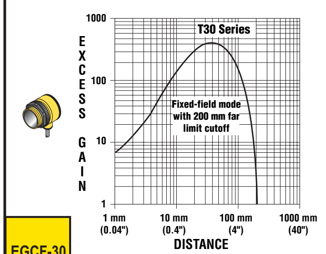
S30



EGCF-29

Cutoff: 600 mm | LED: ○ | Pg. 122

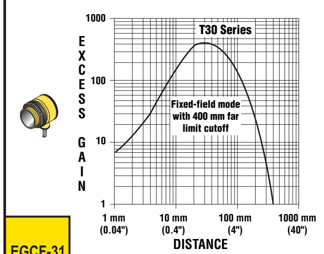
T30



EGCF-30

Cutoff: 200 mm | LED: ○ | Pg. 130

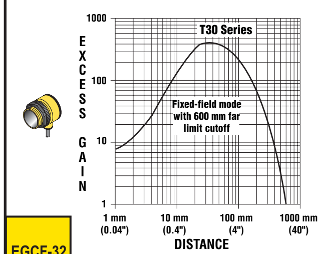
T30



EGCF-31

Cutoff: 400 mm | LED: ○ | Pg. 130

T30

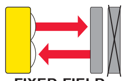


EGCF-32

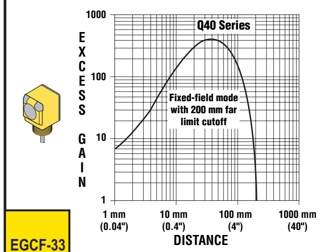
Cutoff: 600 mm | LED: ○ | Pg. 130

Fixed-Field Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED



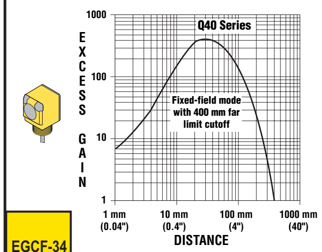
Q40



EGCF-33

Cutoff: 200 mm	LED: ○	Pg. 134

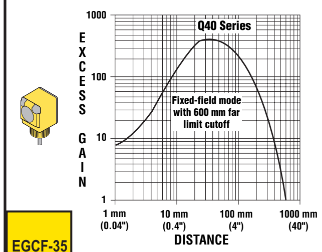
Q40



EGCF-34

Cutoff: 400 mm	LED: ○	Pg. 134

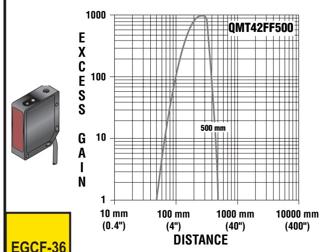
Q40



EGCF-35

Cutoff: 600 mm	LED: ○	Pg. 134

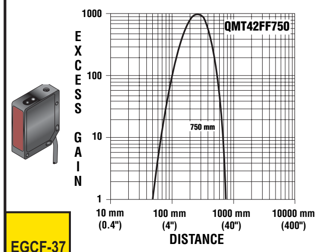
QMT42



EGCF-36

Cutoff: 500 mm	LED: ○	Pg. 141

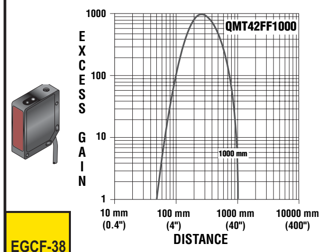
QMT42



EGCF-37

Cutoff: 750 mm	LED: ○	Pg. 141

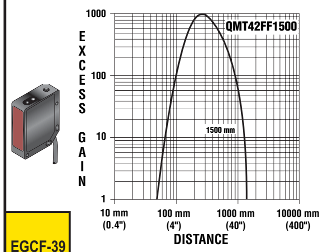
QMT42



EGCF-38

Cutoff: 1000 mm	LED: ○	Pg. 141

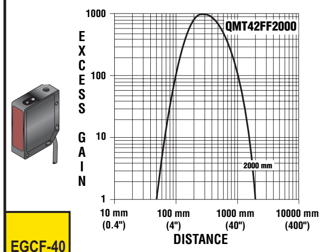
QMT42



EGCF-39

Cutoff: 1500 mm	LED: ○	Pg. 141

QMT42



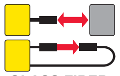
EGCF-40

Cutoff: 2000 mm	LED: ○	Pg. 141

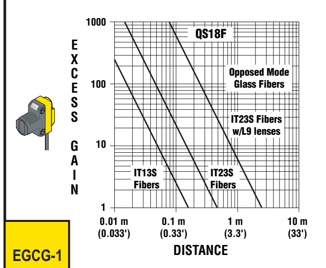
iKNOW®
PERFORMANCE CURVES
HOOKUP DIAGRAMS
GLOSSARY
INTERNATIONAL REPS

Glass Fiber Optic Mode (Performance based on 90% reflectance white test card)

⭕ = Infrared LED
🔴 = Visible Red LED
🟢 = Visible Green LED
🔵 = Visible Blue LED
○ = Visible White LED



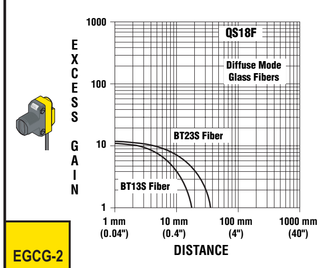
WORLD-BEAM® QS18



EGCG-1

Fiber: Individual	LED: ⭕	Pg. 74

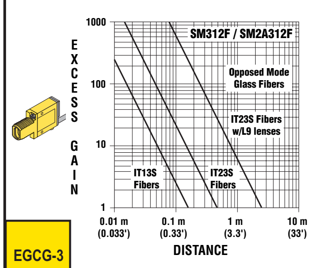
WORLD-BEAM® QS18



EGCG-2

Fiber: Bifurcated	LED: ⭕	Pg. 74

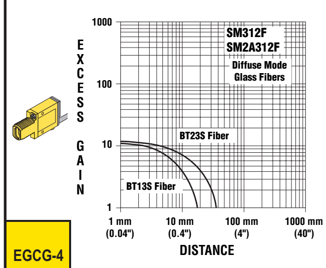
MINI-BEAM®



EGCG-3

Fiber: Individual	LED: ⭕	Pg. 81

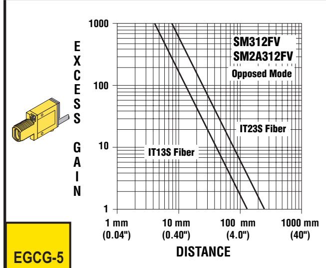
MINI-BEAM®



EGCG-4

Fiber: Bifurcated	LED: ⭕	Pg. 81

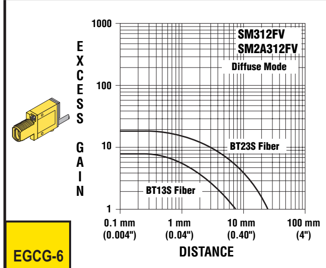
MINI-BEAM®



EGCG-5

Fiber: Individual	LED: 🔴	Pg. 81

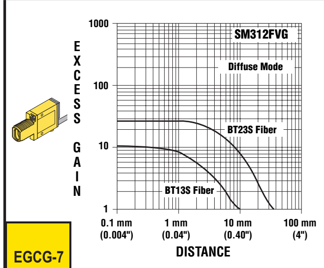
MINI-BEAM®



EGCG-6

Fiber: Bifurcated	LED: 🔴	Pg. 81

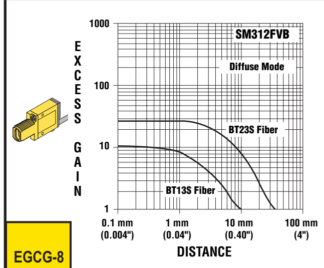
MINI-BEAM®



EGCG-7

Fiber: Bifurcated	LED: 🟢	Pg. 81

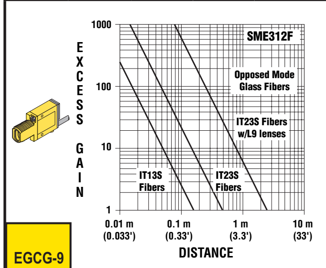
MINI-BEAM®



EGCG-8

Fiber: Bifurcated	LED: 🔵	Pg. 81

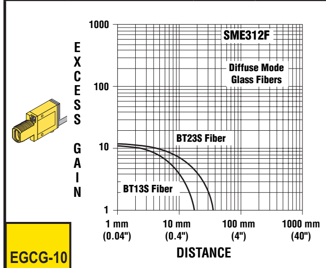
MINI-BEAM® *Expert*™



EGCG-9

Fiber: Individual	LED: ⭕	Pg. 86

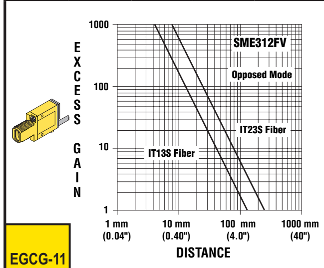
MINI-BEAM® *Expert*™



EGCG-10

Fiber: Bifurcated	LED: ⭕	Pg. 86

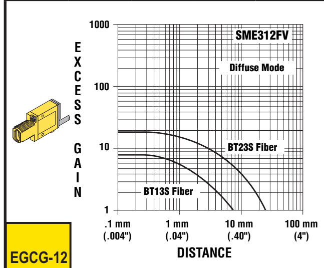
MINI-BEAM® *Expert*™



EGCG-11

Fiber: Individual	LED: 🔴	Pg. 86

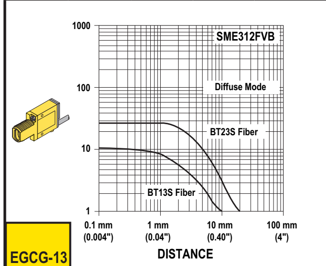
MINI-BEAM® *Expert*™



EGCG-12

Fiber: Bifurcated	LED: 🔴	Pg. 86

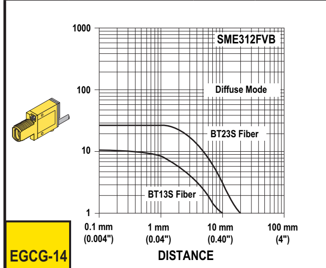
MINI-BEAM® *Expert*™



EGCG-13

Fiber: Bifurcated	LED: 🟢	Pg. 86

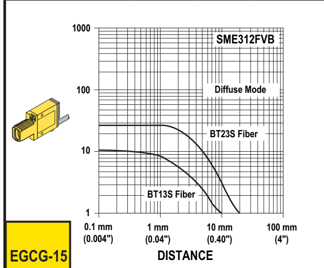
MINI-BEAM® *Expert*™



EGCG-14

Fiber: Bifurcated	LED: 🔵	Pg. 86

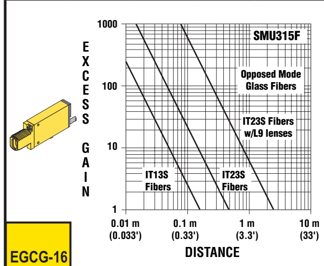
MINI-BEAM® *Expert*™



EGCG-15

Fiber: Bifurcated	LED: ○	Pg. 86

MINI-BEAM® Universal

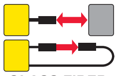


EGCG-16

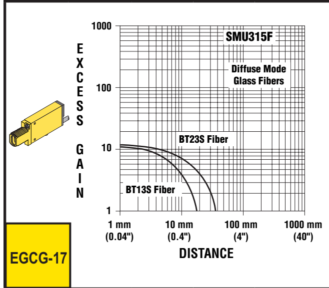
Fiber: Individual	LED: ⭕	Pg. 89

Glass Fiber Optic Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



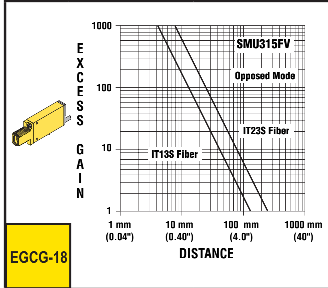
MINI-BEAM® Universal



EGCG-17

Fiber: Bifurcated | LED: ○ | Pg. 89

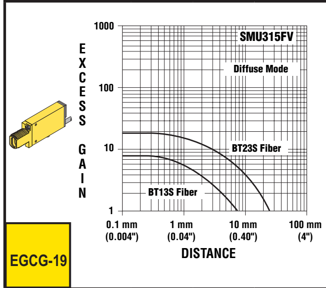
MINI-BEAM® Universal



EGCG-18

Fiber: Individual | LED: ● | Pg. 89

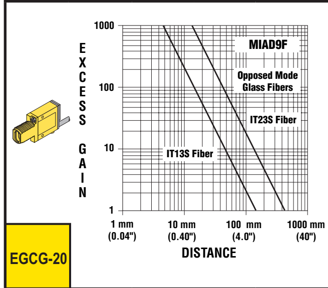
MINI-BEAM® Universal



EGCG-19

Fiber: Bifurcated | LED: ● | Pg. 89

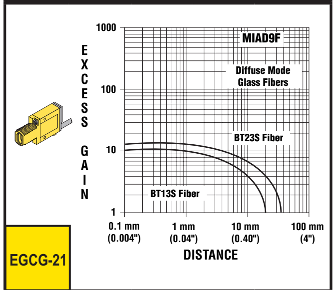
MINI-BEAM® NAMUR



EGCG-20

Fiber: Individual | LED: ○ | Pg. 90

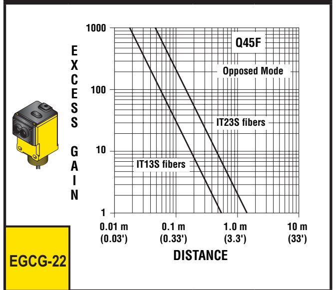
MINI-BEAM® NAMUR



EGCG-21

Fiber: Bifurcated | LED: ○ | Pg. 90

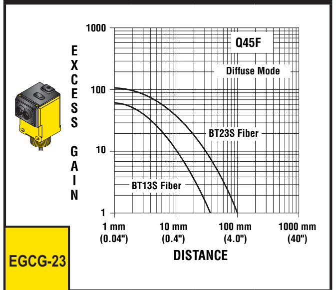
Q45



EGCG-22

Fiber: Individual | LED: ○ | Pg. 148

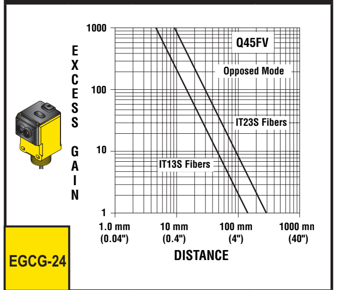
Q45



EGCG-23

Fiber: Bifurcated | LED: ○ | Pg. 148

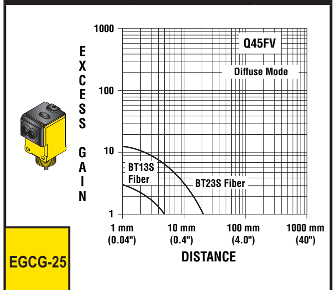
Q45



EGCG-24

Fiber: Individual | LED: ● | Pg. 148

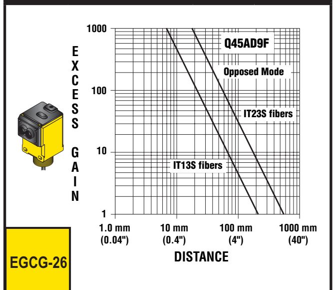
Q45



EGCG-25

Fiber: Bifurcated | LED: ● | Pg. 148

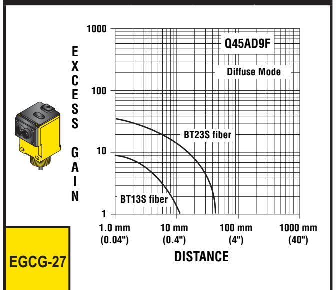
Q45 NAMUR



EGCG-26

Fiber: Individual | LED: ○ | Pg. 158

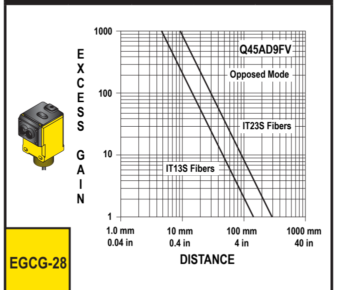
Q45 NAMUR



EGCG-27

Fiber: Bifurcated | LED: ○ | Pg. 158

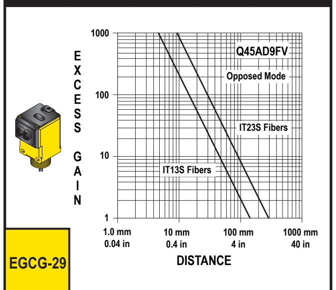
Q45 NAMUR



EGCG-28

Fiber: Individual | LED: ● | Pg. 158

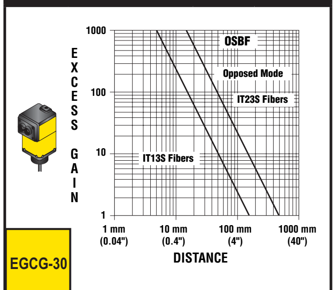
Q45 NAMUR



EGCG-29

Fiber: Bifurcated | LED: ● | Pg. 158

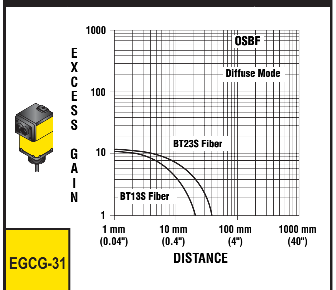
OMNI-BEAM™



EGCG-30

Fiber: Individual | LED: ○ | Pg. 161

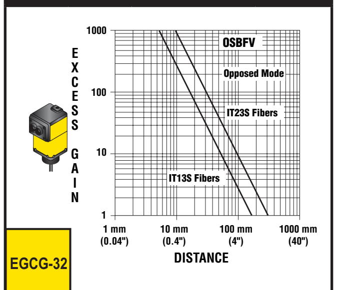
OMNI-BEAM™



EGCG-31

Fiber: Bifurcated | LED: ○ | Pg. 161

OMNI-BEAM™

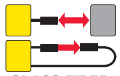


EGCG-32

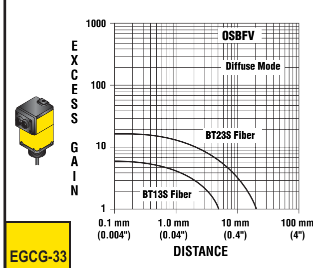
Fiber: Individual | LED: ● | Pg. 161

Glass Fiber Optic Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● (red) = Visible Red LED
● (green) = Visible Green LED
● (blue) = Visible Blue LED



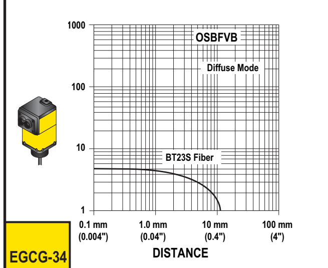
OMNI-BEAM™



EGCG-33

Fiber: Bifurcated | **LED:** ● (red) | Pg. 161

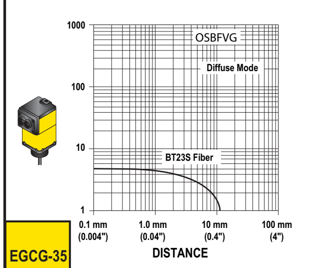
OMNI-BEAM™



EGCG-34

Fiber: Bifurcated | **LED:** ● (blue) | Pg. 161

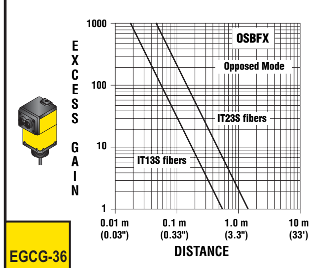
OMNI-BEAM™



EGCG-35

Fiber: Bifurcated | **LED:** ● (green) | Pg. 161

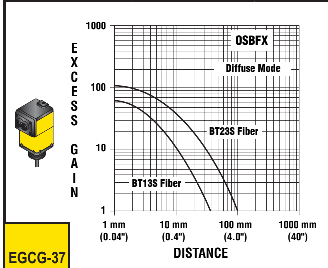
OMNI-BEAM™ High Power



EGCG-36

Fiber: Individual | **LED:** ○ | Pg. 161

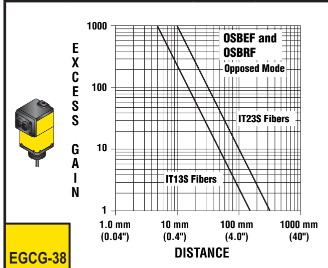
OMNI-BEAM™ High Power



EGCG-37

Fiber: Bifurcated | **LED:** ○ | Pg. 161

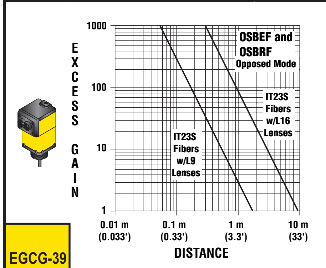
OMNI-BEAM™ Emitter/Receiver



EGCG-38

Fiber: Individual | **LED:** ○ | Pg. 161

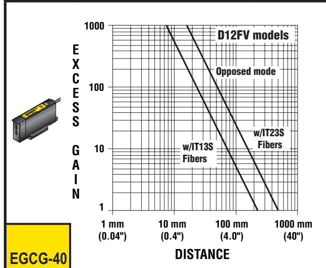
OMNI-BEAM™ Emitter/Receiver



EGCG-39

Fiber: Individual | **LED:** ○ | Pg. 161

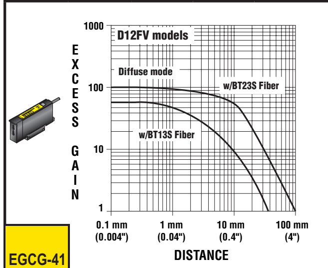
D12 Standard



EGCG-40

Fiber: Individual | **LED:** ● (red) | Pg. 179

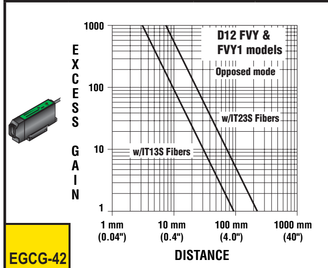
D12 Standard



EGCG-41

Fiber: Bifurcated | **LED:** ● (red) | Pg. 179

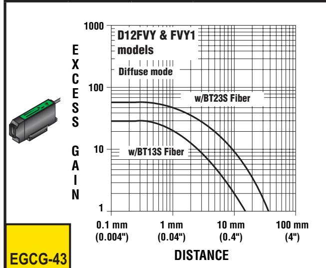
D12 High Speed



EGCG-42

Fiber: Individual | **LED:** ● (red) | Pg. 179

D12 High Speed

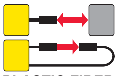


EGCG-43

Fiber: Bifurcated | **LED:** ● (red) | Pg. 179

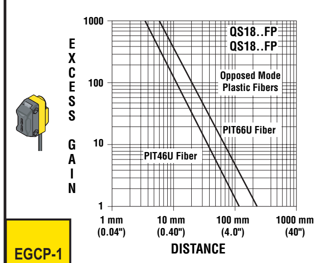
Plastic Fiber Optic Mode (Performance based on 90% reflectance white test card)

🔴 = Visible Red LED
🟢 = Visible Green LED
🔵 = Visible Blue LED
⚪ = Visible White LED



PLASTIC FIBER

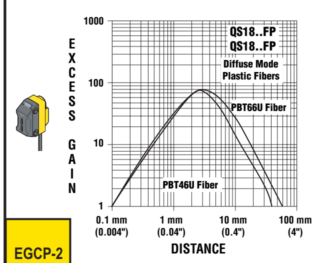
WORLD-BEAM® QS18



EGCP-1

Fiber: Individual | **LED:** 🔴 | Pg. 74

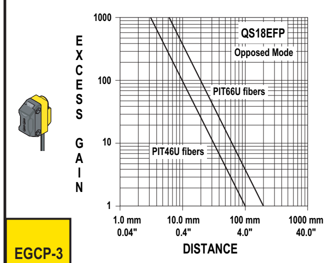
WORLD-BEAM® QS18



EGCP-2

Fiber: Bifurcated | **LED:** 🔴 | Pg. 74

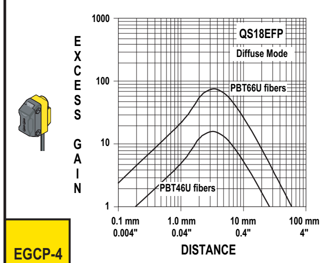
WORLD-BEAM® QS18 *Expert*™



EGCP-3

Fiber: Individual | **LED:** 🔴 | Pg. 77

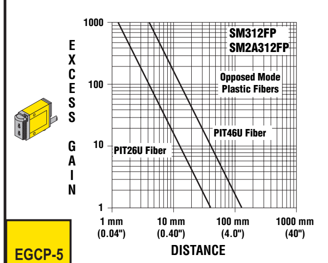
WORLD-BEAM® QS18 *Expert*™



EGCP-4

Fiber: Bifurcated | **LED:** 🔴 | Pg. 77

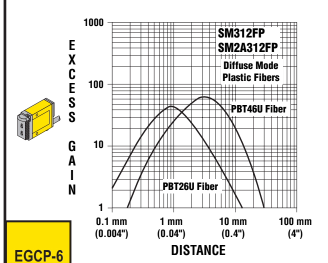
MINI-BEAM®



EGCP-5

Fiber: Individual | **LED:** 🔴 | Pg. 81

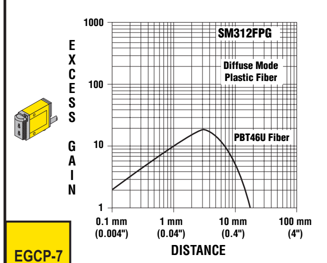
MINI-BEAM®



EGCP-6

Fiber: Bifurcated | **LED:** 🔴 | Pg. 81

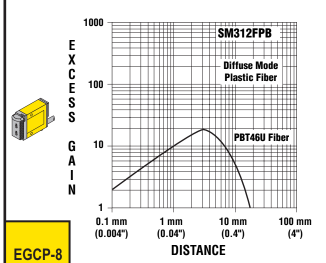
MINI-BEAM®



EGCP-7

Fiber: Bifurcated | **LED:** 🟢 | Pg. 81

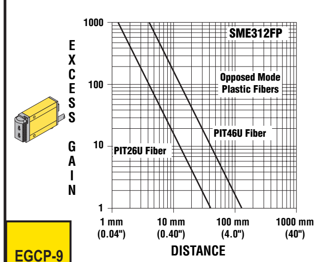
MINI-BEAM®



EGCP-8

Fiber: Bifurcated | **LED:** 🔵 | Pg. 81

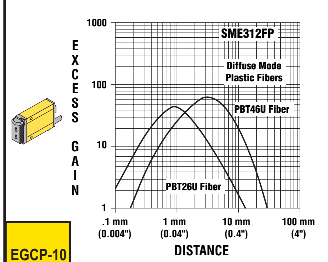
MINI-BEAM® *Expert*™



EGCP-9

Fiber: Individual | **LED:** 🔴 | Pg. 86

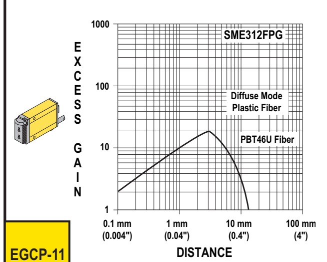
MINI-BEAM® *Expert*™



EGCP-10

Fiber: Bifurcated | **LED:** 🔴 | Pg. 86

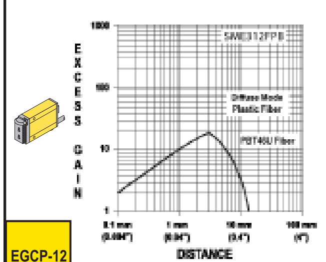
MINI-BEAM® *Expert*™



EGCP-11

Fiber: Bifurcated | **LED:** 🟢 | Pg. 86

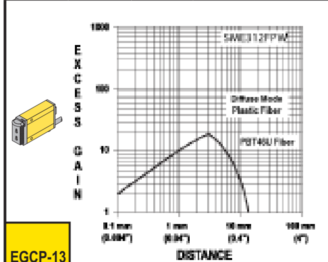
MINI-BEAM® *Expert*™



EGCP-12

Fiber: Bifurcated | **LED:** 🔵 | Pg. 86

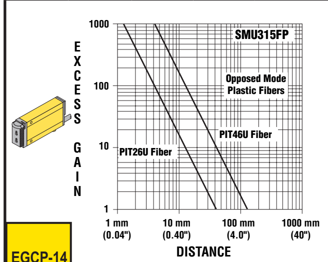
MINI-BEAM® *Expert*™



EGCP-13

Fiber: Bifurcated | **LED:** ⚪ | Pg. 86

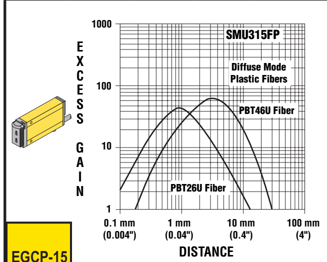
MINI-BEAM® Universal



EGCP-14

Fiber: Individual | **LED:** 🔴 | Pg. 89

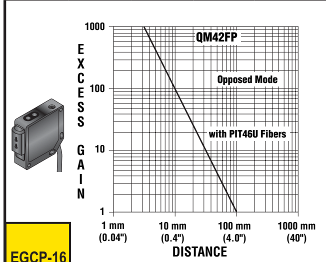
MINI-BEAM® Universal



EGCP-15

Fiber: Bifurcated | **LED:** 🔴 | Pg. 89

QM42



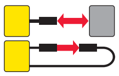
EGCP-16

Fiber: Individual | **LED:** 🔴 | Pg. 142

iKNOW®
PERFORMANCE CURVES
HOOKUP DIAGRAMS
GLOSSARY
INTERNATIONAL REPS

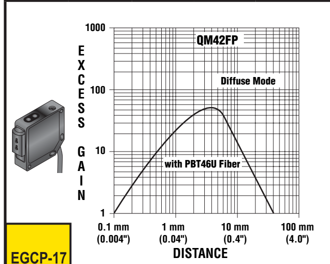
Plastic Fiber Optic Mode (Performance based on 90% reflectance white test card)

🔴 = Visible Red LED
🟢 = Visible Green LED
🔵 = Visible Blue LED



PLASTIC FIBER

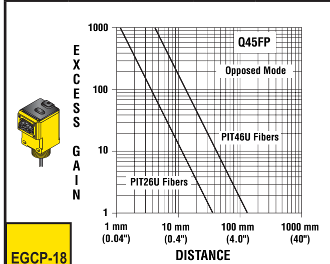
QM42



EGCP-17

Fiber: Bifurcated | **LED:** 🔴 | Pg. 142

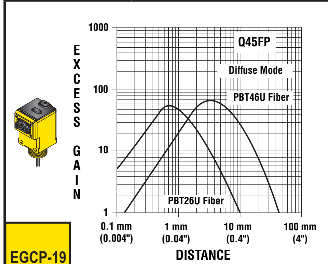
Q45



EGCP-18

Fiber: Individual | **LED:** 🔴 | Pg. 148

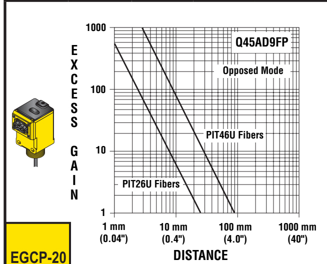
Q45



EGCP-19

Fiber: Bifurcated | **LED:** 🔴 | Pg. 148

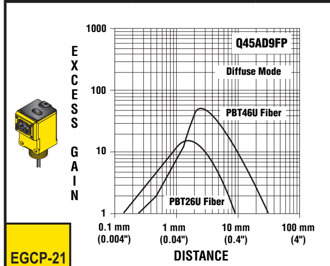
Q45 NAMUR



EGCP-20

Fiber: Individual | **LED:** 🔴 | Pg. 158

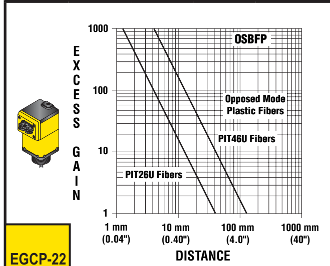
Q45 NAMUR



EGCP-21

Fiber: Bifurcated | **LED:** 🔴 | Pg. 158

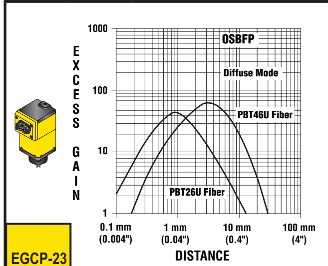
OMNI-BEAM™



EGCP-22

Fiber: Bifurcated | **LED:** 🔴 | Pg. 161

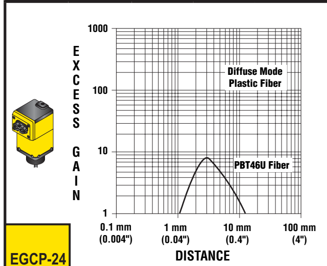
OMNI-BEAM™



EGCP-23

Fiber: Bifurcated | **LED:** 🔴 | Pg. 161

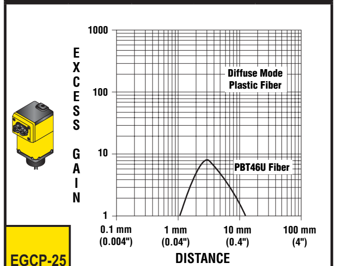
OMNI-BEAM™



EGCP-24

Fiber: Bifurcated | **LED:** 🔵 | Pg. 161

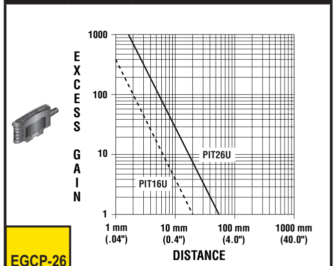
OMNI-BEAM™



EGCP-25

Fiber: Bifurcated | **LED:** 🟢 | Pg. 161

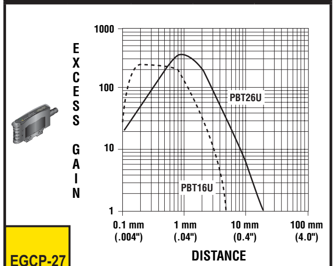
D10 *Expert*™ with Bargraph Display



EGCP-26

Fiber: Individual | **LED:** 🔴 | Pg. 174

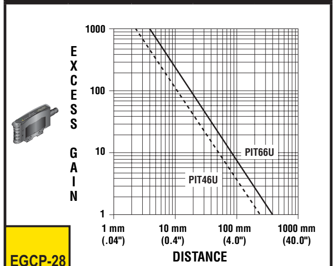
D10 *Expert*™ with Bargraph Display



EGCP-27

Fiber: Bifurcated | **LED:** 🔴 | Pg. 174

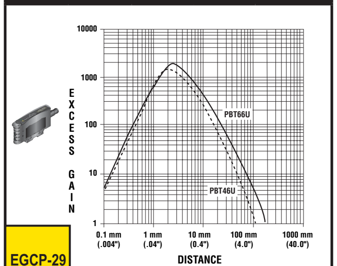
D10 *Expert*™ with Bargraph Display



EGCP-28

Fiber: Individual | **LED:** 🔴 | Pg. 174

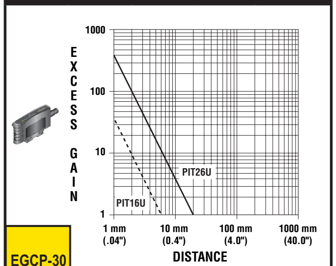
D10 *Expert*™ with Bargraph Display



EGCP-29

Fiber: Bifurcated | **LED:** 🔴 | Pg. 174

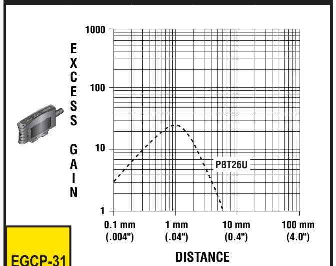
D10 *Expert*™ with Bargraph Display



EGCP-30

Fiber: Individual | **LED:** 🟢 | Pg. 174

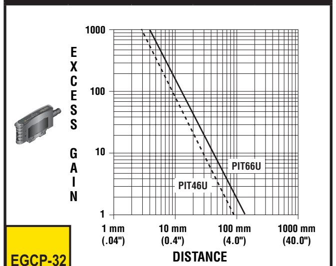
D10 *Expert*™ with Bargraph Display



EGCP-31

Fiber: Bifurcated | **LED:** 🟢 | Pg. 174

D10 *Expert*™ with Bargraph Display



EGCP-32

Fiber: Individual | **LED:** 🟢 | Pg. 174

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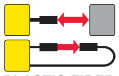
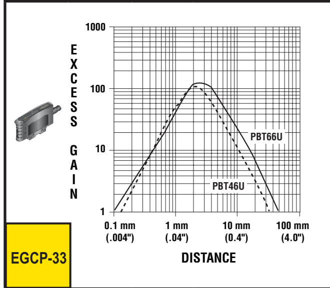
Plastic Fiber Optic Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
● = Visible Green LED

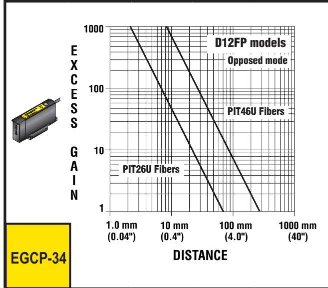


D10 *Expert*™ with Bargraph Display



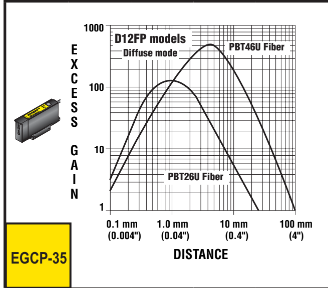
Fiber: Bifurcated | **LED:** ● (green) | Pg. 174

D12 Standard



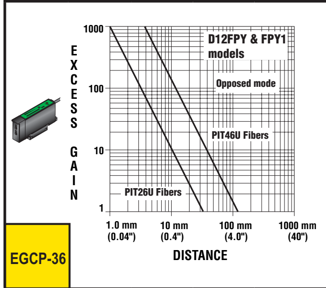
Fiber: Individual | **LED:** ● (red) | Pg. 179

D12 Standard



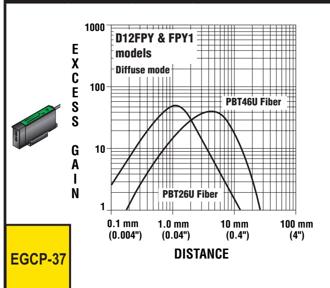
Fiber: Bifurcated | **LED:** ● (red) | Pg. 179

D12 High Speed



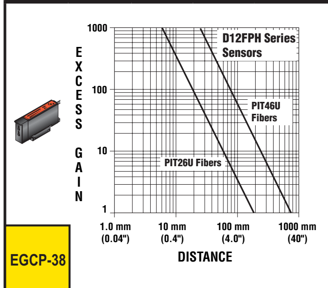
Fiber: Individual | **LED:** ● (red) | Pg. 179

D12 High Speed



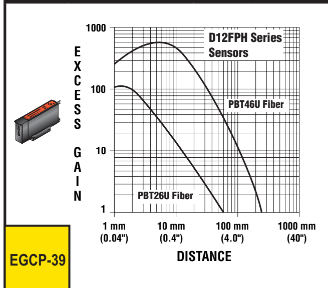
Fiber: Bifurcated | **LED:** ● (red) | Pg. 179

D12 High Power



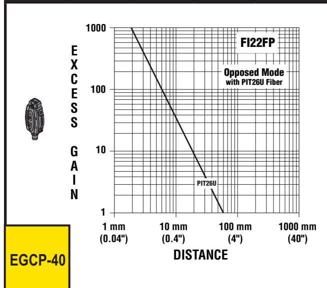
Fiber: Individual | **LED:** ● (red) | Pg. 180

D12 High Power



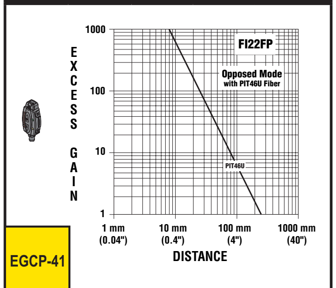
Fiber: Bifurcated | **LED:** ● (red) | Pg. 180

FI22 with PIT26U Fiber



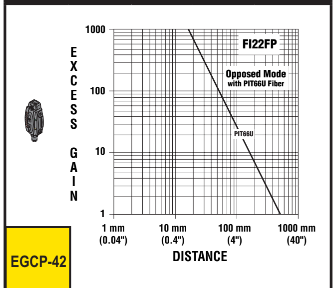
Fiber: Individual | **LED:** ● (red) | Pg. 187

FI22 with PIT46U Fiber



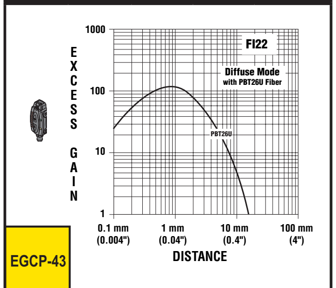
Fiber: Individual | **LED:** ● (red) | Pg. 187

FI22 with PIT66U Fiber



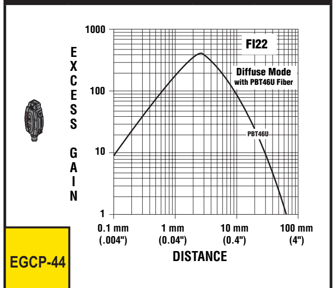
Fiber: Individual | **LED:** ● (red) | Pg. 187

FI22 with PBT26U Fiber



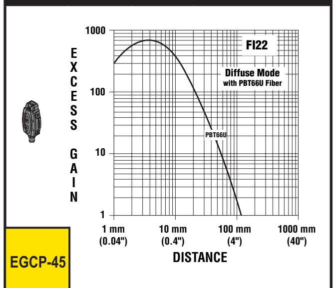
Fiber: Bifurcated | **LED:** ● (red) | Pg. 187

FI22 with PBT46U Fiber



Fiber: Bifurcated | **LED:** ● (red) | Pg. 187

FI22 with PBT66U Fiber



Fiber: Bifurcated | **LED:** ● (red) | Pg. 187

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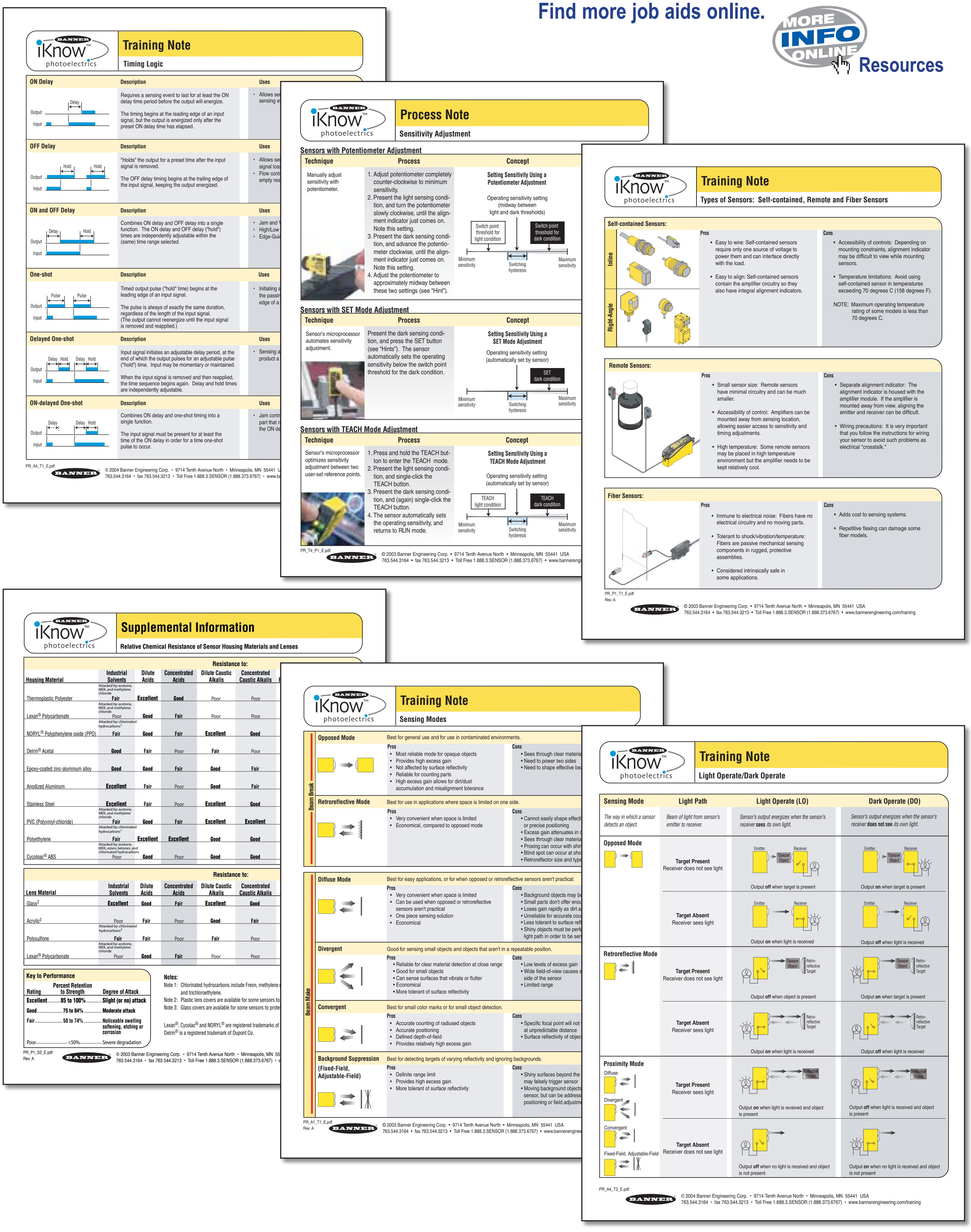

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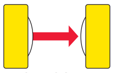
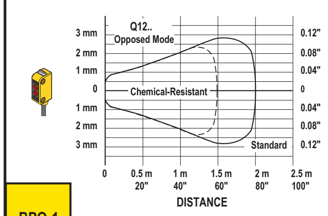
Opposed Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



WORLD-BEAM® Q12

Effective Beam: 5.7 mm

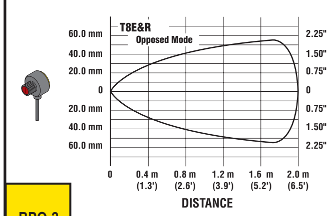


BPO-1

Range: 2 m | **LED:** ● | Pg. 47

T8

Effective Beam: 4.3 mm

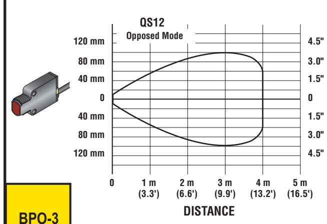


BPO-2

Range: 2 m | **LED:** ● | Pg. 50

MINI-BEAM® 2 QS12

Effective Beam: 5 mm

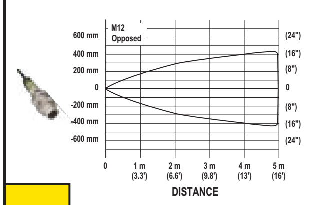


BPO-3

Range: 4 m | **LED:** ● | Pg. 53

M12

Effective Beam: 10 mm

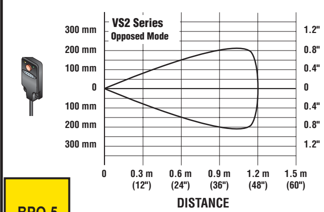


BPO-4

Range: 5 m | **LED:** ● | Pg. 56

VS2

Effective Beam: 3 mm

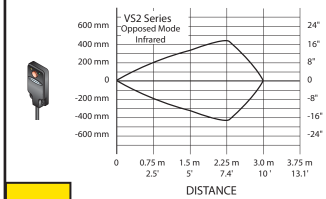


BPO-5

Range: 1.2 m | **LED:** ● | Pg. 62

VS2

Effective Beam: 3 mm

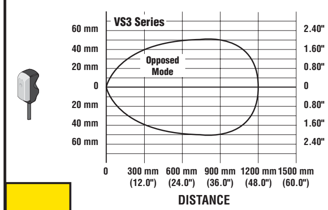


BPO-6

Range: 3 m | **LED:** ○ | Pg. 62

VS3

Effective Beam: 3 mm

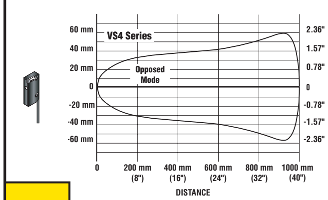


BPO-7

Range: 1.2 m | **LED:** ● | Pg. 65

VS4

Effective Beam: 3 mm

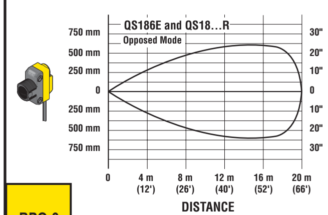


BPO-8

Range: 1 m | **LED:** ● | Pg. 68

WORLD-BEAM® QS18

Effective Beam: 13 mm

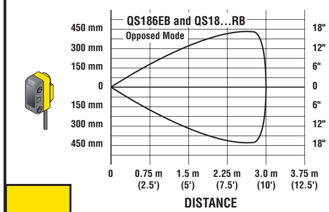


BPO-9

Range: 20 m | **LED:** ○ | Pg. 71

WORLD-BEAM® QS18

Effective Beam: 13 mm

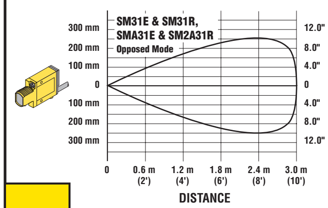


BPO-10

Range: 3 m | **LED:** ○ | Pg. 71

MINI-BEAM®

Effective Beam: 3.5 mm

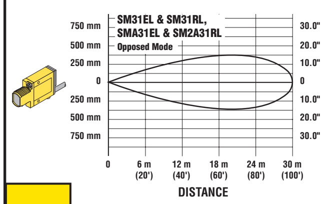


BPO-11

Range: 3 m | **LED:** ○ | Pg. 80

MINI-BEAM®

Effective Beam: 13 mm

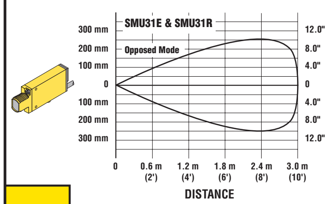


BPO-12

Range: 30 m | **LED:** ○ | Pg. 80

MINI-BEAM® Universal

Effective Beam: 3.5 mm

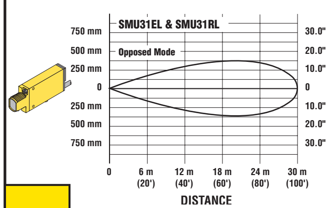


BPO-13

Range: 3 m | **LED:** ○ | Pg. 88

MINI-BEAM® Universal

Effective Beam: 13 mm

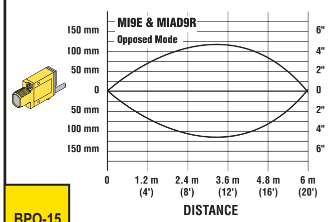


BPO-14

Range: 30 m | **LED:** ○ | Pg. 88

MINI-BEAM® NAMUR

Effective Beam: 13 mm

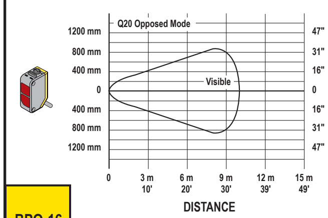


BPO-15

Range: 6 m | **LED:** ○ | Pg. 90

WORLD-BEAM® Q20

Effective Beam: 10 mm

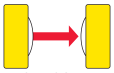


BPO-16

Range: 10 m | **LED:** ● | Pg. 93

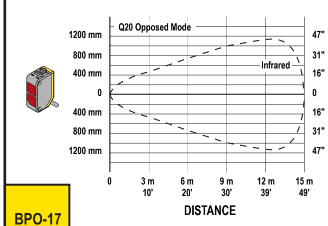
Opposed Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED



WORLD-BEAM® Q20

Effective Beam: 10 mm

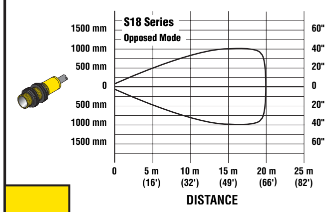


BPO-17

Range: 15 m | **LED:** ○ | Pg. 93

S18

Effective Beam: 13 mm

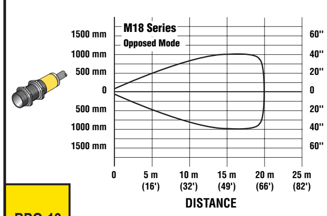


BPO-18

Range: 20 m | **LED:** ○ | Pg. 96

M18

Effective Beam: 13 mm

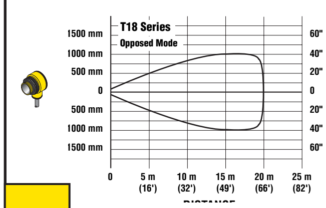


BPO-19

Range: 20 m | **LED:** ○ | Pg. 97

T18

Effective Beam: 13 mm

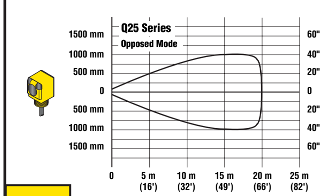


BPO-20

Range: 20 m | **LED:** ○ | Pg. 102

Q25

Effective Beam: 23 mm

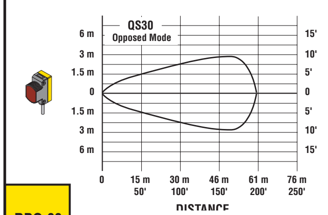


BPO-21

Range: 20 m | **LED:** ○ | Pg. 107

WORLD-BEAM® QS30

Effective Beam: 13 mm

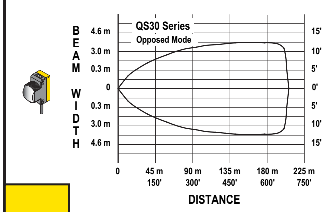


BPO-22

Range: 60 m | **LED:** ○ | Pg. 113

WORLD-BEAM® QS30 High Power

Effective Beam: 18 mm

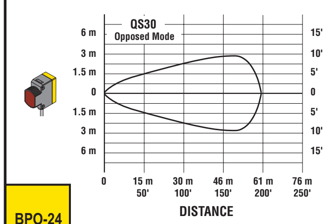


BPO-23

Range: 213 m | **LED:** ○ | Pg. 113

WORLD-BEAM® QS30 Universal

Effective Beam: 27 mm

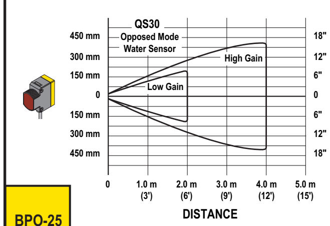


BPO-24

Range: 60 m | **LED:** ○ | Pg. 119

WORLD-BEAM® QS30 High-Power Water

Effective Beam: 13 mm

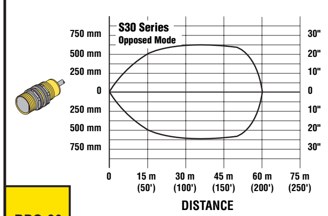


BPO-25

Range: 4 m | **LED:** ○ | Pg. 113

S30

Effective Beam: 23 mm

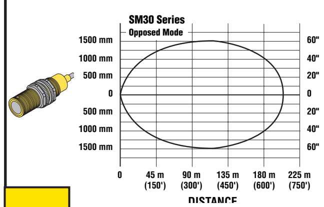


BPO-26

Range: 60 m | **LED:** ○ | Pg. 122

SM30

Effective Beam: 19 mm

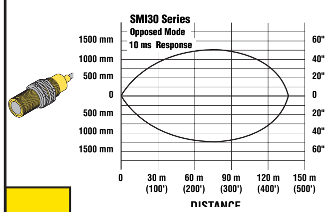


BPO-27

Range: 200 m | **LED:** ○ | Pg. 126

SMI30

Effective Beam: 19 mm

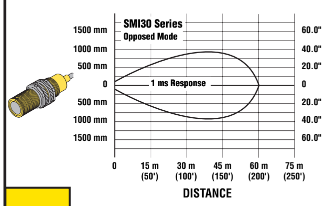


BPO-28

Range: 140 m | **LED:** ○ | Pg. 128

SMI30

Effective Beam: 22 mm

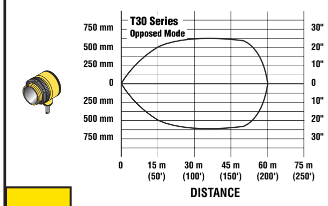


BPO-29

Range: 60 m | **LED:** ○ | Pg. 128

T30

Effective Beam: 23 mm

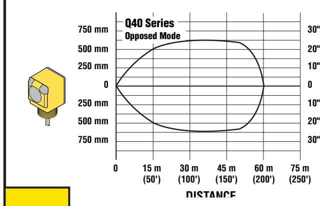


BPO-30

Range: 60 m | **LED:** ○ | Pg. 130

Q40

Effective Beam: 23 mm

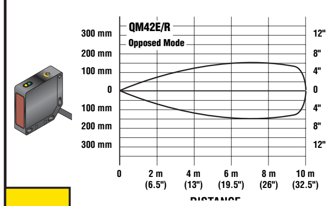


BPO-31

Range: 60 mm | **LED:** ○ | Pg. 134

QM42

Effective Beam: 8 mm



BPO-32

Range: 10 m | **LED:** ○ | Pg. 141

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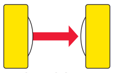
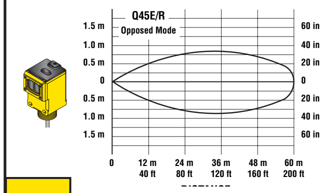
Opposed Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED



Q45

Effective Beam: 13 mm

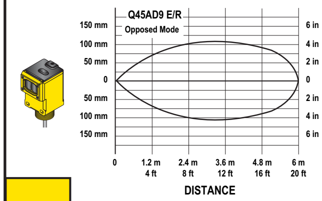


BPO-33

Range: 60 m	**LED:** ○	Pg. 147

Q45 NAMUR

Effective Beam: 13 mm

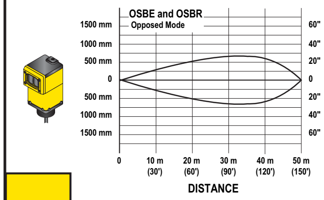


BPO-34

Range: 6 m	**LED:** ○	Pg. 157

OMNI-BEAM™

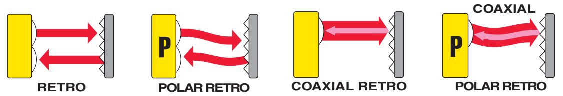
Effective Beam: 25 mm



BPO-35

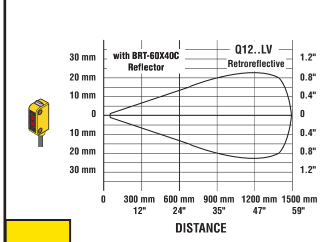
Range: 45 m	**LED:** ○	Pg. 160

Retroreflective Mode



● = Visible Red LED
P = Visible Red LED Polarized

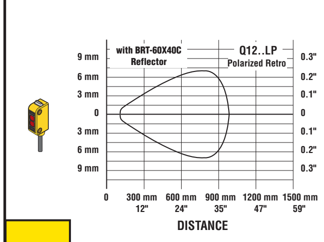
WORLD-BEAM® Q12



BPR-1

Range: 1.5 m | LED: ● | Pg. 47

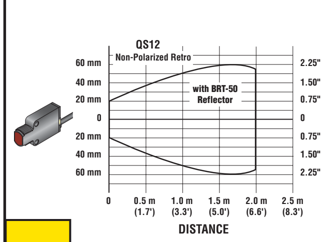
WORLD-BEAM® Q12



BPR-2

Range: 1 m | LED: P | Pg. 47

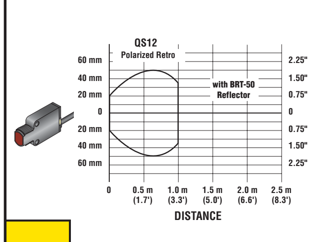
MINI-BEAM® QS12



BPR-3

Range: 2 m | LED: ● | Pg. 53

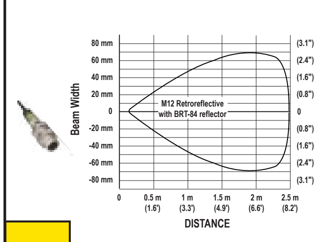
MINI-BEAM® QS12



BPR-4

Range: 1 m | LED: P | Pg. 53

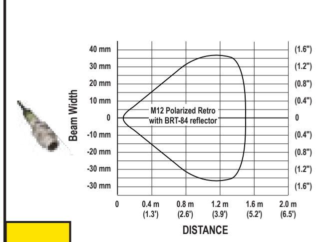
M12



BPR-5

Range: 2.5 m | LED: ● | Pg. 56

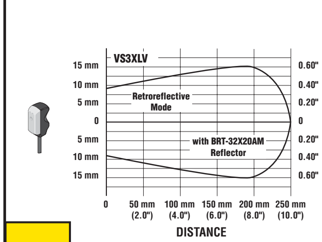
M12



BPR-6

Range: 1.5 m | LED: P | Pg. 56

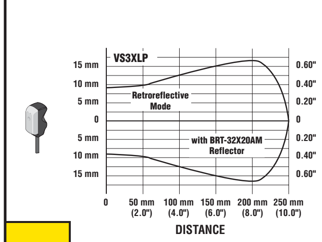
VS3



BPR-7

Range: 250 mm | LED: ● | Pg. 65

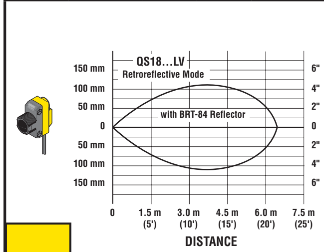
VS3



BPR-8

Range: 250 mm | LED: P | Pg. 65

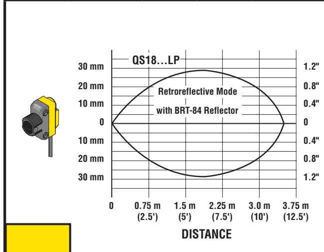
WORLD-BEAM® QS18



BPR-9

Range: 6.5 m | LED: ● | Pg. 72

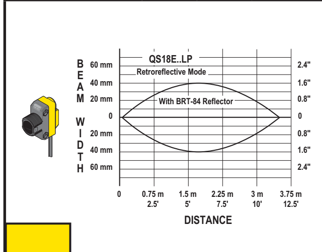
WORLD-BEAM® QS18



BPR-10

Range: 3.5 m | LED: P | Pg. 72

WORLD-BEAM® QS18 *Expert*™



BPR-11

Range: 3.5 m | LED: P | Pg. 76

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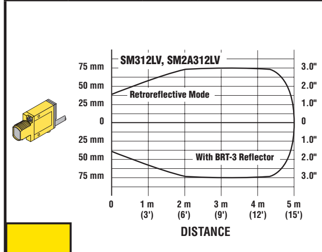
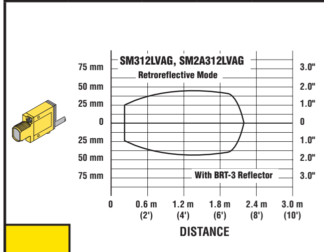


BPR-12

Range: 5 m | LED: ● | Pg. 80

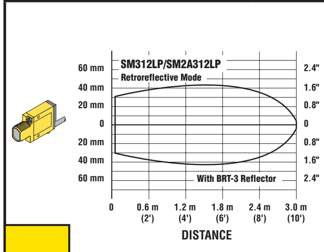
MINI-BEAM®



BPR-13

Range: 2 m | LED: P | Pg. 80

MINI-BEAM®



BPR-14

Range: 3 m | LED: P | Pg. 80

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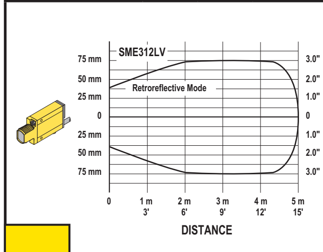
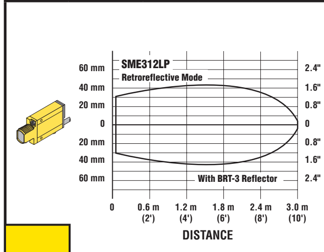


BPR-15

Range: 5 m | LED: ● | Pg. 85

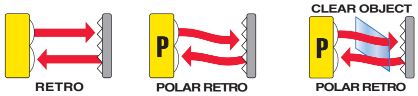
MINI-BEAM® *Expert*™



BPR-16

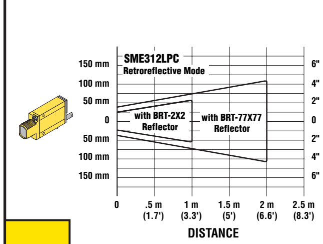
Range: 3 m | LED: ● | Pg. 85

Retroreflective Mode



○ = Infrared LED
● = Visible Red LED
P = Visible Red LED Polarized
■ = Visible Red Clear Object Detection Polarized

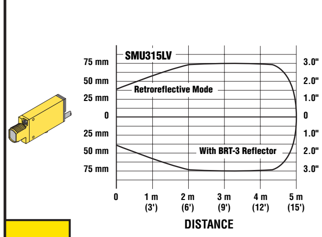
MINI-BEAM® *Expert*™



BPR-17

Range: 1 m	LED: ■	Pg. 85

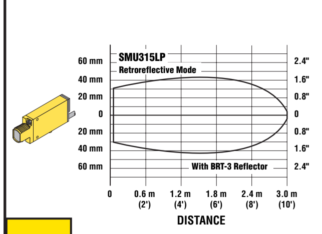
MINI-BEAM® Universal



BPR-18

Range: 5 m	LED: ●	Pg. 88

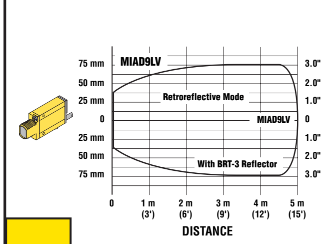
MINI-BEAM® Universal



BPR-19

Range: 3 m	LED: P	Pg. 88

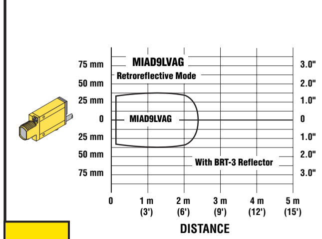
MINI-BEAM® NAMUR



BPR-20

Range: 5 m	LED: ●	Pg. 90

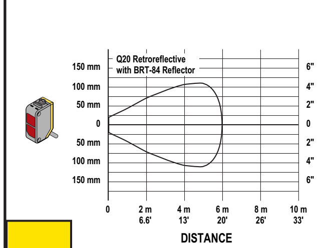
MINI-BEAM® NAMUR



BPR-21

Range: 2 mm	LED: P	Pg. 90

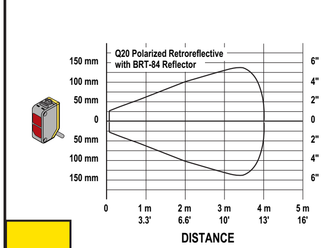
WORLD-BEAM® Q20



BPR-22

Range: 6 m	LED: ●	Pg. 93

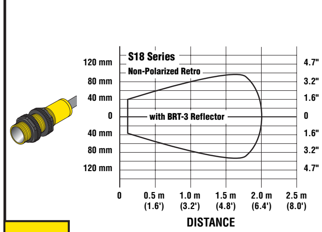
WORLD-BEAM® Q20



BPR-23

Range: 4 m	LED: P	Pg. 93

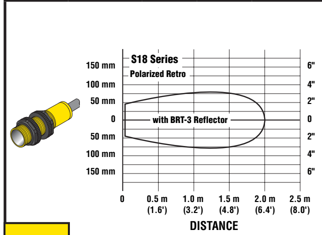
S18



BPR-24

Range: 2 m	LED: ○	Pg. 96

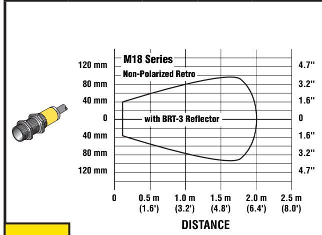
S18



BPR-25

Range: 2 m	LED: P	Pg. 96

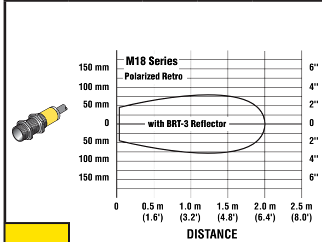
M18



BPR-26

Range: 2 m	LED: ○	Pg. 97

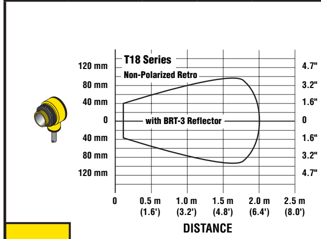
M18



BPR-27

Range: 2 m	LED: P	Pg. 97

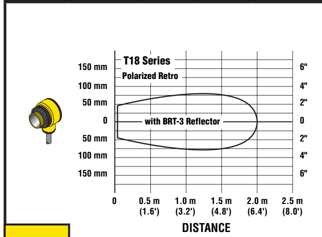
T18



BPR-28

Range: 2 m	LED: ○	Pg. 102

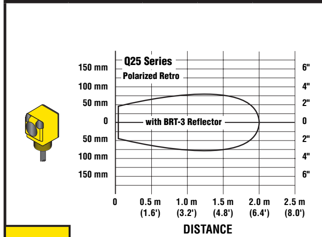
T18



BPR-29

Range: 2 m	LED: P	Pg. 102

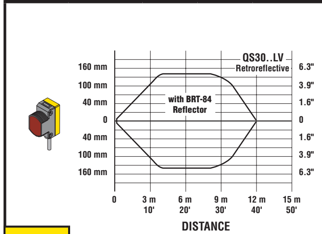
Q25



BPR-30

Range: 2 m	LED: P	Pg. 107

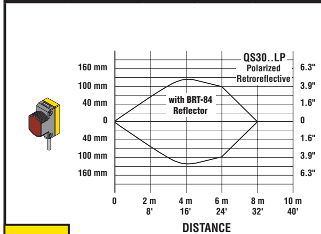
WORLD-BEAM® QS30



BPR-31

Range: 12 m	LED: ●	Pg. 114

WORLD-BEAM® QS30



BPR-32

Range: 8 m	LED: P	Pg. 114

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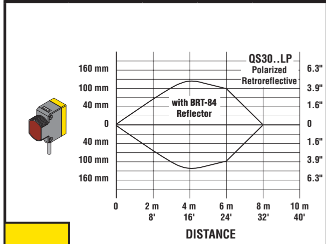
Retroreflective Mode

● = Visible Red LED
P = Visible Red LED Polarized
✸ = Visible Red Laser LED

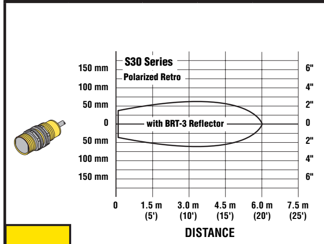
WORLD-BEAM® QS30 Universal



BPR-33

Range: 8 m | **LED:** P | Pg. 119

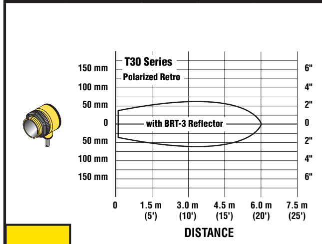
S30



BPR-34

Range: 6 m | **LED:** P | Pg. 122

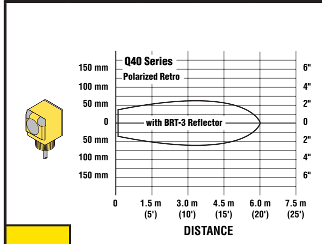
T30



BPR-35

Range: 6 m | **LED:** P | Pg. 130

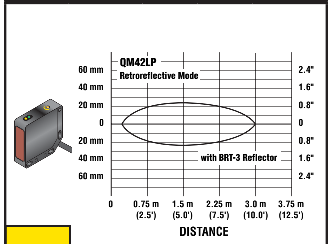
Q40



BPR-36

Range: 6 m | **LED:** P | Pg. 134

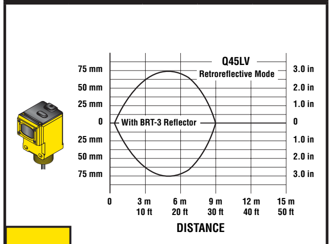
QM42



BPR-37

Range: 3 m | **LED:** P | Pg. 141

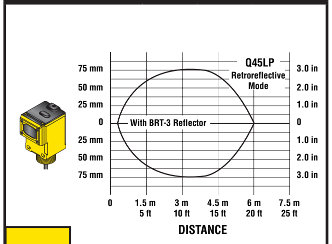
Q45



BPR-38

Range: 9 m | **LED:** ● | Pg. 147

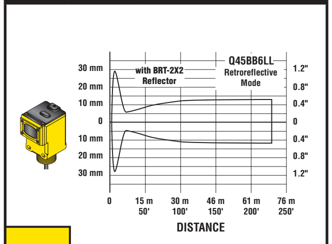
Q45



BPR-39

Range: 6 m | **LED:** P | Pg. 147

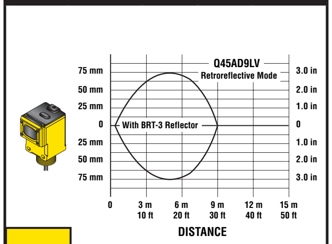
Q45 Class 2 Laser



BPR-40

Range: 70 m | **LED:** ✸ | Pg. 147

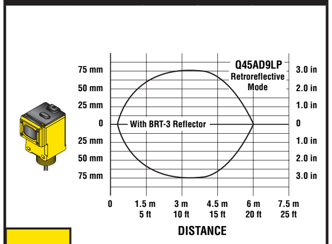
Q45 NAMUR



BPR-41

Range: 9 m | **LED:** ● | Pg. 157

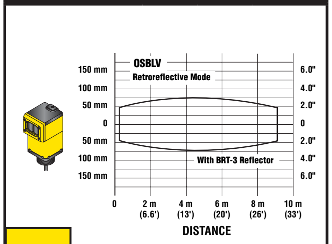
Q45 NAMUR



BPR-42

Range: 6 m | **LED:** P | Pg. 157

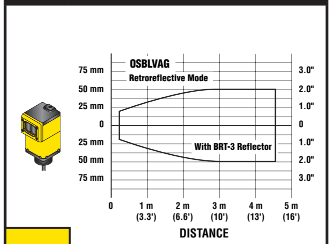
OMNI-BEAM™



BPR-43

Range: 9 m | **LED:** ● | Pg. 160

OMNI-BEAM™



BPR-44

Range: 4.5 m | **LED:** P | Pg. 160

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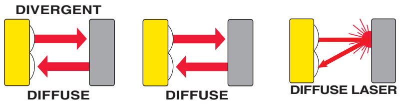
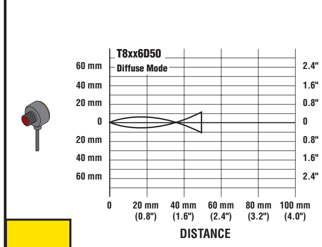
Diffuse Mode (Performance based on 90% reflectance white test card)



○ = Infrared LED
● = Visible Red LED
✸ = Visible Red Laser LED

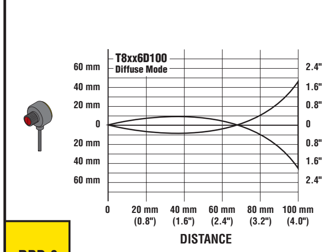
T8



BPD-1

Range: 50 mm | LED: ● | Pg. 50

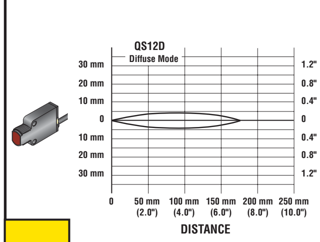
T8



BPD-2

Range: 100 mm | LED: ● | Pg. 50

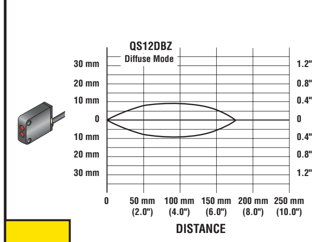
MINI-BEAM®2 QS12



BPD-3

Range: 180 mm | LED: ● | Pg. 53

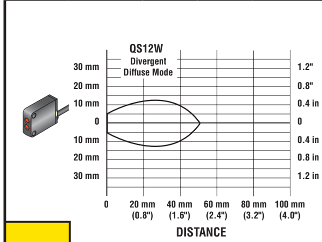
MINI-BEAM®2 QS12



BPD-4

Range: 180 mm | LED: ● | Pg. 53

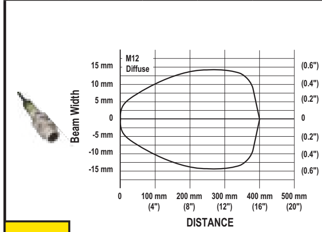
MINI-BEAM®2 QS12



BPD-5

Range: 50 mm | LED: ● | Pg. 53

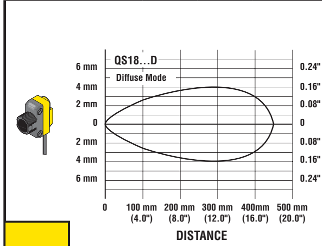
M12



BPD-6

Range: 400 mm | LED: ● | Pg. 56

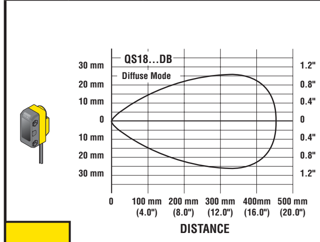
WORLD-BEAM® QS18



BPD-7

Range: 450 mm | LED: ○ | Pg. 73

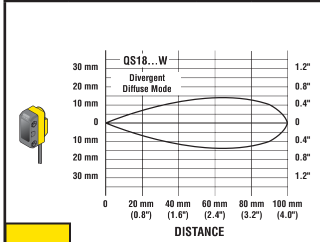
WORLD-BEAM® QS18



BPD-8

Range: 450 mm | LED: ○ | Pg. 73

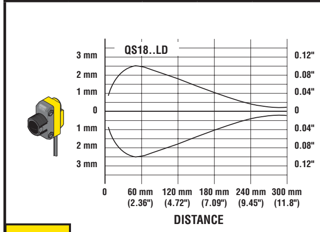
WORLD-BEAM® QS18



BPD-9

Range: 100 mm | LED: ○ | Pg. 73

WORLD-BEAM® QS18 Class 1 Laser



BPD-10

Range: 300 mm | LED: ✸ | Pg. 73

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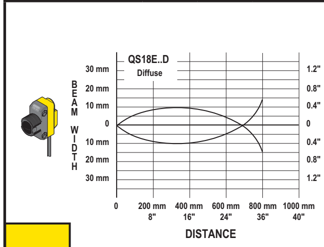
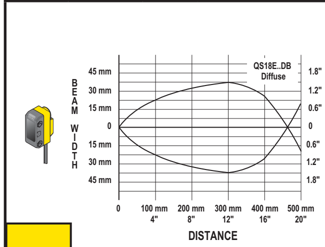


BPD-11

Range: 800 mm | LED: ○ | Pg. 76

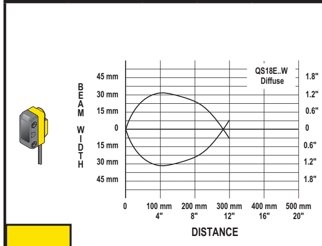
WORLD-BEAM® QS18 *Expert*™



BPD-12

Range: 500 mm | LED: ○ | Pg. 76

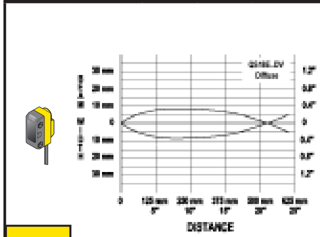
WORLD-BEAM® QS18 *Expert*™



BPD-13

Range: 300 mm | LED: ○ | Pg. 77

WORLD-BEAM® QS18 *Expert*™



BPD-14

Range: 600 mm | LED: ● | Pg. 77

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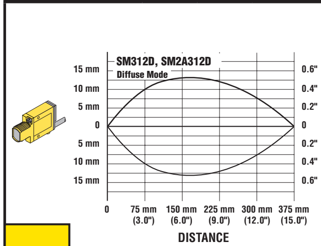
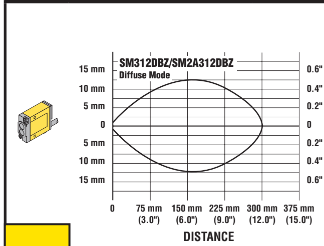


BPD-15

Range: 380 mm | LED: ○ | Pg. 80

MINI-BEAM®

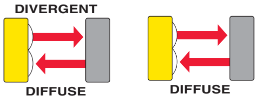


BPD-16

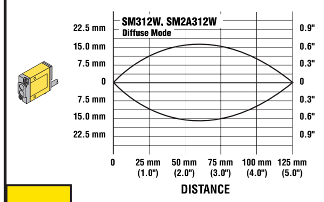
Range: 300 mm | LED: ○ | Pg. 80

Diffuse Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



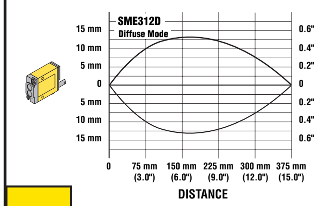
MINI-BEAM®



BPD-17

Range: 130 mm | **LED:** ○ | Pg. 80

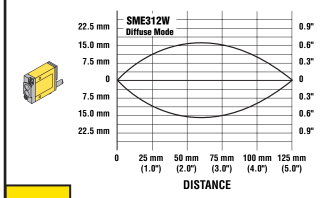
MINI-BEAM® *Expert*™



BPD-18

Range: 380 mm | **LED:** ○ | Pg. 85

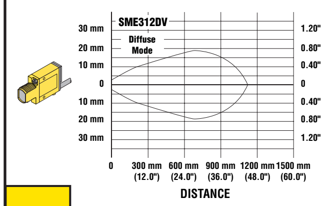
MINI-BEAM® *Expert*™



BPD-19

Range: 130 mm | **LED:** ○ | Pg. 85

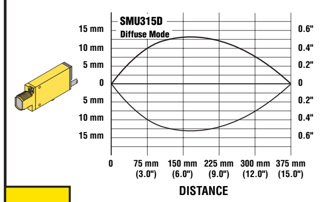
MINI-BEAM® *Expert*™



BPD-20

Range: 1100 mm | **LED:** ● | Pg. 85

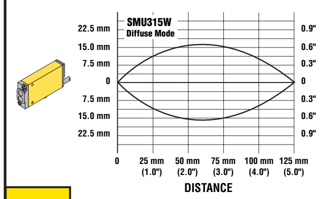
MINI-BEAM® Universal



BPD-21

Range: 380 mm | **LED:** ○ | Pg. 88

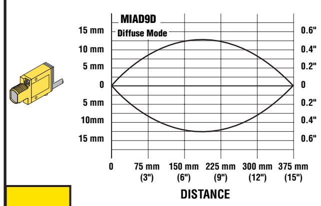
MINI-BEAM® Universal



BPD-22

Range: 130 mm | **LED:** ○ | Pg. 88

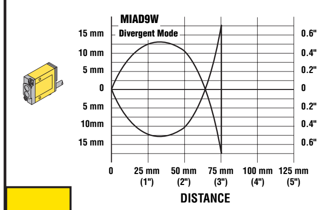
MINI-BEAM® NAMUR



BPD-23

Range: 380 mm | **LED:** ○ | Pg. 90

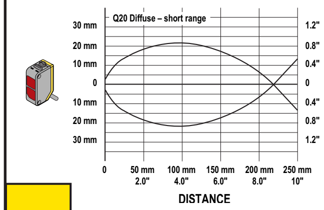
MINI-BEAM® NAMUR



BPD-24

Range: 75 mm | **LED:** ○ | Pg. 90

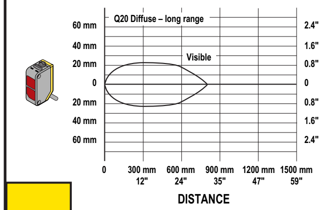
WORLD-BEAM® Q20



BPD-25

Range: 250 mm | **LED:** ● | Pg. 93

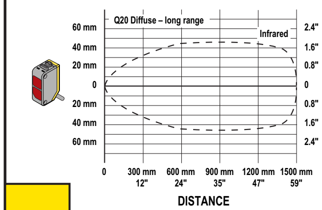
WORLD-BEAM® Q20



BPD-26

Range: 800 mm | **LED:** ● | Pg. 93

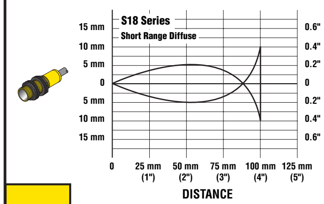
WORLD-BEAM® Q20



BPD-27

Range: 1500 mm | **LED:** ○ | Pg. 93

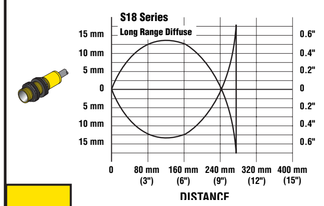
S18



BPD-28

Range: 100 mm | **LED:** ○ | Pg. 96

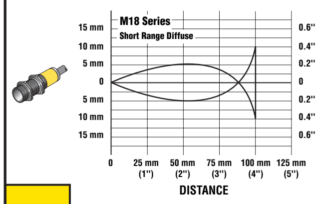
S18



BPD-29

Range: 300 mm | **LED:** ○ | Pg. 96

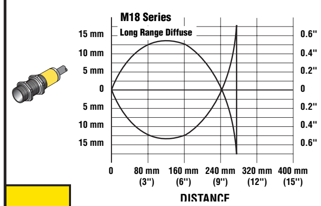
M18



BPD-30

Range: 100 mm | **LED:** ○ | Pg. 97

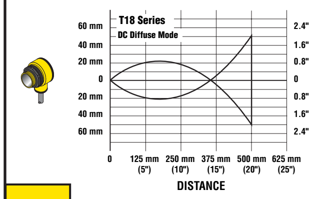
M18



BPD-31

Range: 300 mm | **LED:** ○ | Pg. 97

T18



BPD-32

Range: 500 mm | **LED:** ○ | Pg. 102

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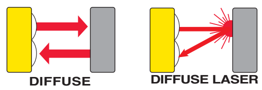
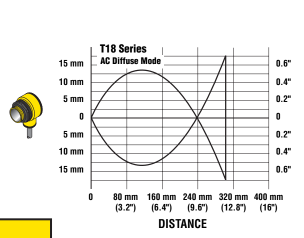
Diffuse Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED
✹ = Visible Red Laser LED



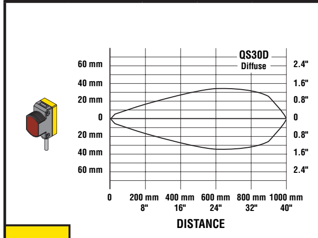
T18



BPD-33

Range: 300 mm	LED: ○	Pg. 104

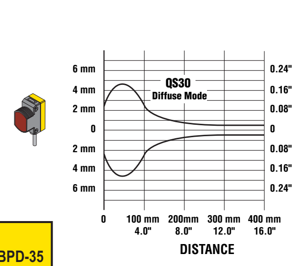
WORLD-BEAM® QS30



BPD-34

Range: 1 m	LED: ○	Pg. 114

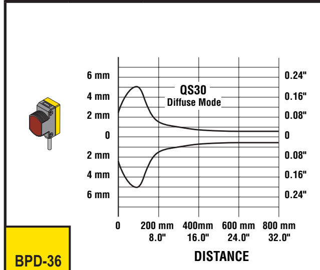
WORLD-BEAM® QS30 Class 1 Laser



BPD-35

Range: 400 mm	LED: ✹	Pg. 116

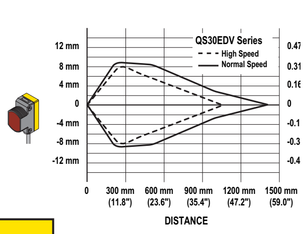
WORLD-BEAM® QS30 Class 2 Laser



BPD-36

Range: 800 mm	LED: ✹	Pg. 116

WORLD-BEAM® *Expert*™ Visible Red

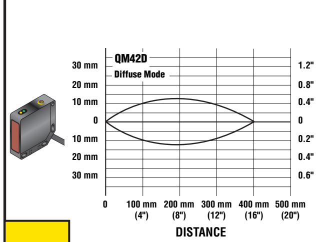


BPD-37

Normal mode: 1100 mm;
High-speed mode: 1400 mm

Range: 1400 mm	LED: ●	Pg. 116

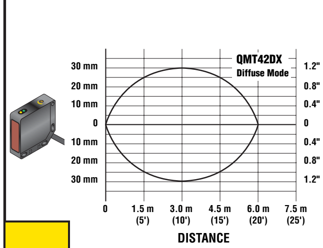
QM42



BPD-38

Range: 400 mm	LED: ○	Pg. 141

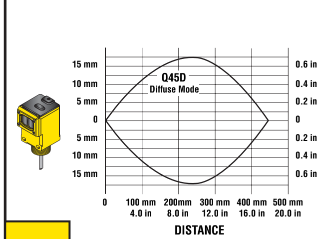
QMT42



BPD-39

Range: 6 m	LED: ○	Pg. 141

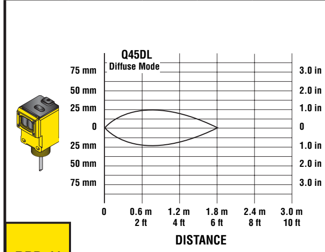
Q45



BPD-40

Range: 450 mm	LED: ○	Pg. 148

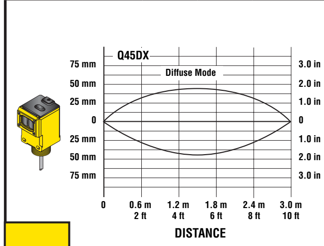
Q45



BPD-41

Range: 1.8 m	LED: ○	Pg. 148

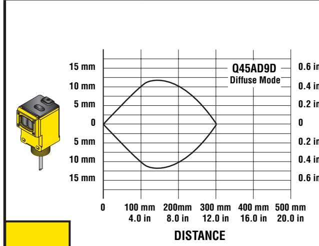
Q45



BPD-42

Range: 3 m	LED: ○	Pg. 148

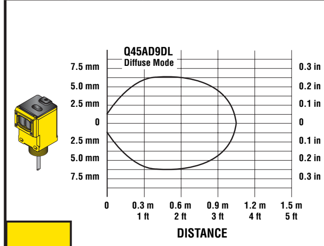
Q45 NAMUR



BPD-43

Range: 300 mm	LED: ○	Pg. 157

Q45 NAMUR



BPD-44

Range: 1 m	LED: ○	Pg. 157

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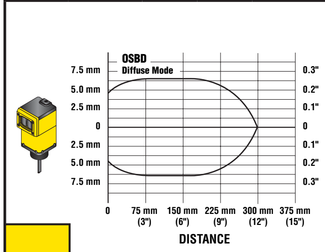
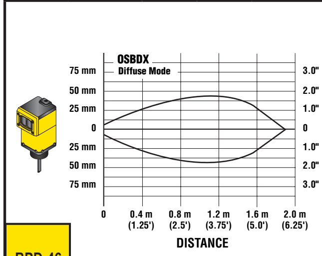


BPD-45

Range: 300 mm	LED: ○	Pg. 160

OMNI-BEAM™



BPD-46

Range: 2 m	LED: ○	Pg. 160

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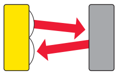
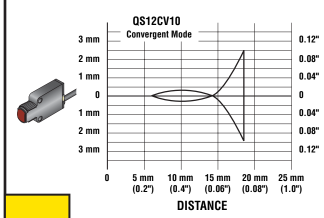
Convergent Mode (Performance based on 90% reflectance white test card)

○ = Infrared LED
● = Visible Red LED



CONVERGENT

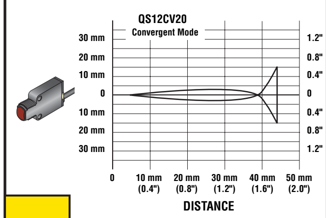
MINI-BEAM®2 QS12



BPC-1

Range: 10 mm | LED: ● | Pg. 53

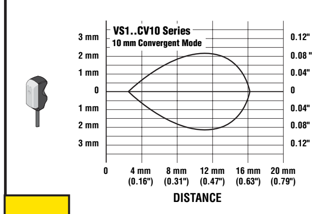
MINI-BEAM®2 QS12



BPC-2

Range: 20 mm | LED: ● | Pg. 53

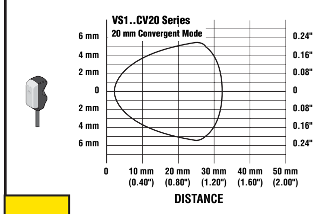
VS1



BPC-3

Range: 10 mm | LED: ● | Pg. 59

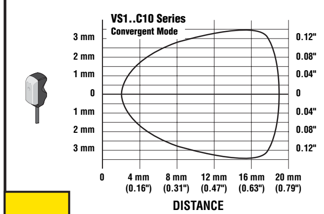
VS1



BPC-4

Range: 20 mm | LED: ● | Pg. 59

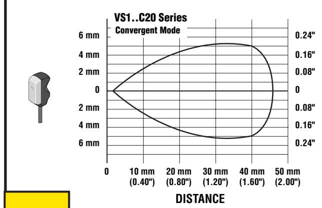
VS1



BPC-5

Range: 10 mm | LED: ○ | Pg. 59

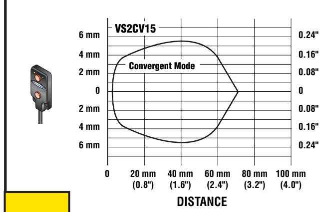
VS1



BPC-6

Range: 20 mm | LED: ○ | Pg. 59

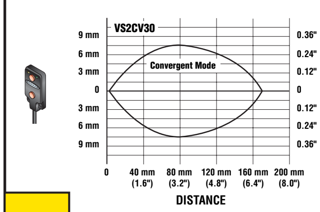
VS2



BPC-7

Range: 15 mm | LED: ● | Pg. 62

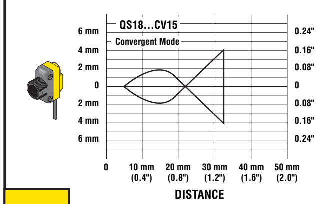
VS2



BPC-8

Range: 30 mm | LED: ● | Pg. 62

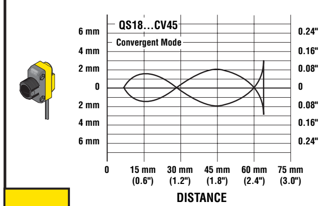
WORLD-BEAM® QS18



BPC-9

Range: 16 mm | LED: ● | Pg. 72

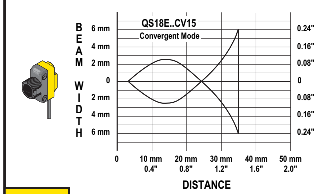
WORLD-BEAM® QS18



BPC-10

Range: 43 mm | LED: ● | Pg. 72

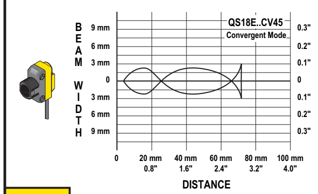
WORLD-BEAM® QS18 *Expert*™



BPC-11

Range: 16 mm | LED: ● | Pg. 76

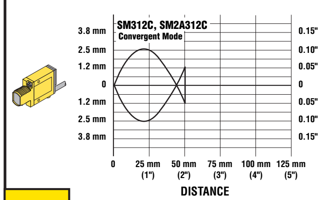
WORLD-BEAM® QS18 *Expert*™



BPC-12

Range: 43 mm | LED: ● | Pg. 76

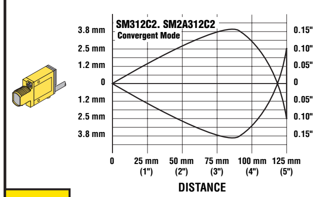
MINI-BEAM®



BPC-13

Range: 16 mm | LED: ○ | Pg. 80

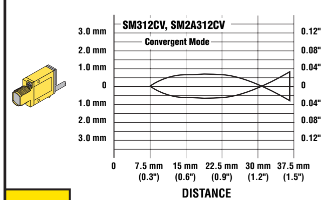
MINI-BEAM®



BPC-14

Range: 43 mm | LED: ○ | Pg. 80

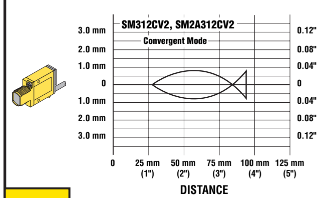
MINI-BEAM®



BPC-15

Range: 16 mm | LED: ● | Pg. 80

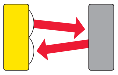
MINI-BEAM®

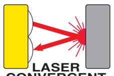


BPC-16

Range: 43 mm | LED: ● | Pg. 80

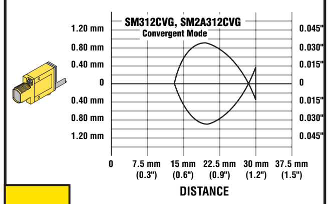
Convergent Mode (Performance based on 90% reflectance white test card)





- 🔴 = Visible Red LED
- 🟢 = Visible Green LED
- 🔵 = Visible Blue LED
- ○ = Visible White LED
- ✸ = Visible Red Laser LED

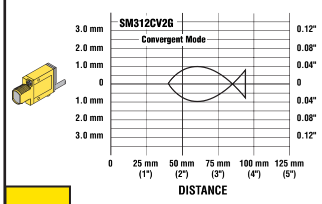
MINI-BEAM®



BPC-17

Range: 16 mm | LED: Green | Pg. 80

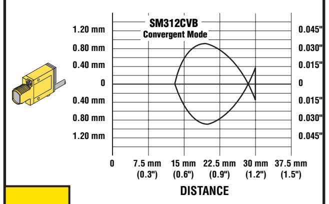
MINI-BEAM®



BPC-18

Range: 49 mm | LED: Green | Pg. 80

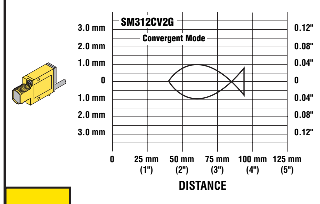
MINI-BEAM®



BPC-19

Range: 16 mm | LED: Blue | Pg. 80

MINI-BEAM®



BPC-20

Range: 49 mm | LED: Blue | Pg. 80

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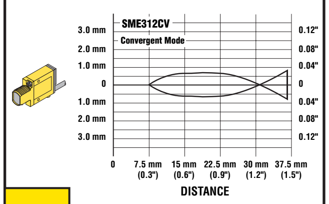

BPC-21

Range: 16 mm | LED: Red | Pg. 86

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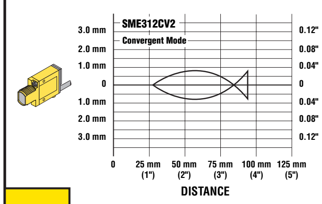
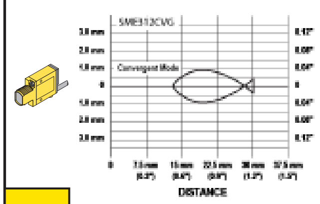


BPC-22

Range: 43 mm | LED: Red | Pg. 86

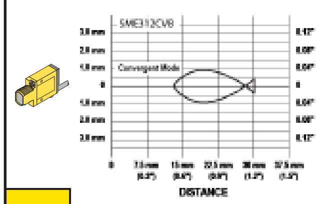
MINI-BEAM® *Expert*™



BPC-23

Range: 16 mm | LED: Green | Pg. 86

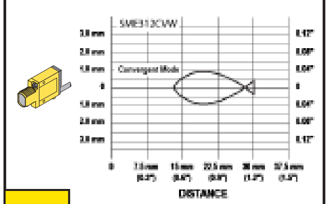
MINI-BEAM® *Expert*™



BPC-24

Range: 16 mm | LED: Blue | Pg. 86

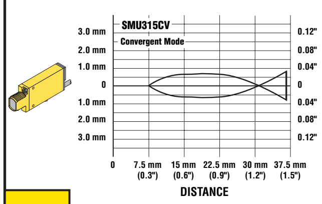
MINI-BEAM® *Expert*™



BPC-25

Range: 16 mm | LED: White | Pg. 86

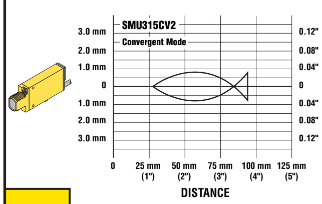
MINI-BEAM® Universal



BPC-26

Range: 16 mm | LED: Red | Pg. 88

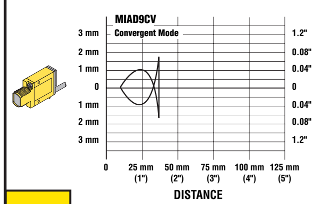
MINI-BEAM® Universal



BPC-27

Range: 43 mm | LED: Red | Pg. 88

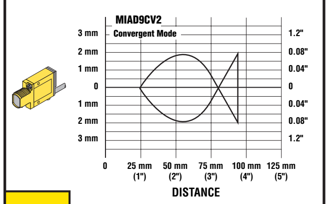
MINI-BEAM® NAMUR



BPC-28

Range: 16 mm | LED: Red | Pg. 90

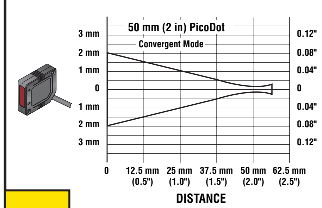
MINI-BEAM® NAMUR



BPC-29

Range: 43 mm | LED: Red | Pg. 90

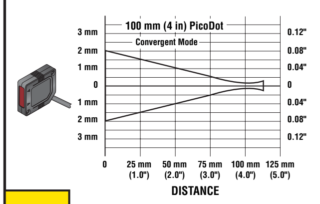
PicoDot® Class 2 Laser



BPC-30

Range: 50 mm | LED: Red Laser | Pg. 138

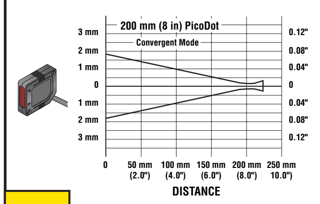
PicoDot® Class 2 Laser



BPC-31

Range: 102 mm | LED: Red Laser | Pg. 138

PicoDot® Class 2 Laser

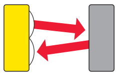


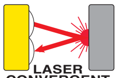
BPC-32

Range: 203 mm | LED: Red Laser | Pg. 138

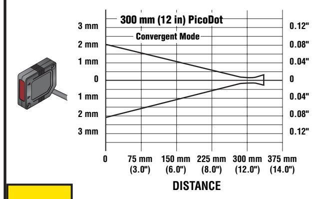
Convergent Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
● = Visible Green LED
● = Visible Blue LED
✸ = Visible Red Laser LED


CONVERGENT


LASER CONVERGENT

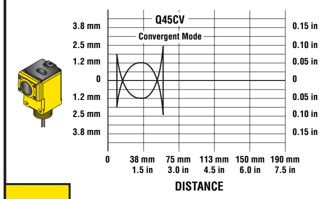
PicoDot® Class 2 Laser



BPC-33

Range: 305 mm | **LED:** | Pg. 138

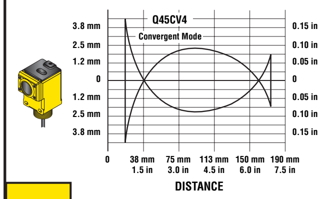
Q45



BPC-34

Range: 38 mm | **LED:** | Pg. 148

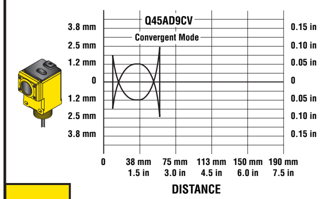
Q45



BPC-35

Range: 100 mm | **LED:** | Pg. 148

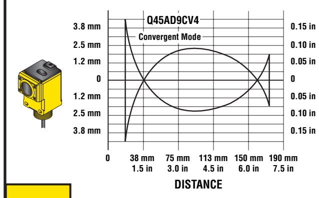
Q45 NAMUR



BPC-36

Range: 38 mm | **LED:** | Pg. 157

Q45 NAMUR



BPC-37

Range: 100 mm | **LED:** | Pg. 157

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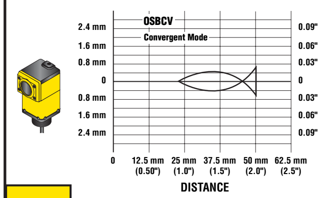
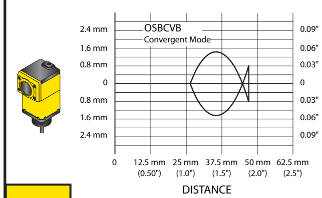


BPC-38

Range: 38 mm | **LED:** | Pg. 161

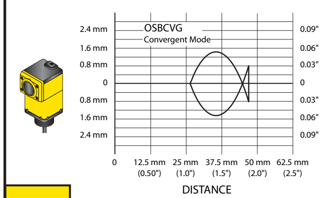
OMNI-BEAM™



BPC-39

Range: 38 mm | **LED:** | Pg. 161

OMNI-BEAM™



BPC-40

Range: 38 mm | **LED:** | Pg. 161

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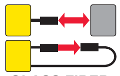
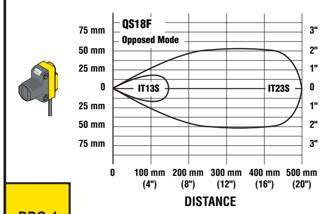
Glass Fiber Optic Mode (Performance based on 90% reflectance white test card)



- ● = Visible Red LED
- ● = Visible Green LED
- ● = Visible Blue LED
- ○ = Infrared LED
- ○ = Visible White LED

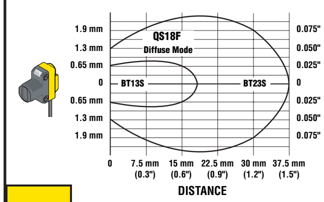
WORLD-BEAM® QS18



BPG-1

Fiber: Individual | LED: ○ (Infrared) | Pg. 74

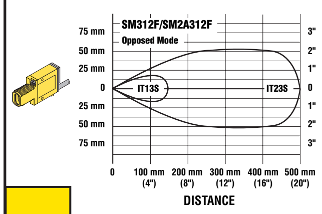
WORLD-BEAM® QS18



BPG-2

Fiber: Bifurcated | LED: ○ (Infrared) | Pg. 74

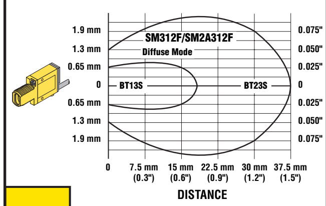
MINI-BEAM®



BPG-3

Fiber: Individual | LED: ○ (Infrared) | Pg. 81

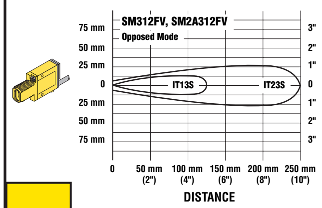
MINI-BEAM®



BPG-4

Fiber: Bifurcated | LED: ○ (Infrared) | Pg. 81

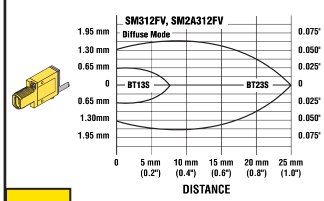
MINI-BEAM®



BPG-5

Fiber: Individual | LED: ● (Visible Red) | Pg. 81

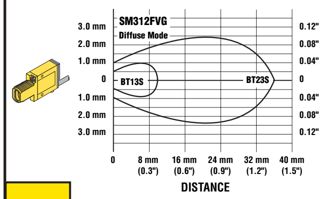
MINI-BEAM®



BPG-6

Fiber: Bifurcated | LED: ● (Visible Red) | Pg. 81

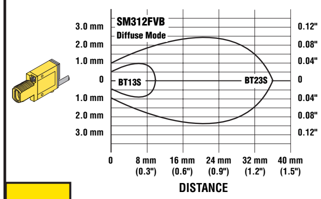
MINI-BEAM®



BPG-7

Fiber: Bifurcated | LED: ● (Visible Green) | Pg. 81

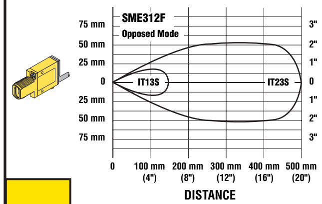
MINI-BEAM®



BPG-8

Fiber: Bifurcated | LED: ● (Visible Blue) | Pg. 81

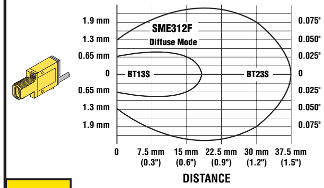
MINI-BEAM® *Expert* ™



BPG-9

Fiber: Individual | LED: ○ (Infrared) | Pg. 86

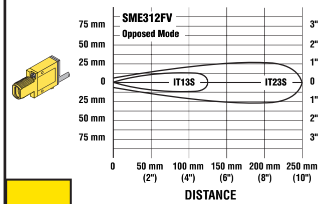
MINI-BEAM® *Expert* ™



BPG-10

Fiber: Bifurcated | LED: ○ (Infrared) | Pg. 86

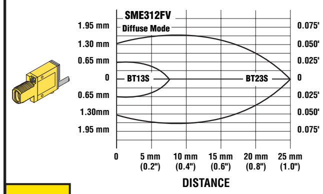
MINI-BEAM® *Expert* ™



BPG-11

Fiber: Individual | LED: ● (Visible Red) | Pg. 86

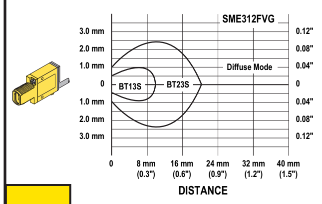
MINI-BEAM® *Expert* ™



BPG-12

Fiber: Bifurcated | LED: ● (Visible Red) | Pg. 86

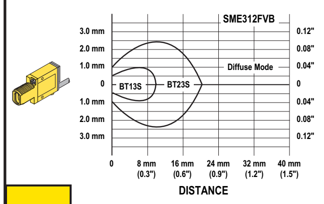
MINI-BEAM® *Expert* ™



BPG-13

Fiber: Bifurcated | LED: ● (Visible Green) | Pg. 86

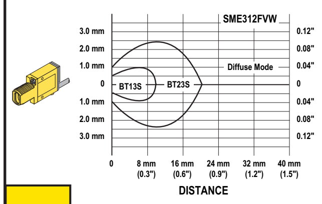
MINI-BEAM® *Expert* ™



BPG-14

Fiber: Bifurcated | LED: ● (Visible Blue) | Pg. 86

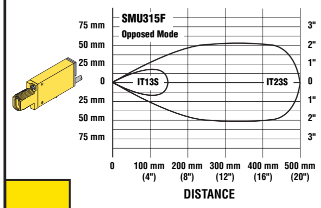
MINI-BEAM® *Expert* ™



BPG-15

Fiber: Bifurcated | LED: ○ (Visible White) | Pg. 86

MINI-BEAM® Universal

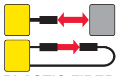


BPG-16

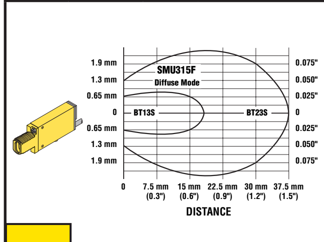
Fiber: Individual | LED: ○ (Infrared) | Pg. 89

Glass Fiber Optic Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
○ = Infrared LED



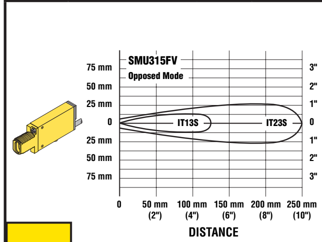
MINI-BEAM® Universal



BPG-17

Fiber: Bifurcated	LED: ○	Pg. 89

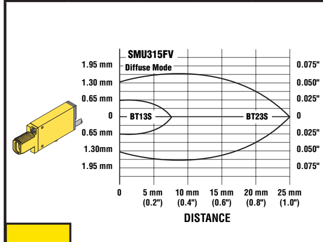
MINI-BEAM® Universal



BPG-18

Fiber: Individual	LED: ●	Pg. 89

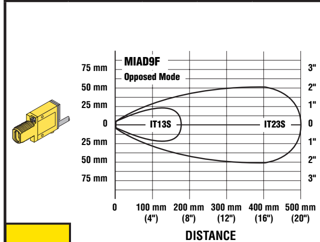
MINI-BEAM® Universal



BPG-19

Fiber: Bifurcated	LED: ●	Pg. 89

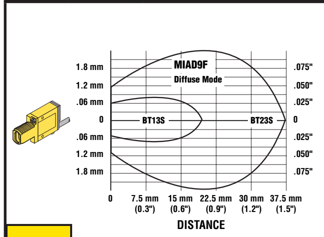
MINI-BEAM® NAMUR



BPG-20

Fiber: Individual	LED: ○	Pg. 90

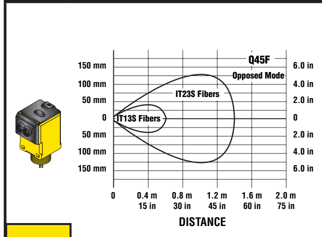
MINI-BEAM® NAMUR



BPG-21

Fiber: Bifurcated	LED: ○	Pg. 90

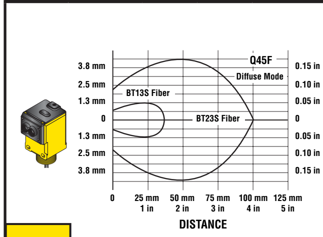
Q45



BPG-22

Fiber: Individual	LED: ○	Pg. 148

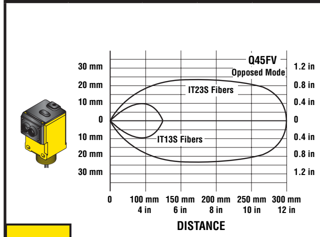
Q45



BPG-23

Fiber: Bifurcated	LED: ○	Pg. 148

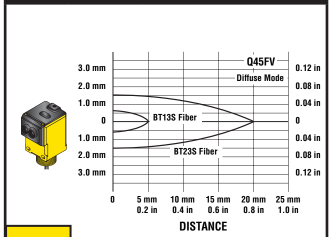
Q45



BPG-24

Fiber: Individual	LED: ●	Pg. 148

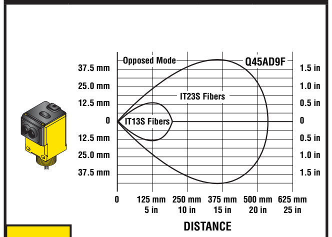
Q45



BPG-25

Fiber: Bifurcated	LED: ●	Pg. 148

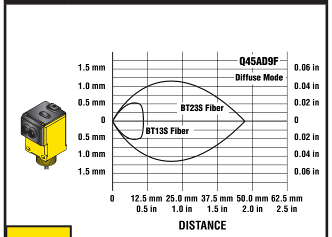
Q45 NAMUR



BPG-26

Fiber: Individual	LED: ○	Pg. 158

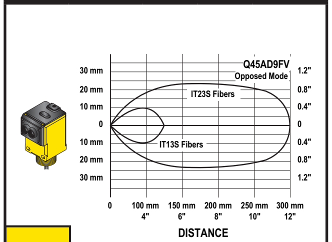
Q45 NAMUR



BPG-27

Fiber: Bifurcated	LED: ○	Pg. 158

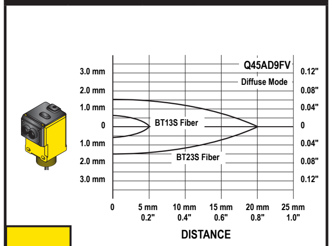
Q45 NAMUR



BPG-28

Fiber: Individual	LED: ●	Pg. 158

Q45 NAMUR



BPG-29

Fiber: Bifurcated	LED: ●	Pg. 158

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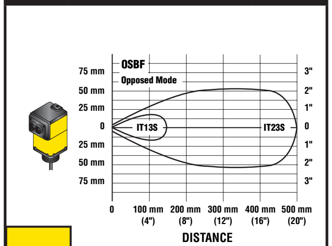
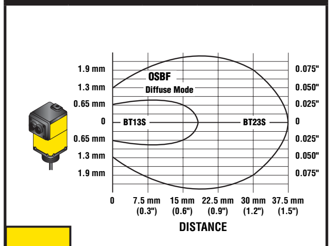


BPG-30

Fiber: Individual	LED: ○	Pg. 161

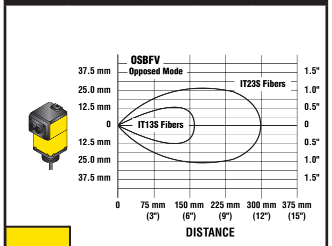
OMNI-BEAM™



BPG-31

Fiber: Bifurcated	LED: ○	Pg. 161

OMNI-BEAM™



BPG-32

Fiber: Individual	LED: ●	Pg. 161

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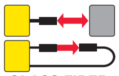
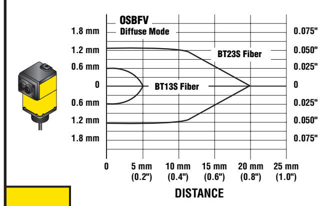
Glass Fiber Optic Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
● = Visible Green LED
● = Visible Blue LED
○ = Infrared LED



GLASS FIBER

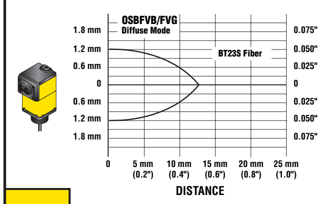
OMNI-BEAM™



BPG-33

Fiber: Bifurcated | **LED:** ● | Pg. 161

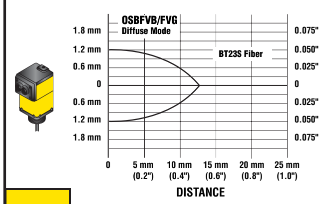
OMNI-BEAM™



BPG-34

Fiber: Bifurcated | **LED:** ● | Pg. 161

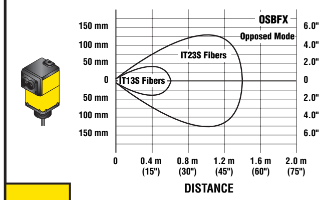
OMNI-BEAM™



BPG-35

Fiber: Bifurcated | **LED:** ● | Pg. 161

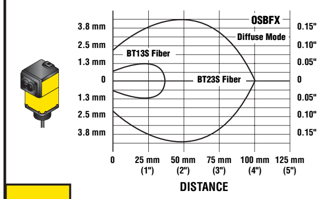
OMNI-BEAM™ High Power



BPG-36

Fiber: Individual | **LED:** ○ | Pg. 161

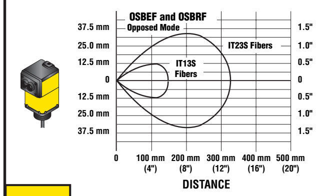
OMNI-BEAM™ High Power



BPG-37

Fiber: Bifurcated | **LED:** ○ | Pg. 161

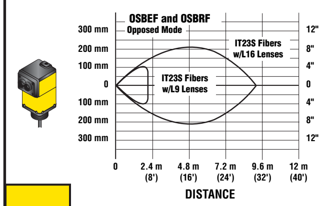
OMNI-BEAM™ Emitter/Receiver



BPG-38

Fiber: Individual | **LED:** ○ | Pg. 161

OMNI-BEAM™ Emitter/Receiver



BPG-39

Fiber: Bifurcated | **LED:** ○ | Pg. 161

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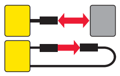
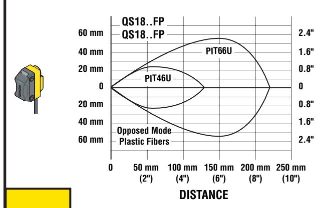
Plastic Fiber Optic Mode (Performance based on 90% reflectance white test card)



● = Visible Red LED
● = Visible Green LED
● = Visible Blue LED
○ = Visible White LED

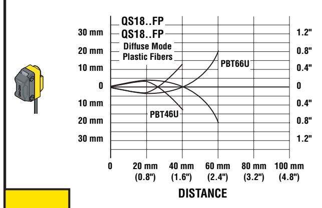
WORLD-BEAM® QS18



BPP-1

Fiber: Individual | **LED:** ● (Red) | Pg. 74

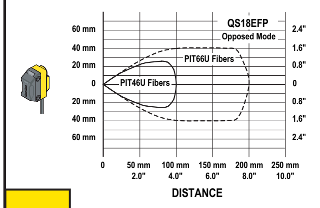
WORLD-BEAM® QS18



BPP-2

Fiber: Bifurcated | **LED:** ● (Red) | Pg. 74

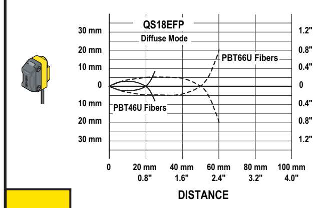
WORLD-BEAM® QS18 *Expert*™



BPP-3

Fiber: Individual | **LED:** ● (Red) | Pg. 77

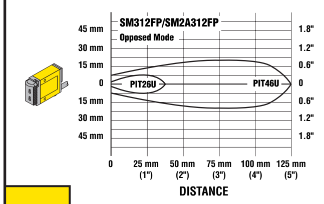
WORLD-BEAM® QS18 *Expert*™



BPP-4

Fiber: Bifurcated | **LED:** ● (Red) | Pg. 77

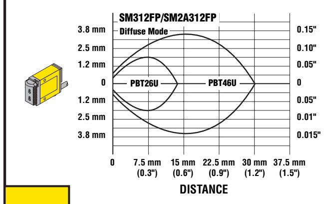
MINI-BEAM®



BPP-5

Fiber: Individual | **LED:** ● (Red) | Pg. 81

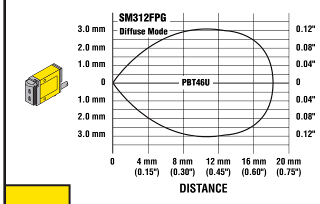
MINI-BEAM®



BPP-6

Fiber: Bifurcated | **LED:** ● (Red) | Pg. 81

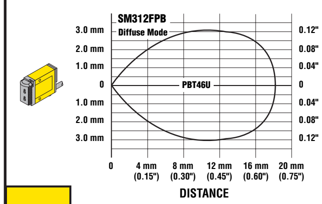
MINI-BEAM®



BPP-7

Fiber: Bifurcated | **LED:** ● (Green) | Pg. 81

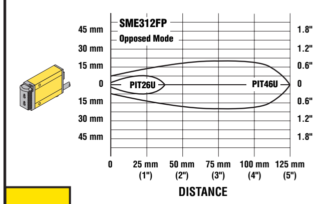
MINI-BEAM®



BPP-8

Fiber: Bifurcated | **LED:** ● (Blue) | Pg. 81

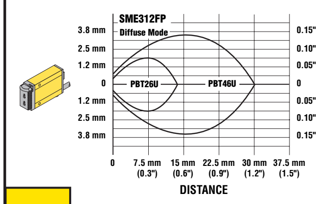
MINI-BEAM® *Expert*™



BPP-9

Fiber: Individual | **LED:** ● (Red) | Pg. 86

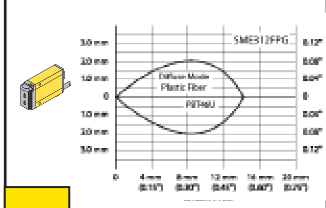
MINI-BEAM® *Expert*™



BPP-10

Fiber: Bifurcated | **LED:** ● (Red) | Pg. 86

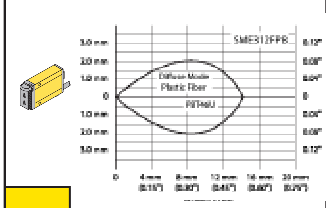
MINI-BEAM® *Expert*™



BPP-11

Fiber: Bifurcated | **LED:** ● (Green) | Pg. 86

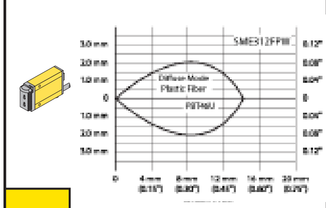
MINI-BEAM® *Expert*™



BPP-12

Fiber: Bifurcated | **LED:** ● (Blue) | Pg. 86

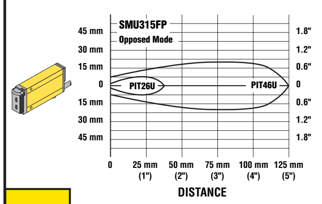
MINI-BEAM® *Expert*™



BPP-13

Fiber: Bifurcated | **LED:** ○ (White) | Pg. 86

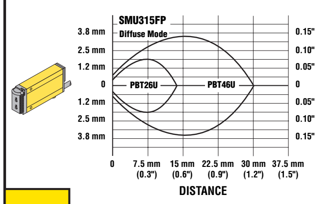
MINI-BEAM® Universal



BPP-14

Fiber: Individual | **LED:** ● (Red) | Pg. 89

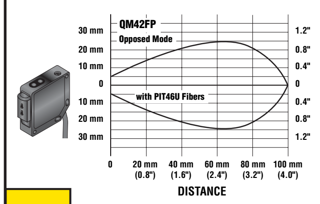
MINI-BEAM® Universal



BPP-15

Fiber: Bifurcated | **LED:** ● (Red) | Pg. 89

QM42

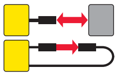


BPP-16

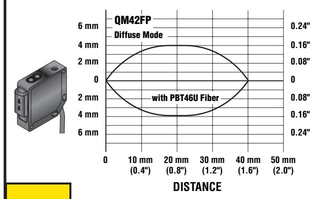
Fiber: Individual | **LED:** ● (Red) | Pg. 142

Plastic Fiber Optic Mode (Performance based on 90% reflectance white test card)

⭕ = Infrared LED
🔴 = Visible Red LED
🟢 = Visible Green LED
🔵 = Visible Blue LED



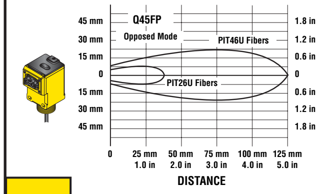
QM42



BPP-17

Fiber: Bifurcated | LED: 🔴 | Pg. 142

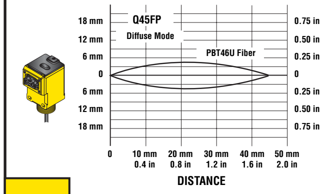
Q45



BPP-18

Fiber: Individual | LED: 🔴 | Pg. 148

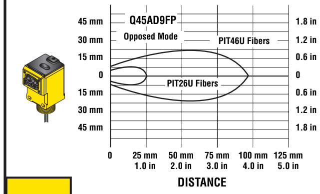
Q45



BPP-19

Fiber: Bifurcated | LED: 🔴 | Pg. 148

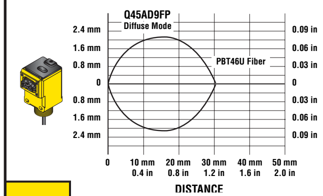
Q45 NAMUR



BPP-20

Fiber: Individual | LED: 🔴 | Pg. 158

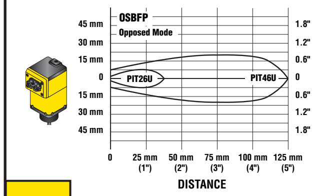
Q45 NAMUR



BPP-21

Fiber: Bifurcated | LED: 🔴 | Pg. 158

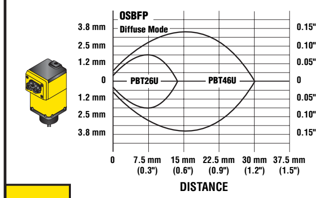
OMNI-BEAM™



BPP-22

Fiber: Individual | LED: 🔴 | Pg. 161

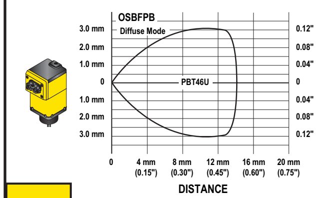
OMNI-BEAM™



BPP-23

Fiber: Bifurcated | LED: 🔴 | Pg. 161

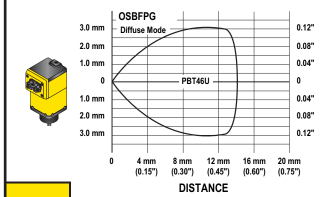
OMNI-BEAM™



BPP-24

Fiber: Bifurcated | LED: 🔵 | Pg. 161

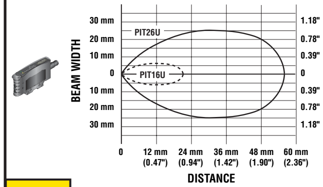
OMNI-BEAM™



BPP-25

Fiber: Bifurcated | LED: 🟢 | Pg. 161

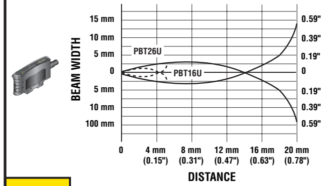
D10 *Expert*™ with Bargraph Display



BPP-26

Fiber: Individual | LED: 🔴 | Pg. 174

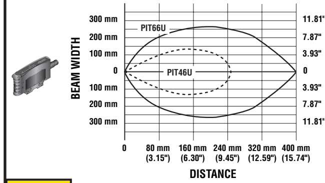
D10 *Expert*™ with Bargraph Display



BPP-27

Fiber: Bifurcated | LED: 🔴 | Pg. 174

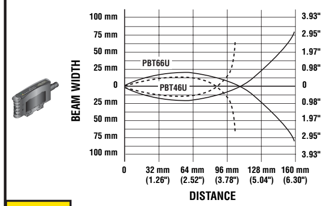
D10 *Expert*™ with Bargraph Display



BPP-28

Fiber: Individual | LED: 🔴 | Pg. 174

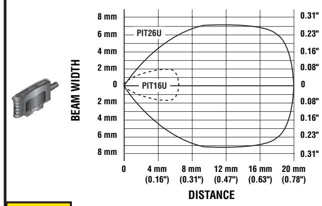
D10 *Expert*™ with Bargraph Display



BPP-29

Fiber: Bifurcated | LED: 🔴 | Pg. 174

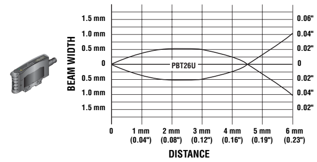
D10 *Expert*™ with Bargraph Display



BPP-30

Fiber: Individual | LED: 🟢 | Pg. 172

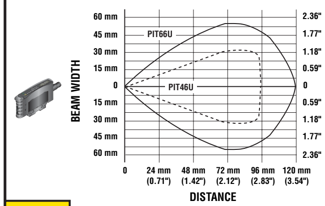
D10 Expert™ with Bargraph Display



BPP-31

Fiber: Bifurcated | LED: 🟢 | Pg. 174

D10 *Expert*™ with Bargraph Display



BPP-32

Fiber: Bifurcated | LED: 🟢 | Pg. 174

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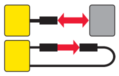
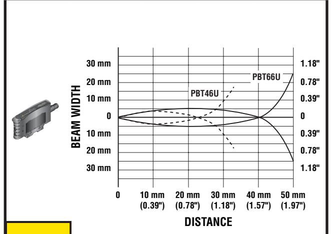
Plastic Fiber Optic Mode (Performance based on 90% reflectance white test card)

● = Visible Red LED
● = Visible Green LED



PLASTIC FIBER

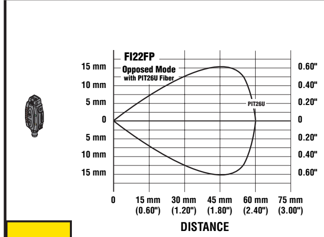
D10 *Expert*™ with Bargraph Display



BPP-33

Fiber: Bifurcated	LED:	Pg. 174

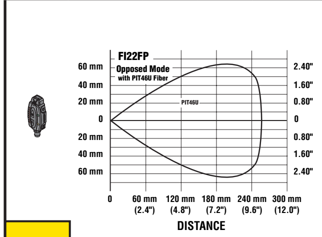
FI22 with PIT26U Fiber



BPP-34

Fiber: Individual	LED:	Pg. 187

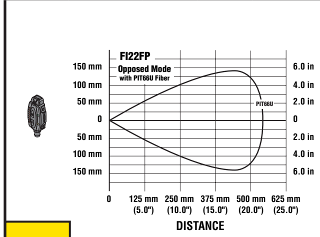
FI22 with PIT46U Fiber



BPP-35

Fiber: Individual	LED:	Pg. 187

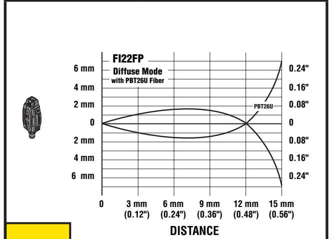
FI22 with PIT66U Fiber



BPP-36

Fiber: Individual	LED:	Pg. 187

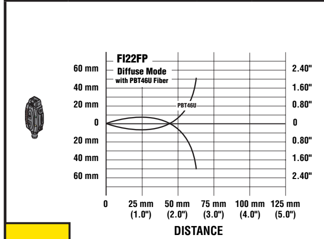
FI22 with PBT26U Fiber



BPP-37

Fiber: Bifurcated	LED:	Pg. 187

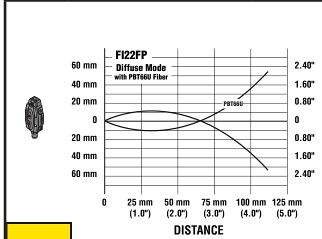
FI22 with PBT46U Fiber



BPP-38

Fiber: Bifurcated	LED:	Pg. 187

FI22 with PBT66U Fiber



BPP-39

Fiber: Individual	LED:	Pg. 187

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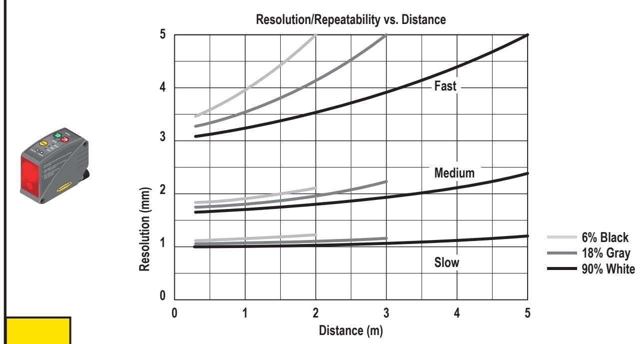
Repeatability/Resolution Curves

● = Visible Red LED
○ = Infrared LED
✸= Visible Red Laser LED

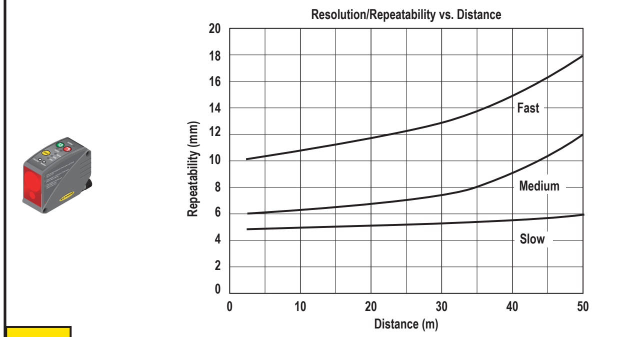
LT3



RRC-1

Range: 5 m	**Mode:** Diffuse	**LED:** ✸	Pg. 244

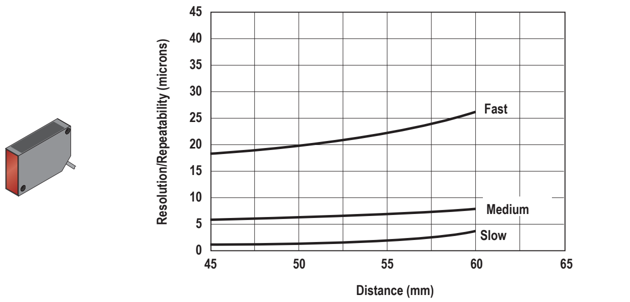
LT3



RRC-2

Range: 50 m	**Mode:** Retroreflective	**LED:** ✸	Pg. 244

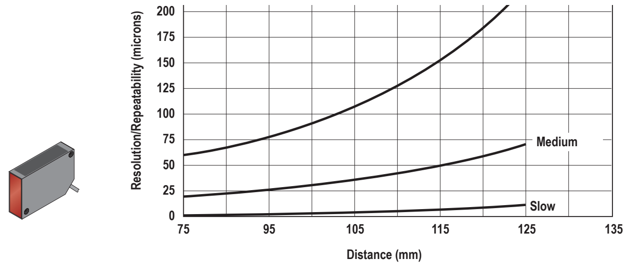
LG5



RRC-3

Range: 60 mm	**Mode:** Diffuse	**LED:** ✸	Pg. 252

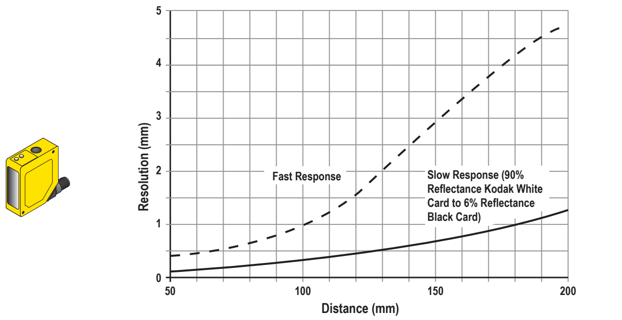
LG10



RRC-4

Range: 125 mm	**Mode:** Diffuse	**LED:** ✸	Pg. 252

Q50A Analog

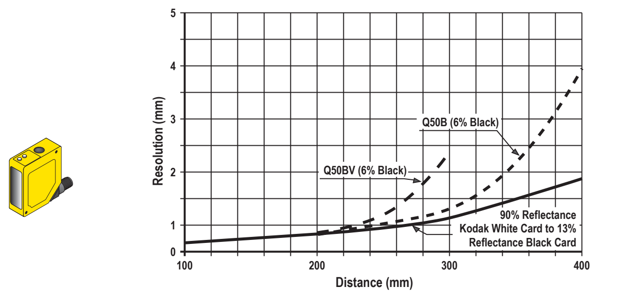


NOTE: Resolution is independent of color (90% Kodak White Card to 6% Black)

RRC-5

Range: 200 mm	**Mode:** Diffuse	**LED:** ● ○	Pg. 256

Q50B Analog



NOTE: Slow response performance shown; with fast response, resolution is 4 times larger.

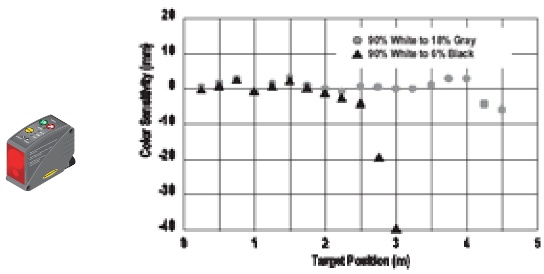
RRC-6

Range: 400 mm	**Mode:** Diffuse	**LED:** ● ○	Pg. 256

Color Sensitivity Curves

● = Visible Red LED
○ = Infrared LED
✸= Visible Red Laser LED

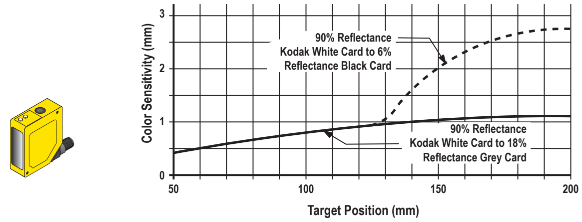
LT3



CSC-1

Range: 5 m	Mode: Diffuse	LED: ✸	Pg. 244

Q50A Discrete*

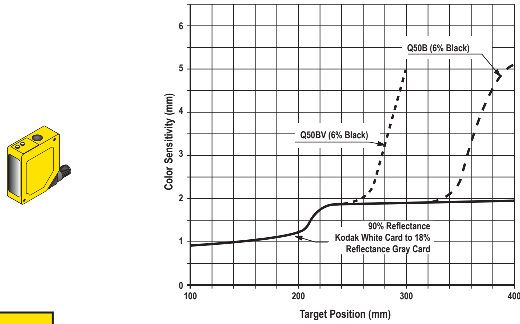


NOTES: Color sensitivity is independent of response time.
Q50A (infrared models) span is 50-200 mm.
Q50AV (visible models) span 50-150 mm.

CSC-2

Range: 200 mm	Mode: Diffuse	LED: ● ○	Pg. 256

Q50B Discrete*

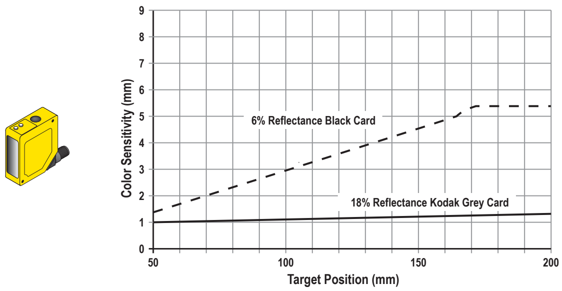


NOTES: Color sensitivity is independent of response time.
Q50A (infrared models) span is 100-400 mm.
Q50AV (visible models) span 100-300 mm.

CSC-3

Range: 400 mm	Mode: Diffuse	LED: ● ○	Pg. 256

Q50A Analog*



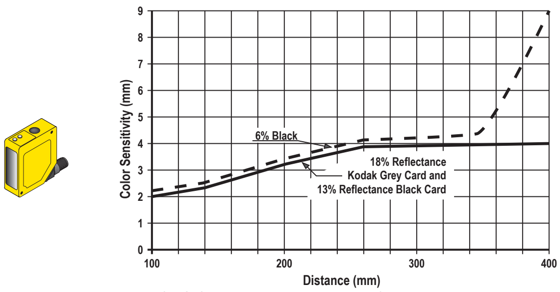
NOTES: Color sensitivity is independent of response time
Q50A (infrared models) span is 50-200 mm
Q50AV (visible models) span is 50-150 mm

CSC-4

Range: 200 mm	Mode: Diffuse	LED: ● ○	Pg. 256

* Performance based on 6%, 13% or 18% reflectance white test card.

Q50B Analog*



NOTES: Color sensitivity is independent of response time
Q50B (infrared models) span is 100-400 mm
Q50BV (visible red models) span is 100-300 mm

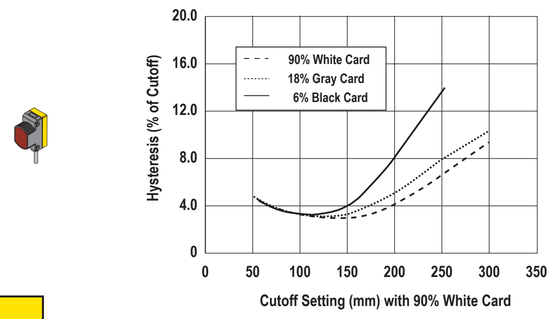
CSC-5

Range: 400 mm	Mode: Diffuse	LED: ● ○	Pg. 256

Hysteresis Curves

● = Visible Red LED
○ = Infrared LED
✸= Visible Red Laser LED

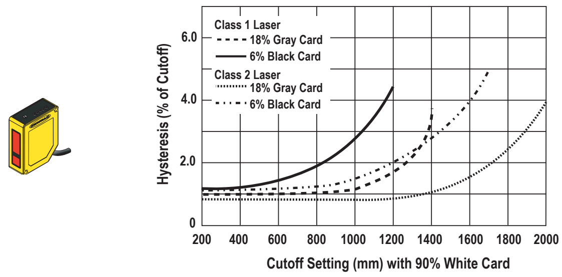
WORLD-BEAM® QS30 Adjustable-Field



HC-1

Range: 300 mm	Mode: Adjustable-Field	LED: ●	Pg. 116

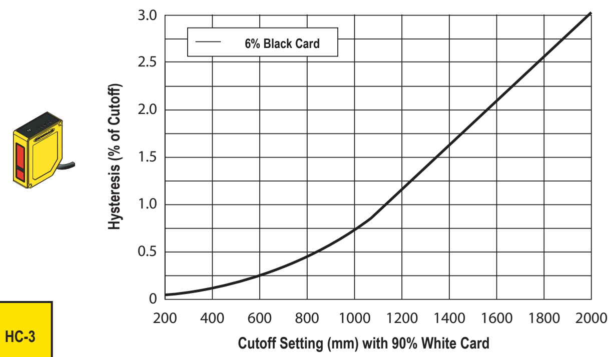
Q60 Adjustable-Field Laser



HC-2

Range: 150 mm	Mode: Adjustable-Field	LED: ✸	Pg. 166

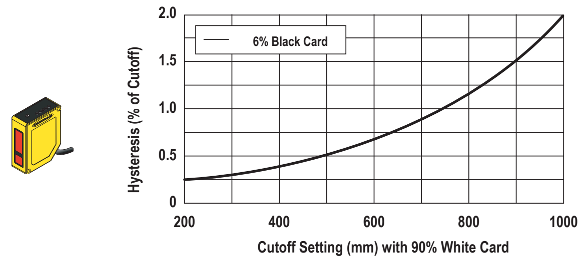
Q60 Adjustable-Field Infrared LED



HC-3

Range: 150 mm	Mode: Adjustable-Field	LED: ○	Pg. 166

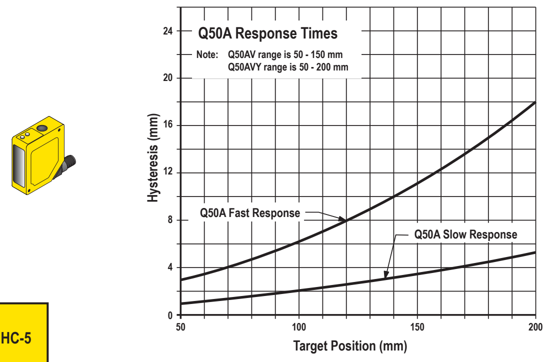
Q60 Adjustable-Field Visible Red LED



HC-4

Range: 400 mm	Mode: Adjustable-Field	LED: ●	Pg. 166

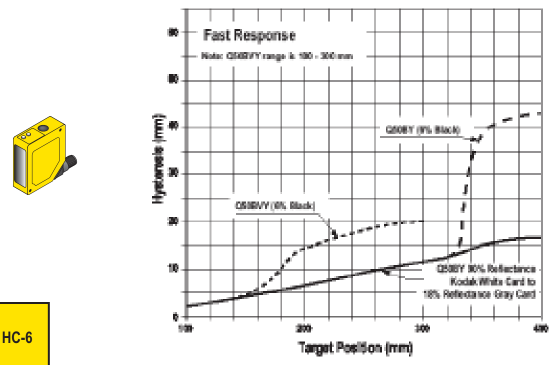
Q50A Discrete



HC-5

Range: 400 mm	Mode: Diffuse	LED: ● ○	Pg. 256

Q50B Discrete



HC-6

Range: 400 mm	Mode: Diffuse	LED: ● ○	Pg. 256

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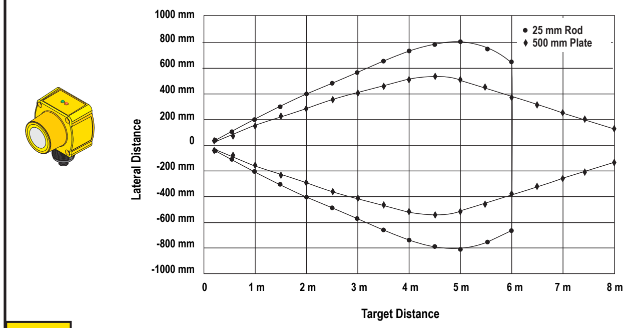
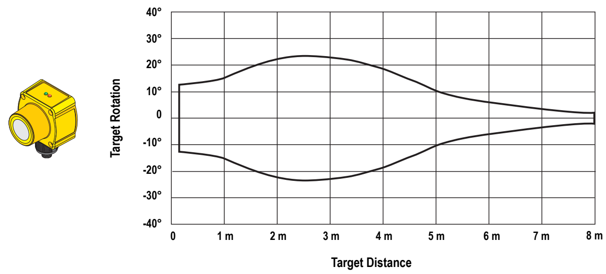
Effective Beam Patterns

QT50U (Typical)



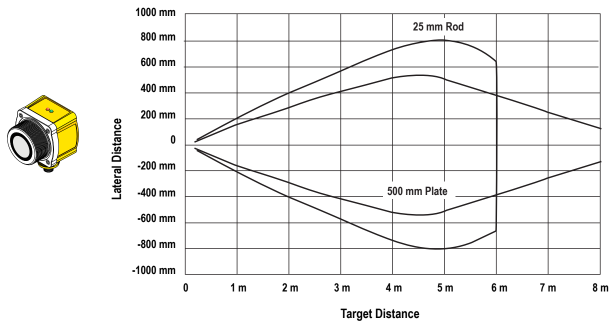
EBPC-1

QT50U (with 500 mm Plate) Maximum Target Rotation Angle



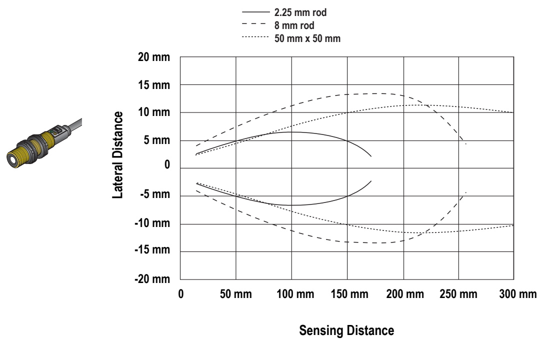
EBPC-2

QT50U Teflon®-Encapsulated (Typical)



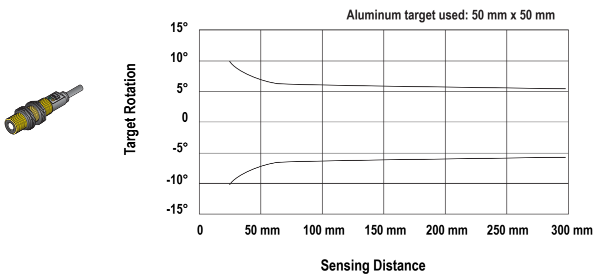
EBPC-3

S18U (Typical)



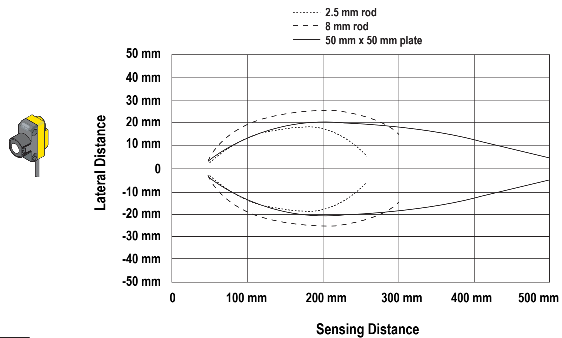
EBPC-4

S18U (with 500 mm Plate) Maximum Target Rotation Angle



EBPC-5

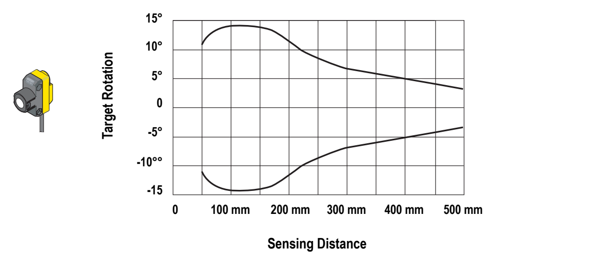
QS18U (Typical)



EBPC-6

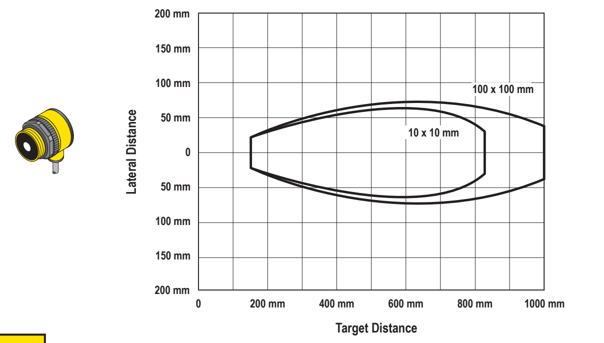
Effective Beam Patterns

QS18U Maximum Target Rotation Angle



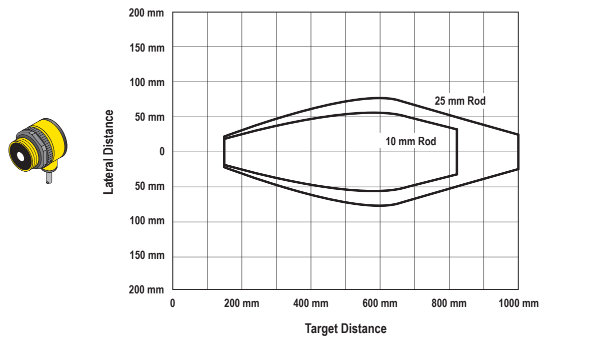
EBPC-7

T30U with Plate Target (Typical) 1-Meter Models



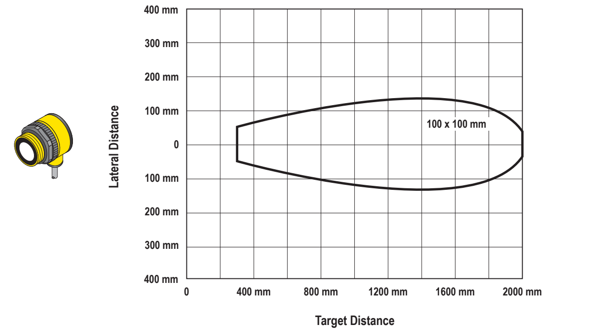
EBPC-8

T30U with Rod Target (Typical) 1-Meter Models



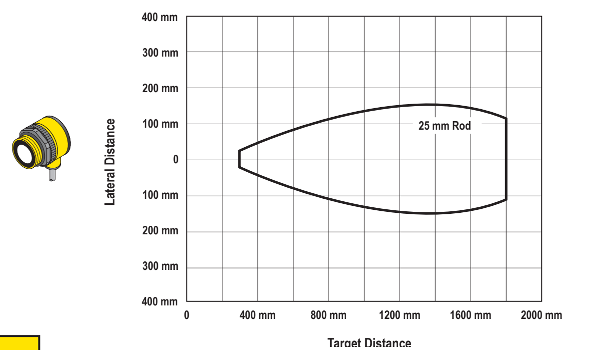
EBPC-9

T30U with Plate Target (Typical) 2-Meter Models



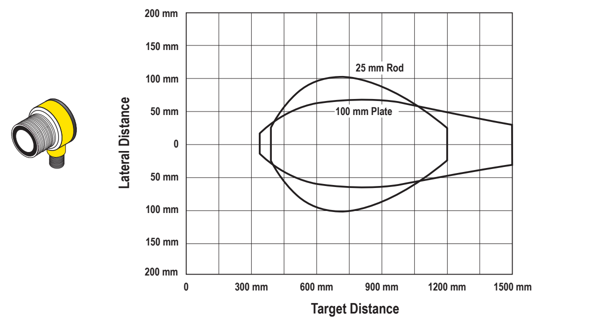
EBPC-10

T30U with Rod Target (Typical) 2-Meter Models



EBPC-11

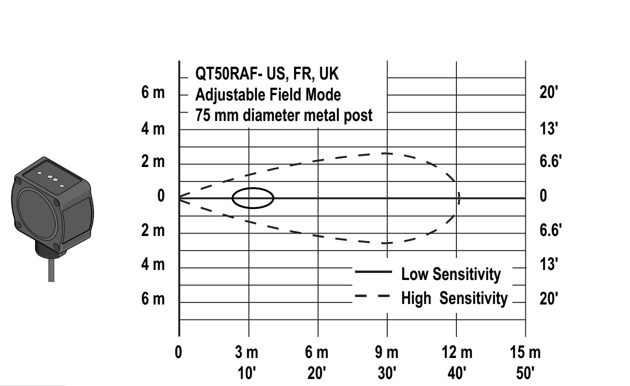
T30U Teflon®-Encapsulated (Typical)



EBPC-12

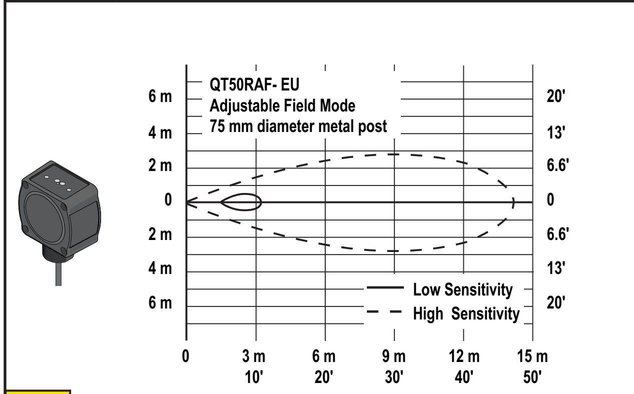
Effective Beam Patterns

QT50R (with 75 mm Post) US, FR, UK (Typical)



EBPC-13

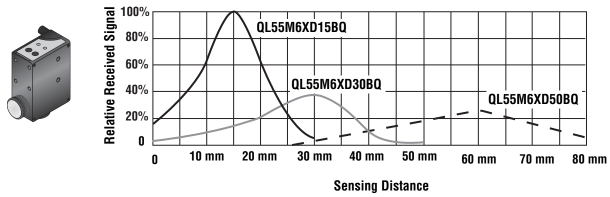
QT50R (with 75 mm Post) EU (Typical)



EBPC-14

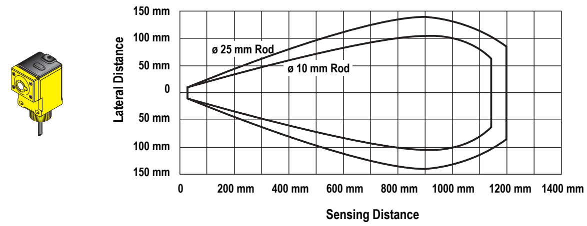
Response Curves

QL55



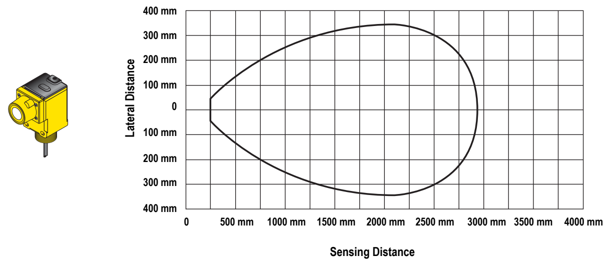
RC-1

Q45U Short Range with Rod Target (Typical)



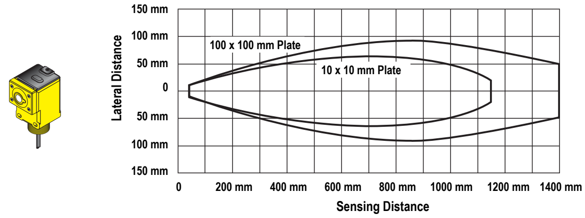
RC-2

Q45U Long Range with 25 mm Rod Target (Typical)



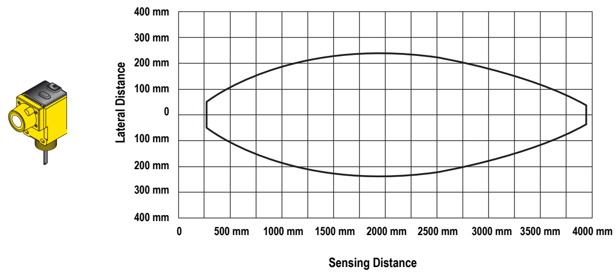
RC-3

Q45U Short Range with Plate Target (Typical)



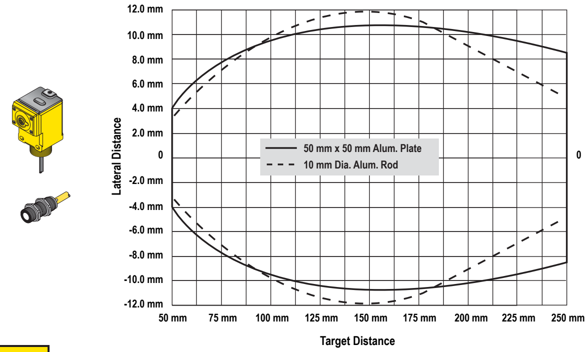
RC-4

Q45U Long Range with 100 x 100 mm Plate Target (Typical)



RC-5

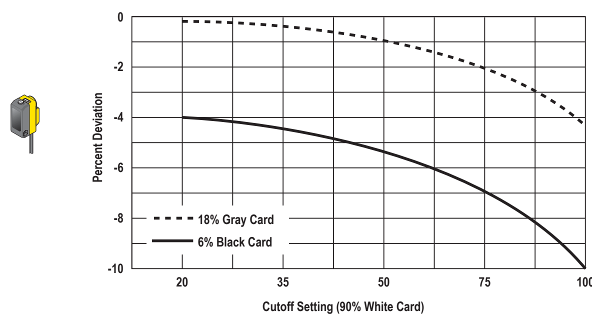
Q45UR



RC-6

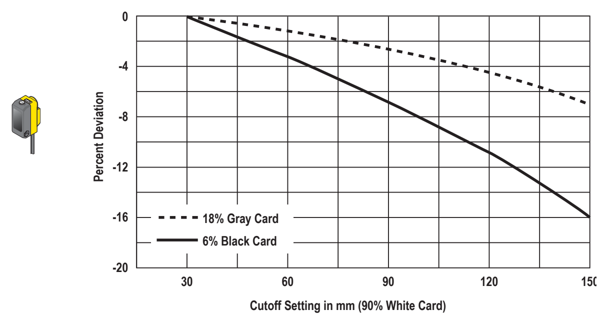
Cutoff Point Deviation Curves

WORLD-BEAM® QS18 Adjustable-Field



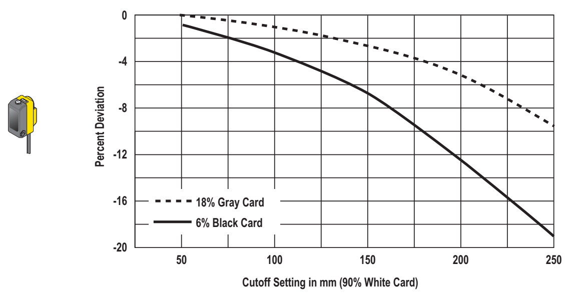
CPDC-1

WORLD-BEAM® QS18 Adjustable-Field Class 1 Laser



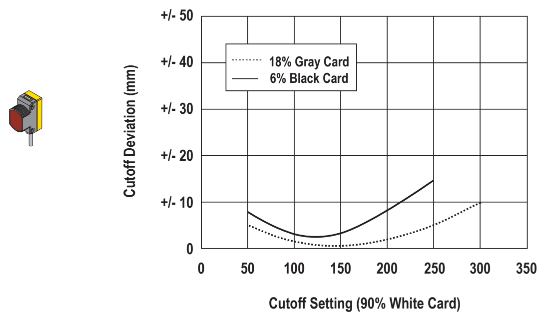
CPDC-2

WORLD-BEAM® QS18 Adjustable-Field Class 2 Laser



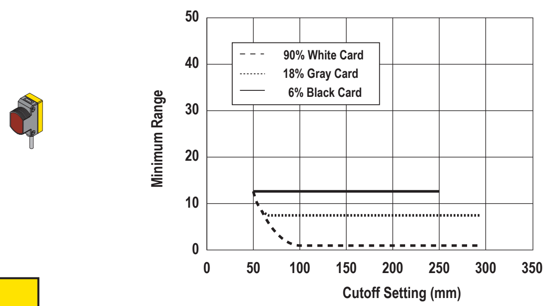
CPDC-3

WORLD-BEAM® QS30 Adjustable-Field



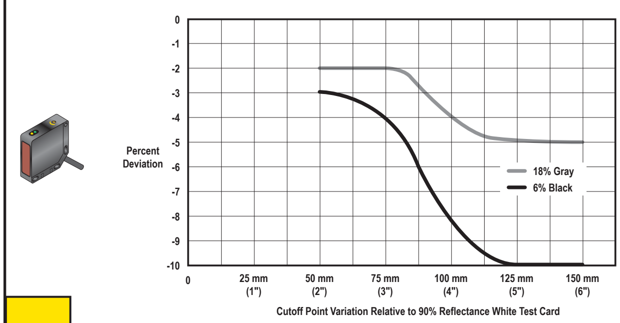
CPDC-4

WORLD-BEAM® QS30 Adjustable-Field



CPDC-5

QM42 Adjustable-Field – 150 mm

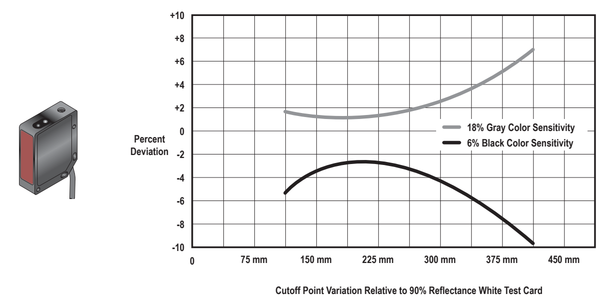


CPDC-6

The percentage of deviation indicates a change in the cutoff point for either 18% gray or 6% black targets, relative to the cutoff point for a 90% reflective white test card. As an example, the cutoff point decreases 10% for a 6% reflectance black target when the cutoff point is 2000 mm using a 90% reflectance white test card. In other words, the cutoff point for the black target is 1800 mm.

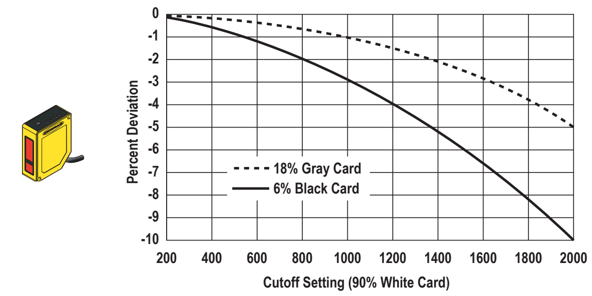
Cutoff Point Deviation Curves

QMT42 Adjustable-Field – 400 mm



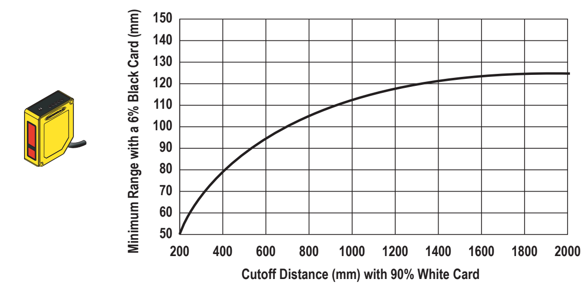
CPDC-7

Q60 Adjustable-Field Infrared LED



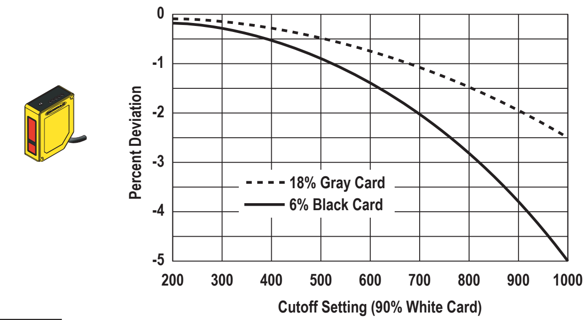
CPDC-8

Q60 Adjustable-Field Infrared LED



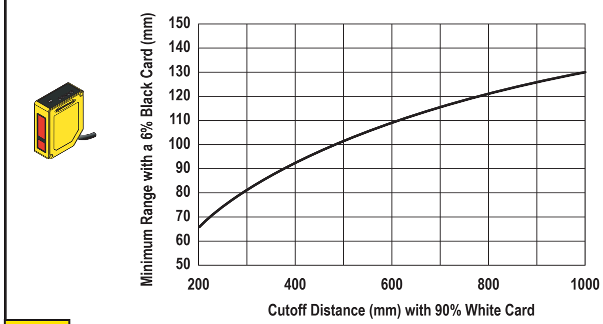
CPDC-9

Q60 Adjustable-Field Visible Red LED



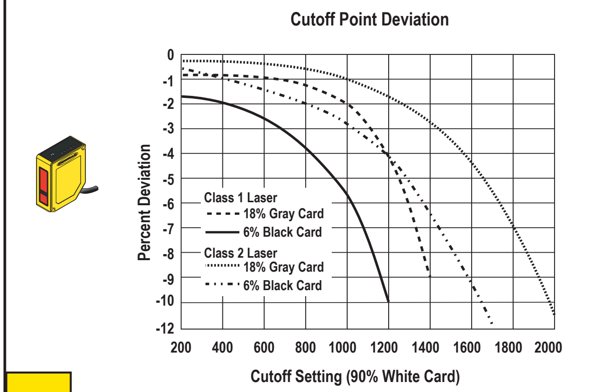
CPDC-10

Q60 Adjustable-Field Visible Red LED



CPDC-11

Q60 Laser Adjustable-Field



CPDC-12

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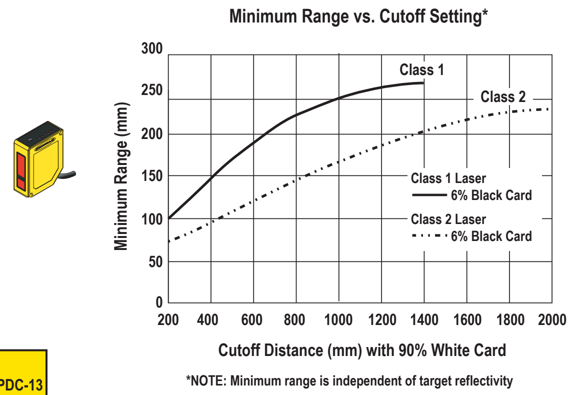
Cutoff Point Deviation Curves

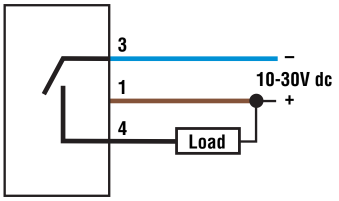
Q60 Laser Adjustable-Field



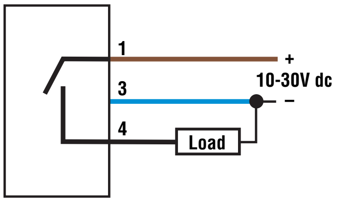
CPDC-13

DC Hookups

DC01 Current Sinking (NPN)



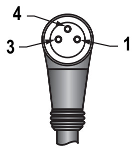
Current Sourcing (PNP)



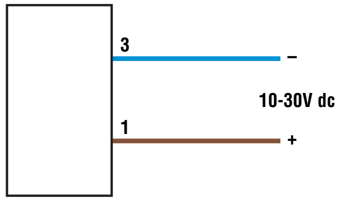
Key

1 = Brown
3 = Blue
4 = Black

3-Pin Pico



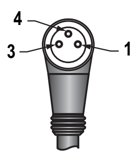
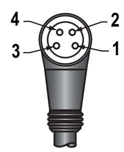
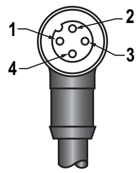
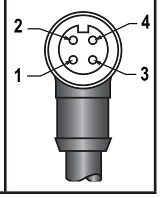
DC02 Emitter



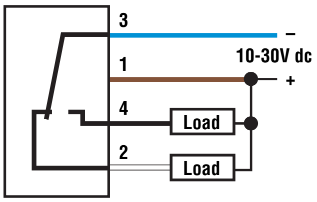
Key

1 = Brown
2 = White†
3 = Blue
4 = Black†

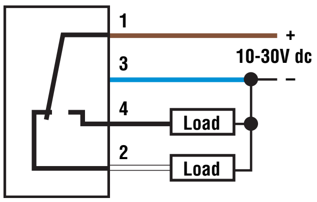
† Not Used

3-Pin Pico	4-Pin Pico	4-Pin Euro	4-Pin Mini
			

DC03 Complementary Current Sinking (NPN)

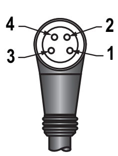
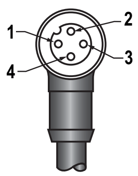
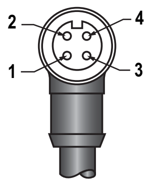


Complementary Current Sourcing (PNP)

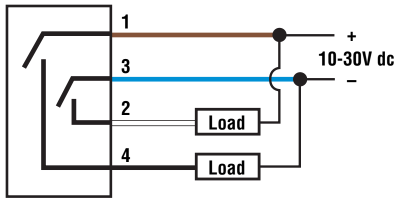


Key

1 = Brown
2 = White
3 = Blue
4 = Black

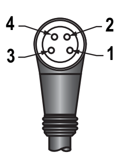
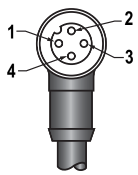
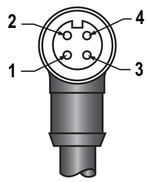
4-Pin Pico	4-Pin Euro	4-Pin Mini
		

DC04 Bipolar (NPN + PNP)



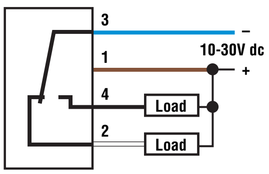
Key

1 = Brown
2 = White
3 = Blue
4 = Black

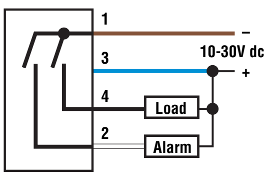
4-Pin Pico	4-Pin Euro	4-Pin Mini
		

DC Hookups

DC05 — Complementary Current Sinking (NPN) Standard Hookup

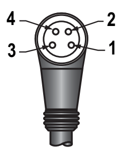
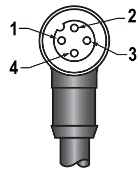


Current Sinking (NPN) Plus Current Sinking Alarm

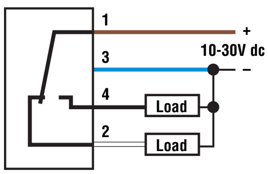


Key

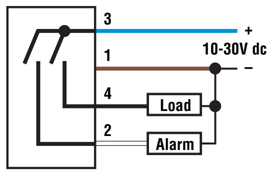
1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Pico	4-Pin Euro
	

DC06 — Complementary Current Sourcing (PNP) Standard Hookup

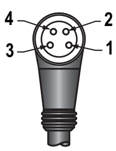
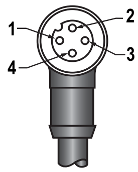


Current Sourcing (PNP) Plus Current Sourcing Alarm

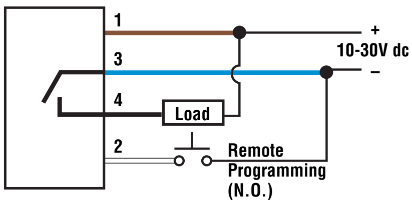


Key

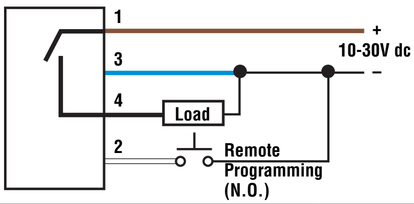
1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Pico	4-Pin Euro
	

DC07 — Current Sinking (NPN)

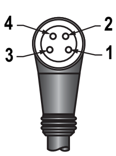
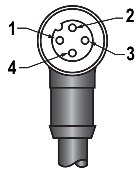


Current Sourcing (PNP)

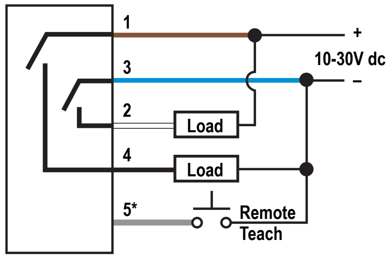


Key

1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Pico	4-Pico Euro
	

DC08 — Bipolar (NPN + PNP)

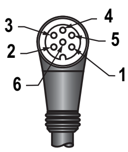
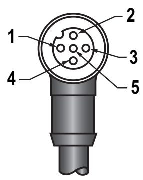


***NOTE:** For some QS30 models, gray wire is used for LO/DO Select. See data sheet.

Key

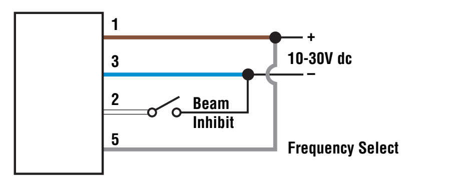
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray
6 = Pink †

† Not Used

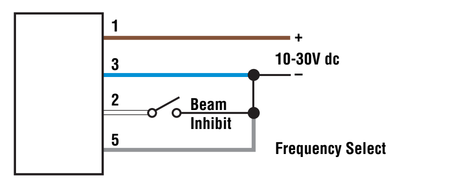
6-Pin Pico	5-Pin Euro
	

DC Hookups

DC09 — Emitter Frequency A



Emitter Frequency B

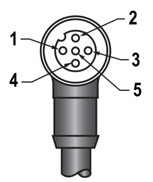


Key

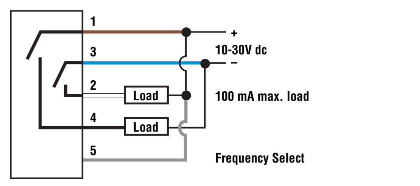
1 = Brown
2 = White
3 = Blue
4 = Black †
5 = Gray

† Not Used

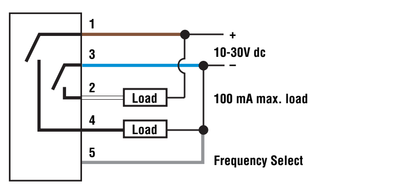
5-Pin Euro



DC10 — Receiver Frequency A



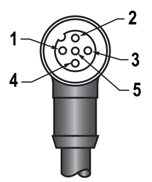
Receiver Frequency B



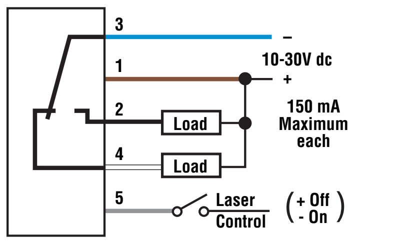
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

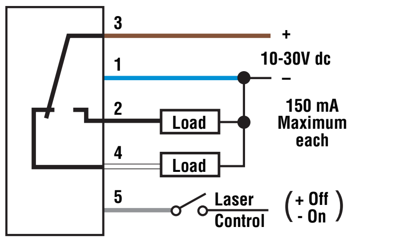
5-Pin Euro



DC11 — Complementary Current Sinking (NPN)



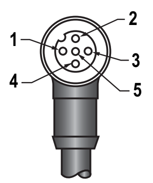
Complementary Current Sourcing (PNP)



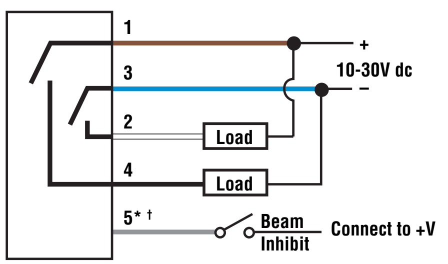
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



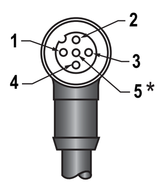
DC12 — Bipolar (NPN + PNP)



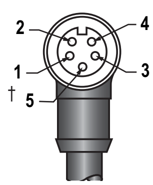
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray*/
Yellow†

5-Pin Euro



5-Pin Mini



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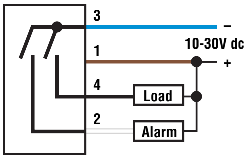
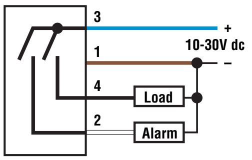
DC Hookups

DC13 Current Sinking (NPN) Configuration



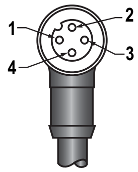
Current Sourcing (PNP) Configuration



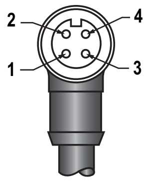
Key

1 = Brown
2 = White
3 = Blue
4 = Black

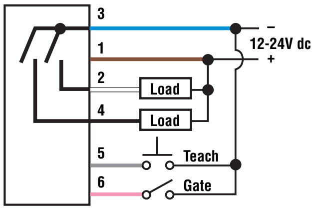
4-Pin Euro



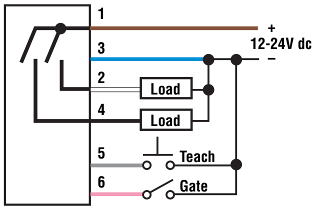
4-Pin Mini



DC14 Current Sinking (NPN)



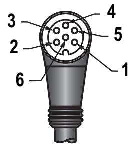
Current Sourcing (PNP)



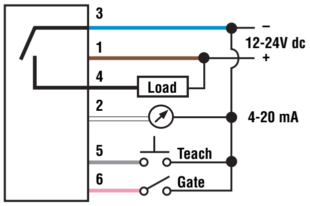
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray
6 = Pink

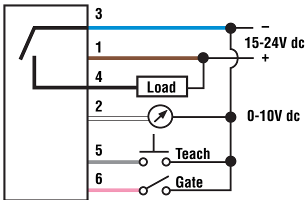
6-Pin Pico



DC15 Current Sinking (NPN) + Analog Current



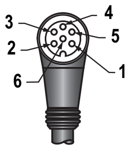
Current Sinking (NPN) + Analog Voltage



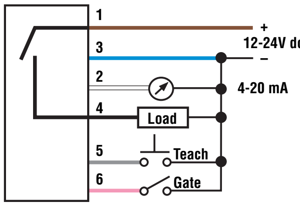
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray
6 = Pink

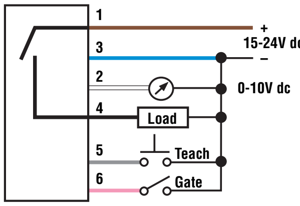
6-Pin Pico



DC16 Current Sourcing (PNP) + Analog Current



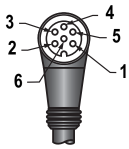
Current Sourcing (PNP) + Analog Voltage



Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray
6 = Pink

6-Pin Pico



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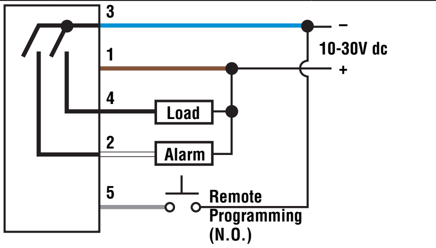
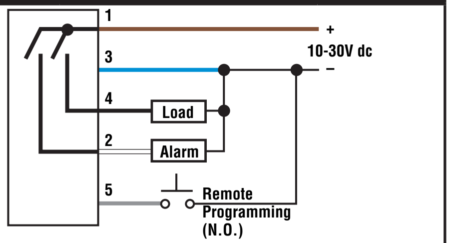
DC Hookups

DC17 Current Sinking (NPN) Cable Hookup



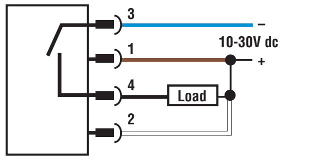
Current Sourcing (PNP) Cable Hookup



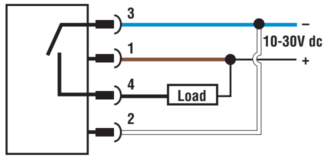
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

DC18 SM30 DC Receivers (NPN) Light Operate



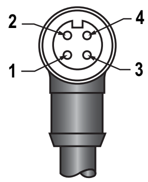
SM30 DC Receivers (NPN) Dark Operate



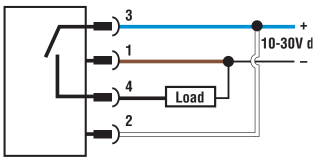
Key

1 = Brown
2 = White
3 = Blue
4 = Black

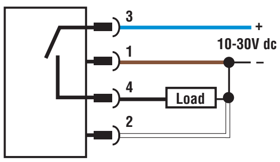
4-Pin Mini



DC19 SM30 DC Receivers (PNP) Light Operate



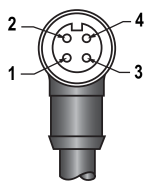
SM30 DC Receivers (PNP) Dark Operate



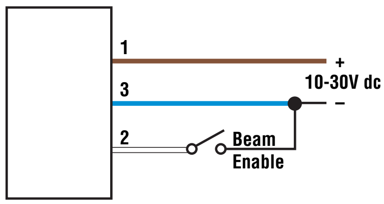
Key

1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Mini



DC20 Laser Emitter

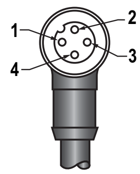


Key

1 = Brown
2 = White
3 = Blue
4 = Black†

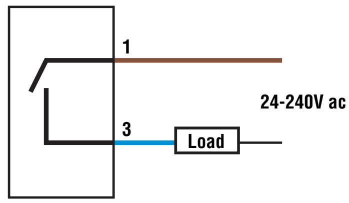
† Not Used

4-Pin Euro



AC Hookups

AC01 2-wire AC

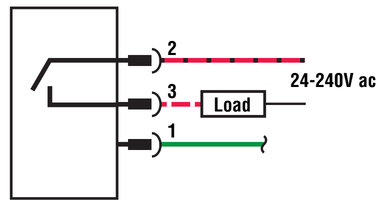


NOTE: Wire a load in series before powering up sensor.

Key

1 = Brown
3 = Blue

AC02 2-wire AC with Quick-Disconnect Cable



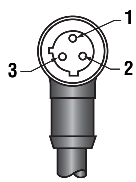
NOTE: Wire a load in series before powering up sensor.

Key

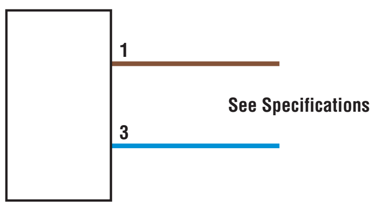
1 = Green†
2 = Red/Black
3 = Red/White

† Not Used

3-Pin Micro



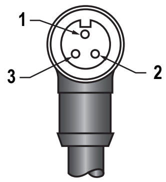
AC03 Emitters



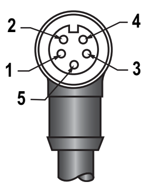
Key

1 = Brown
3 = Blue

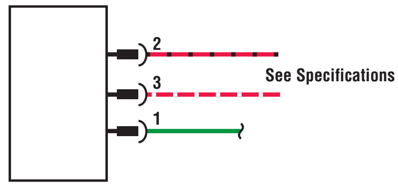
3-Pin Mini



5-Pin Mini



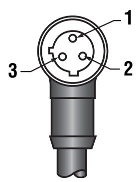
AC04 Emitters with Quick-Disconnect Cable



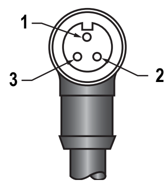
Key

1 = Green
2 = Red/Black
3 = Red/White

3-Pin Micro

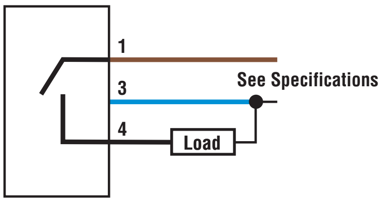


3-Pin Mini



AC Hookups

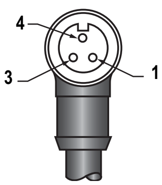
AC05 — 3-wire AC



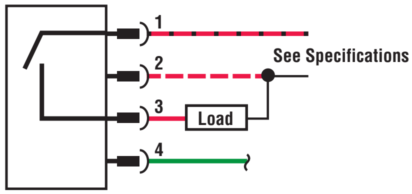
Key

1 = Brown
3 = Blue
4 = Black

3-Pin Mini



AC06 — 3-wire AC with Quick-Disconnect Cable

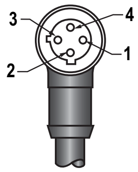


Key

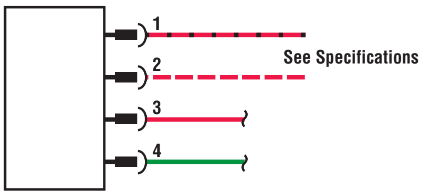
1 = Red/Black
2 = Red/White
3 = Red
4 = Green†

† Not Used

4-Pin Micro



AC07 — Emitters with Quick-Disconnect Cable

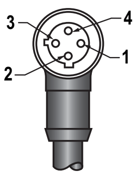


Key

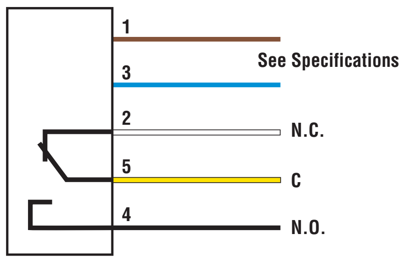
1 = Red/Black
2 = Red/White
3 = Red†
4 = Green†

† Not Used

4-Pin Micro



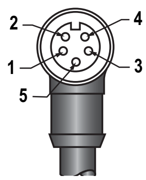
AC08 — SPDT Electromechanical Relay Output



Key

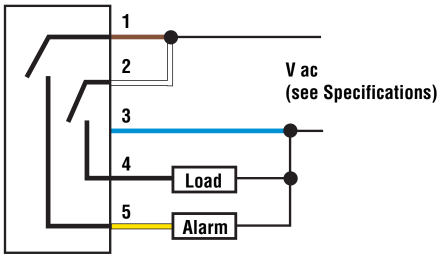
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow

5-Pin Mini



AC Hookups

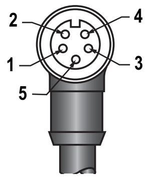
AC09 OPBA2 or OPBB2 3-wire SPST Solid-State Power Block



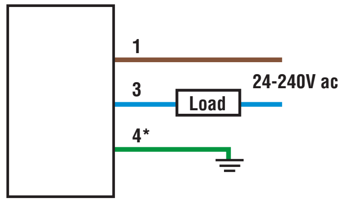
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow

5-Pin Mini



AC10 SM30 2-wire AC Receivers with Attached Cables



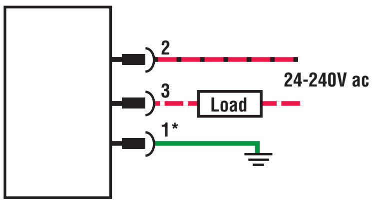
* Connect green wire to earth ground whenever a stainless steel model is powered by ac voltage.

NOTE: Wire a load in series before powering up sensor.

Key

1 = Brown
2 = Blue
3 = Green

AC11 SM30 2-wire AC Receivers



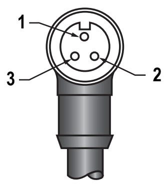
* Connect green wire to earth ground whenever a stainless steel model is powered by ac voltage.

NOTE: Wire a load in series before powering up sensor.

Key

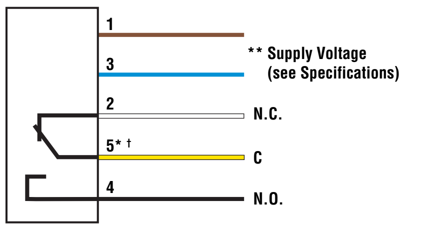
1 = Green
2 = Red/Black
3 = Red/White

3-Pin Mini



Universal AC/DC Hookups

UN01 SPDT Electromechanical Relay Output

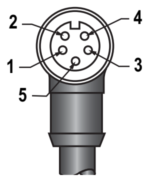


** NOTE: Connection of dc power is without regard to polarity.

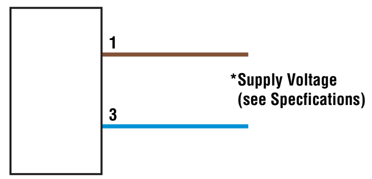
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow

5-Pin Mini



UN02 Emitters



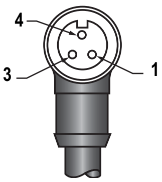
* NOTE: Connection of dc power is without regard to polarity.

Key

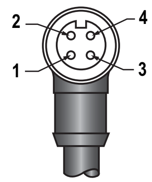
1 = Brown
2 = Blue
3 = Black†

† Not Used

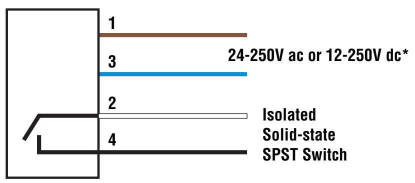
3-Pin Mini



4-Pin Mini



UN03 SPST Solid-State Relay Output

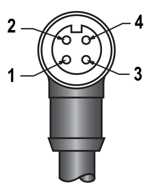


*NOTE: Connection of dc power is without regard to polarity.

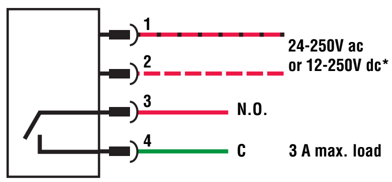
Key

1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Mini



UN04 SPST Electromechanical Relay Output

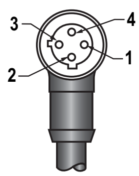


*NOTE: Connection of dc power is without regard to polarity.

Key

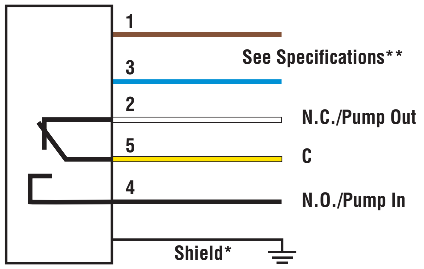
1 = Red/Black
2 = Red/White
3 = Red
4 = Green

4-Pin Micro



Universal AC/DC Hookups

UN05 Normally Open/Pump-In

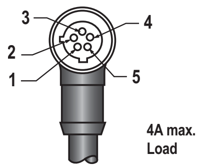


* It is recommended that the shield wire be connected to earth ground.
** DC hookup is without regard to polarity.

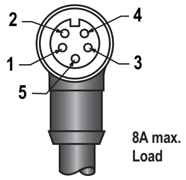
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow

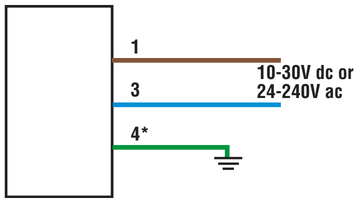
5-Pin Micro



5-Pin Mini



UN06 SM30 Emitters with Attached Cable



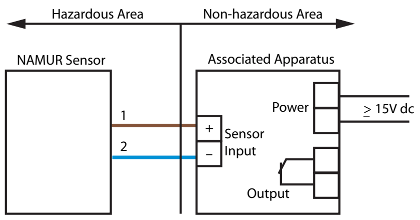
* Connect green wire to earth ground whenever a stainless steel model is powered by ac voltage.

Key

1 = Brown
3 = Blue
4 = Green

Special Hookups

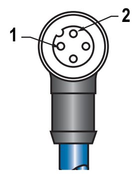
SP01 NAMUR Hookup



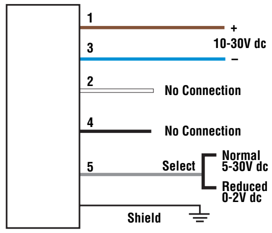
Key

1 = Brown
2 = Blue

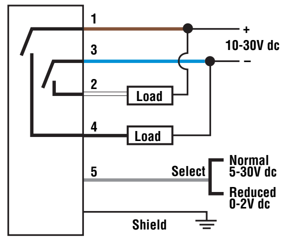
4-Pin Euro Namur



SP02 LX Emitter



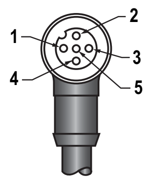
LX Receiver



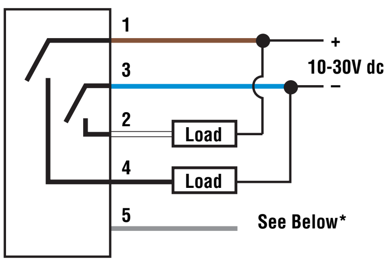
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



SP03 SL10, SL30 and SLO30

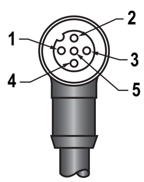


* For Dark Operate, connect gray wire to + (brown). For Light Operate, connect gray wire to – (blue) or leave circuit open.

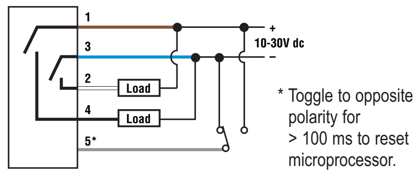
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro

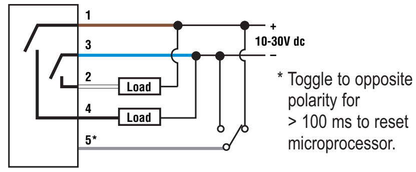


SP04 SLC1 Outputs ON for gap between labels



* Toggle to opposite polarity for > 100 ms to reset microprocessor.

SLC1 Outputs ON for labels

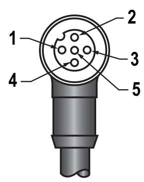


* Toggle to opposite polarity for > 100 ms to reset microprocessor.

Key

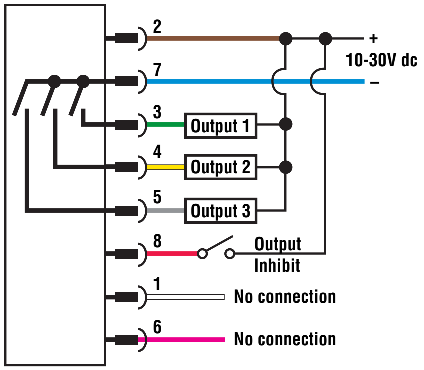
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



Special Hookups

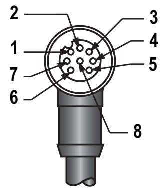
SP05 QC50/QCX50 Current Sinking (NPN)



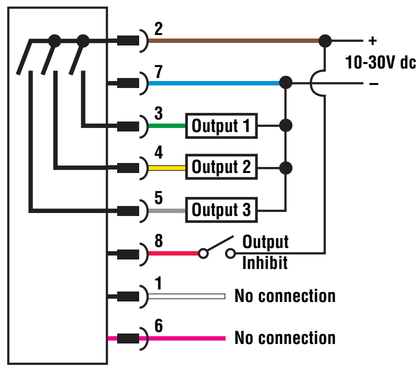
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Pink
7 = Blue
8 = Red

8-Pin Euro



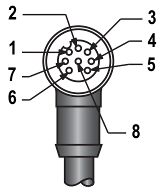
SP06 QC50/QCX50 Current Sourcing (PNP)



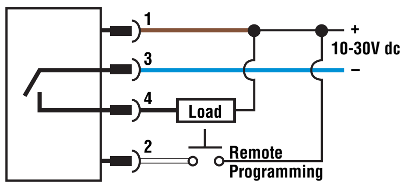
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Pink
7 = Blue
8 = Red

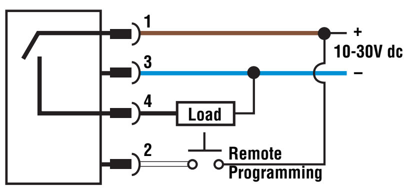
8-Pin Euro



SP07 QL50 Current Sinking (NPN)



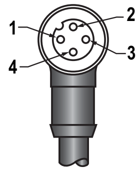
QL50 Current Sourcing (PNP)



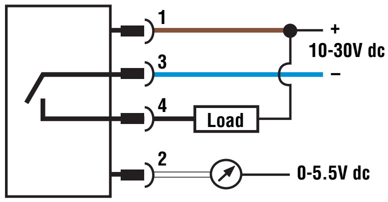
Key

1 = Brown
2 = White
3 = Blue
4 = Black

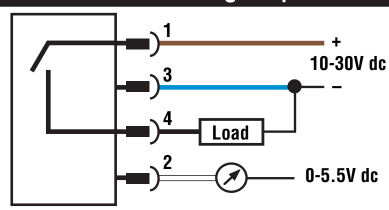
4-Pin Euro



SP08 QL55 Current Sinking (NPN) with Analog Output



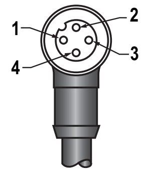
QL55 Current Sourcing (PNP) with Analog Output



Key

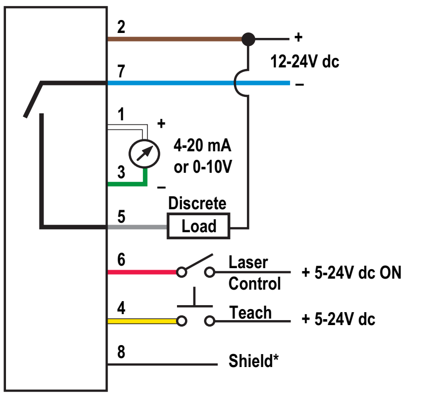
1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Euro



Measurement and Inspection Hookups

MI01 — LT3 Analog and Current Sinking (NPN) Discrete Outputs

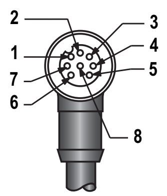


* It is recommended that the shield wire be connected to either earth ground or DC common.

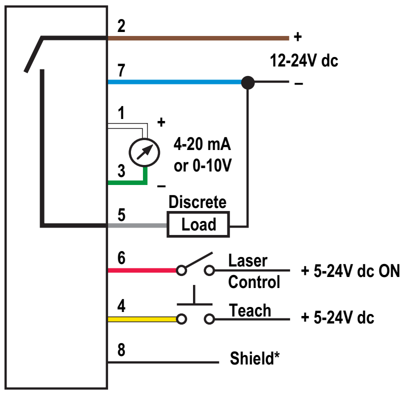
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Red
7 = Blue
8 = Shield

8-Pin Euro



MI02 — LT3 Analog and Current Sourcing (PNP) Discrete Outputs

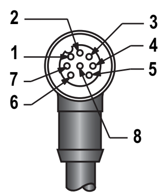


* It is recommended that the shield wire be connected to either earth ground or DC common.

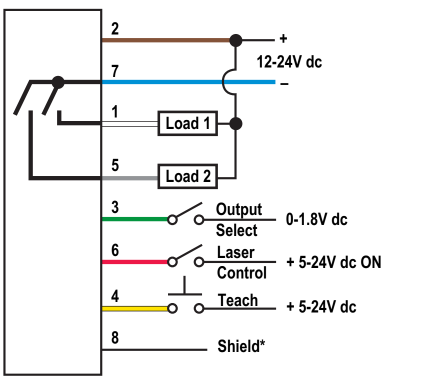
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Red
7 = Blue
8 = Shield

8-Pin Euro



MI03 — LT3 with Two Discrete Outputs Current Sinking (NPN)

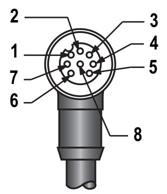


* It is recommended that the shield wire be connected to either earth ground or DC common.

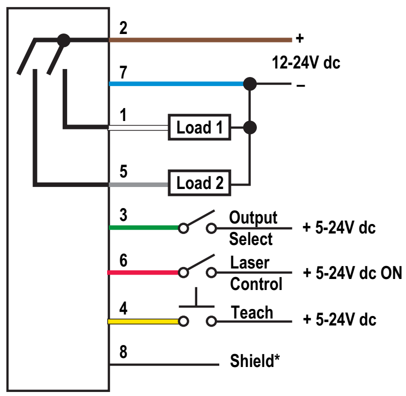
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Red
7 = Blue
8 = Shield

8-Pin Euro



MI04 — LT3 with Two Discrete Outputs Current Sourcing (PNP)

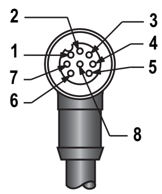


* It is recommended that the shield wire be connected to either earth ground or DC common.

Key

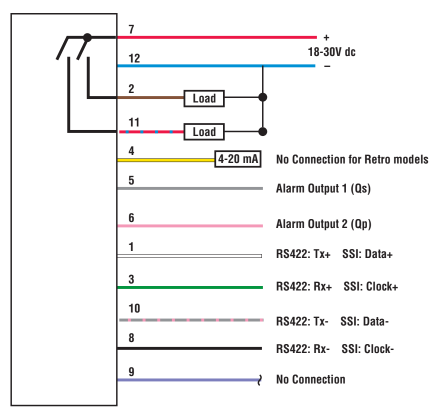
1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Red
7 = Blue
8 = Shield

8-Pin Euro



Measurement and Inspection Hookups

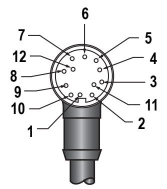
MI05 LT7 Current Sourcing (PNP) and Analog Outputs



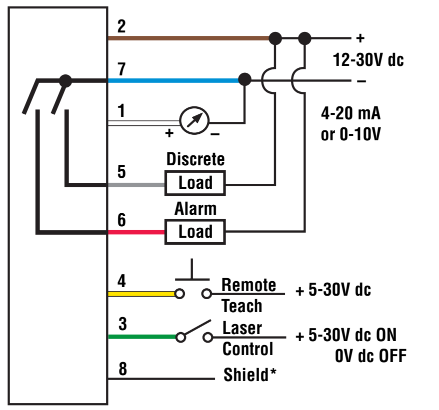
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Pink
7 = Red
8 = Black
9 = Purple
10 = Gray/Pink
11 = Red/Blue
12 = Blue

12-Pin M16



MI06 LG5/LG10 Analog and Current Sinking (NPN) Discrete Outputs

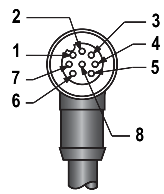


* See data sheet for shield wire connection.

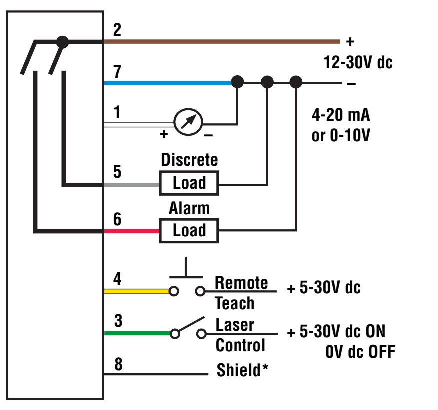
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Red
7 = Blue
8 = Shield

8-Pin Euro



MI07 LG5/LG10 Analog and Current Sourcing (PNP) Discrete Outputs

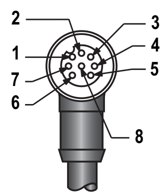


* See data sheet for shield wire connection.

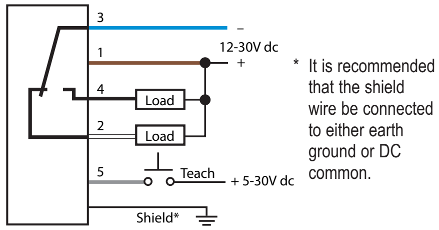
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Red
7 = Blue
8 = Shield

8-Pin Euro

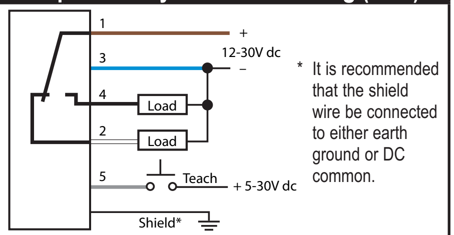


MI08 Q50 with Discrete Outputs Complementary Current Sinking (NPN)



* It is recommended that the shield wire be connected to either earth ground or DC common.

Q50 with Discrete Outputs Complementary Current Sourcing (PNP)

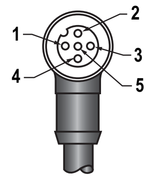


* It is recommended that the shield wire be connected to either earth ground or DC common.

Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



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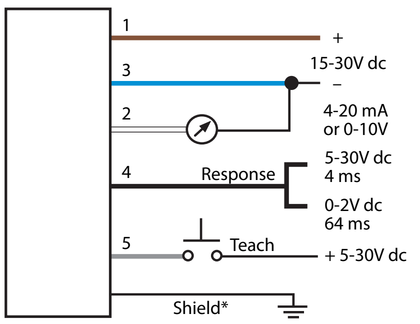
PERFORMANCE CURVES
HOOKUP DIAGRAMS
GLOSSARY
INTERNATIONAL REPS

Measurement and Inspection Hookups

MI09 Q50 with Analog Outputs

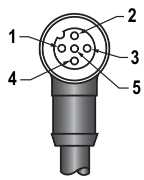


* It is recommended that the shield wire be connected to either earth ground or DC common.

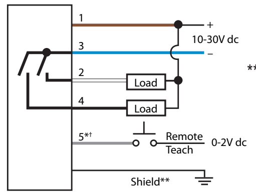
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro

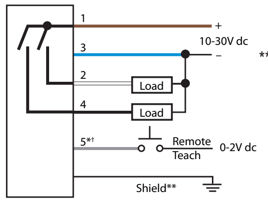


MI10 QT50U with Discrete Outputs Current Sinking (NPN)



** It is recommended that the shield wire be connected to either earth ground or DC common.

QT50U with Discrete Outputs Current Sourcing (PNP)



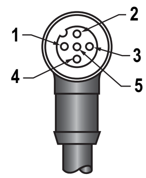
** It is recommended that the shield wire be connected to either earth ground or DC common.

Key

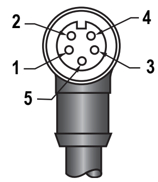
5-Pin Euro
1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray†

5-Pin Mini
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow*

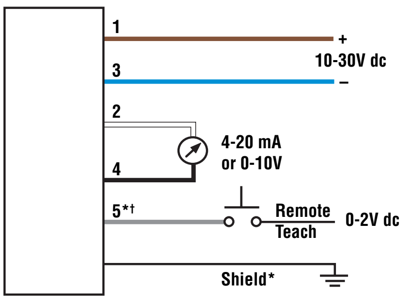
5-Pin Euro



5-Pin Mini



MI11 QT50U with Analog Output



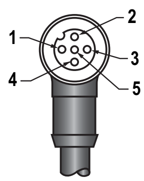
* It is recommended that the shield wire be connected to either earth ground or DC common.

Key

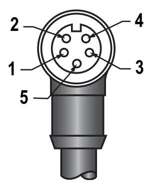
5-Pin Euro
1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray†

5-Pin Mini
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow*

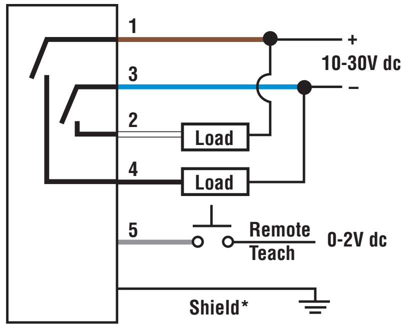
5-Pin Euro



5-Pin Mini



MI12 Bipolar (NPN + PNP) with Shield

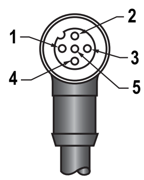


* It is recommended that the shield wire be connected to either earth ground or DC common.

Key

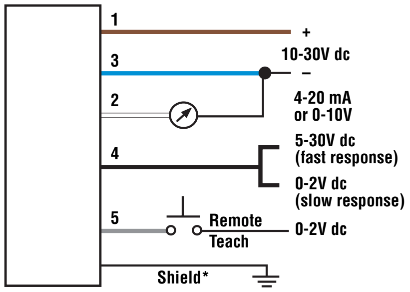
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



Measurement and Inspection Hookups

MI13 S18U with Analog Output

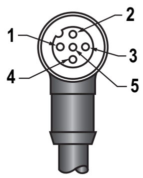


* It is recommended that the shield wire be connected to either earth ground or DC common.

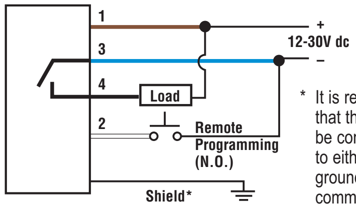
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro

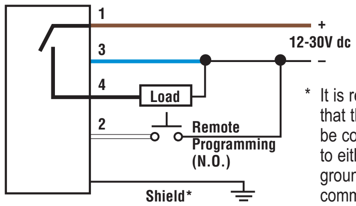


MI14 QS18U Current Sinking (NPN)



* It is recommended that the shield wire be connected to either earth ground or DC common.

QS18U Current Sourcing (PNP)

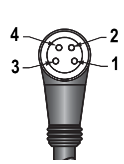


* It is recommended that the shield wire be connected to either earth ground or DC common.

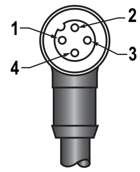
Key

1 = Brown
2 = White
3 = Blue
4 = Black

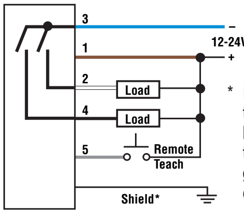
4-Pin Pico



4-Pin Euro

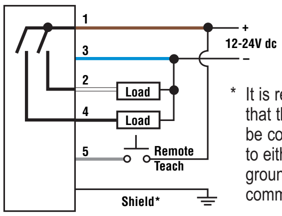


MI15 T30U with Discrete Outputs Current Sinking (NPN)



* It is recommended that the shield wire be connected to either earth ground or DC common.

T30U with Discrete Outputs Current Sourcing (PNP)

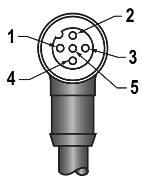


* It is recommended that the shield wire be connected to either earth ground or DC common.

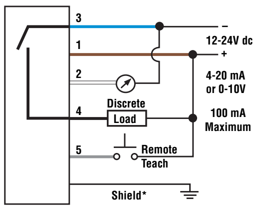
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro

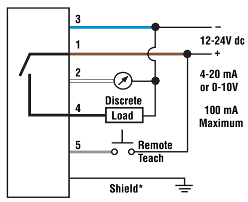


MI16 T30U with Analog & Discrete Outputs Current Sinking (NPN)



* It is recommended that the shield wire be connected to either earth ground or DC common.

T30U with Analog & Discrete Outputs Current Sourcing (PNP)

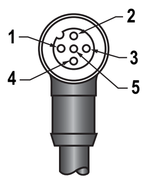


* It is recommended that the shield wire be connected to either earth ground or DC common.

Key

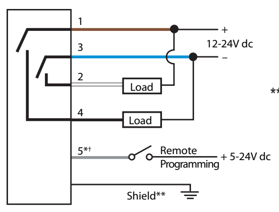
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



Measurement and Inspection Hookups

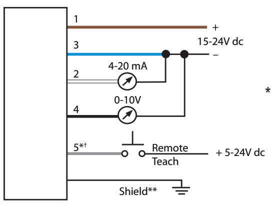
MI17 Q45U & Q45UR with Discrete Outputs



Note: for Q45U models, gray/yellow wire is used for enable.

** It is recommended that the shield wire be connected to either earth ground or DC common.

Q45U & Q45UR with Analog Outputs



Note: for Q45U models, gray/yellow wire is used for enable.

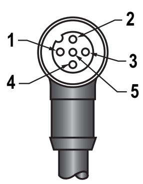
* It is recommended that the shield wire be connected to either earth ground or DC common.

Key

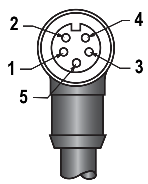
5-Pin Euro
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray†

5-Pin Mini
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Yellow*

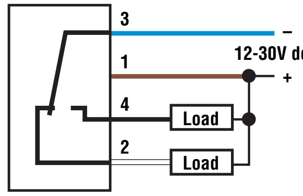
5-Pin Euro



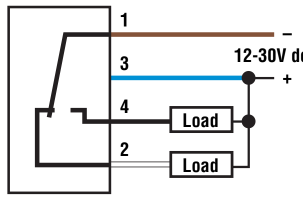
5-Pin Mini



MI18 T18U Current Sinking (NPN) NORMAL Resolution



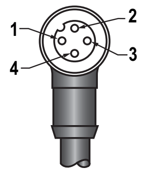
T18U Current Sinking (NPN) HIGH Resolution



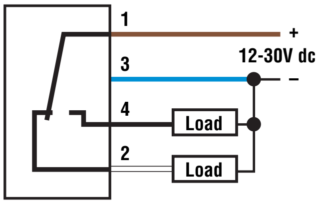
Key

1 = Brown
2 = White
3 = Blue
4 = Black

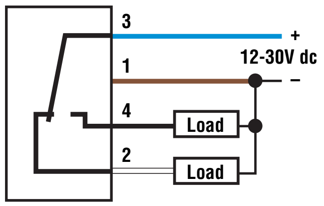
4-Pin Euro



MI19 T18U Current Sourcing (PNP) NORMAL Resolution



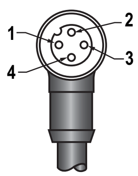
T18U Current Sourcing (PNP) HIGH Resolution



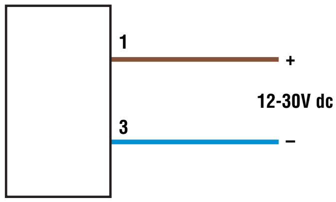
Key

1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Euro



MI20 T18UE Emitter

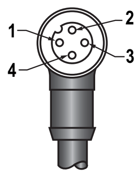


Key

1 = Brown
2 = White
3 = Blue
4 = Black†

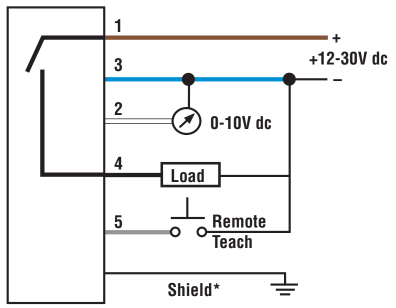
† Not Used

4-Pin Euro



Special Hookups

MI21 M18T with Analog Output

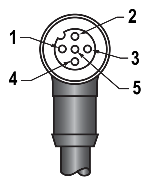


* It is recommended that the shield wire be connected to either earth ground or DC common.

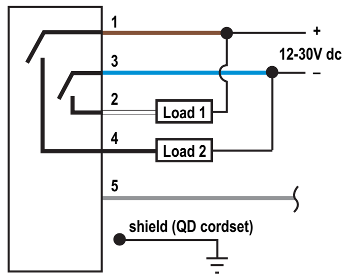
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



MI22 R-GAGE™



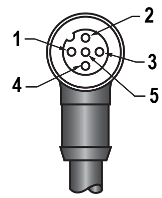
NOTE: It is recommended that the shield wire (QD cordsets only) be connected to earth ground or dc common. Shielded cordsets are recommended for all models.

Key

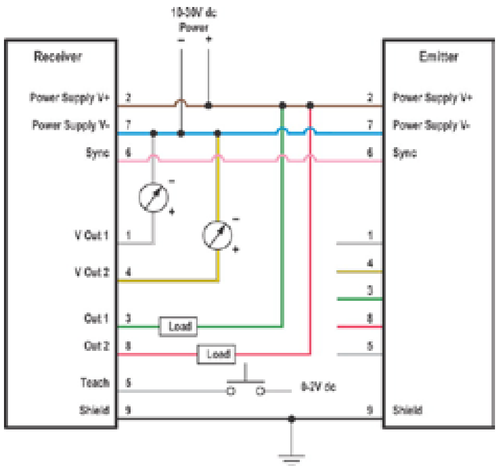
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray*

* Not used

5-Pin Euro



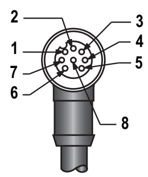
MI23 EZ-ARRAY™ Sinking (NPN) with Analog Output



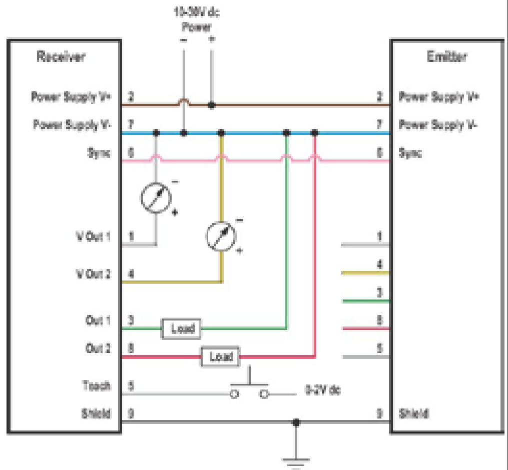
Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Pink
7 = Blue
8 = Red

8-Pin Euro



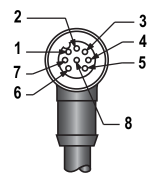
MI24 EZ-ARRAY™ Sourcing (PNP) with Analog Output



Key

1 = White
2 = Brown
3 = Green
4 = Yellow
5 = Gray
6 = Pink
7 = Blue
8 = Red

8-Pin Euro



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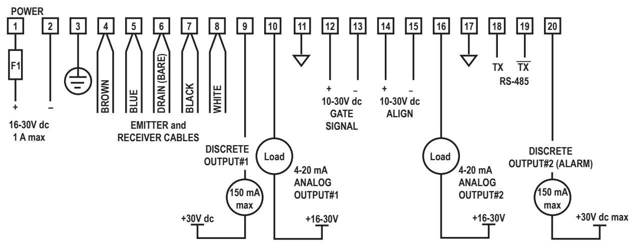
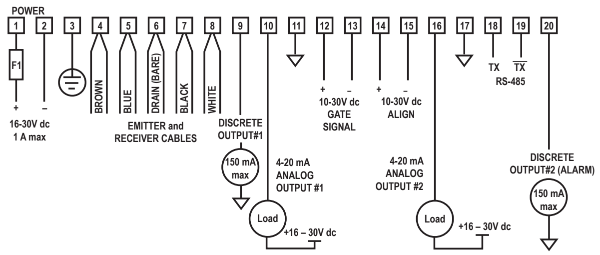
MI25

High-Resolution MINI-ARRAY Discrete (NPN) and Analog (0-10V) MAHCVN-1

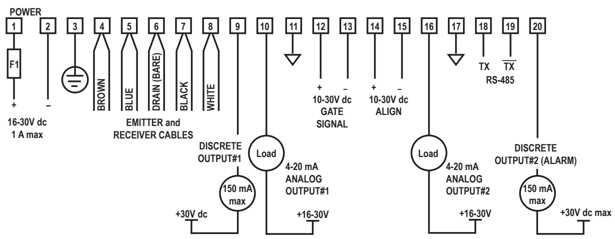


High-Resolution MINI-ARRAY Discrete (PNP) and Analog (0-10V) MAHCVP-1

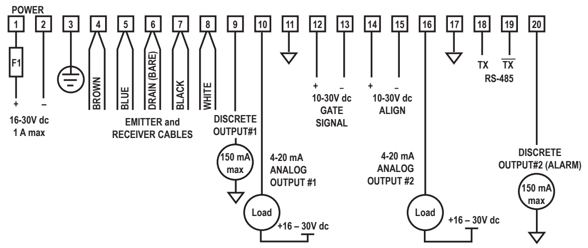


MI26

High-Resolution MINI-ARRAY Discrete (NPN) and Analog (4-20 mA) MAHCIN-1

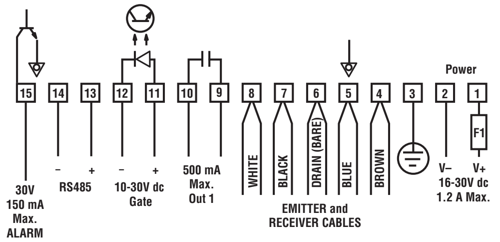


High-Resolution MINI-ARRAY Discrete (PNP) and Analog (4-20 mA) MAHCIP-1



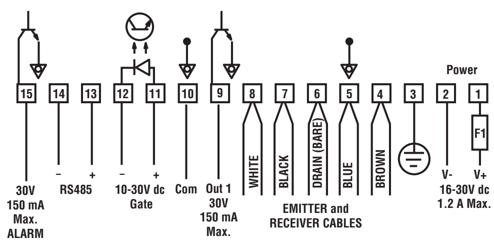
MI27

MINI-ARRAY Discrete Sinking (1-NPN) MAC-1

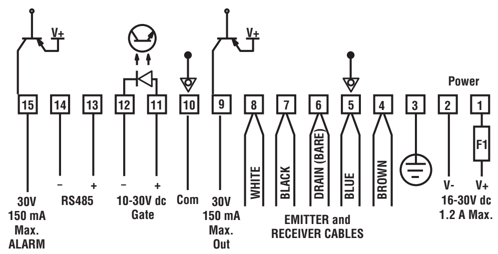


MI28

MINI-ARRAY Discrete Sinking (2-NPN) MACN-1



MINI-ARRAY Discrete Sourcing (2-PNP) MACP-1



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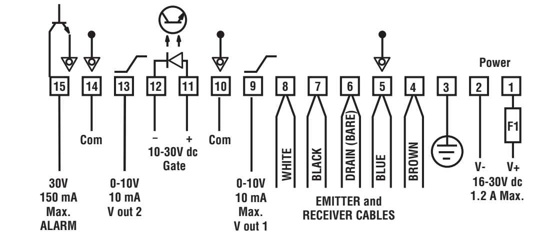
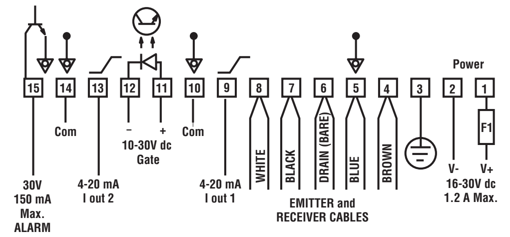
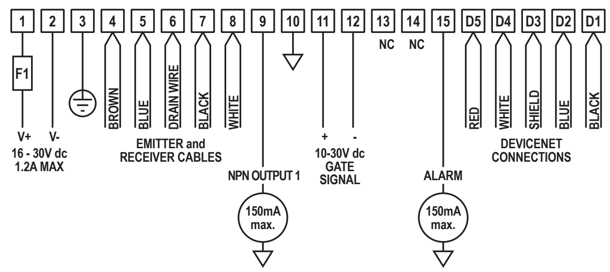
MI29 MINI-ARRAY Discrete Sinking (1-NPN) and Analog (0-10V) MACV-1



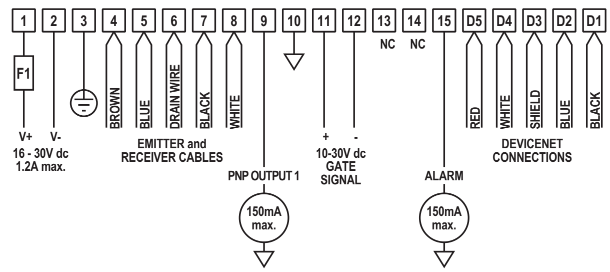
MINI-ARRAY Discrete Sinking (1-NPN) and Analog (4-20 mA) MACI-1



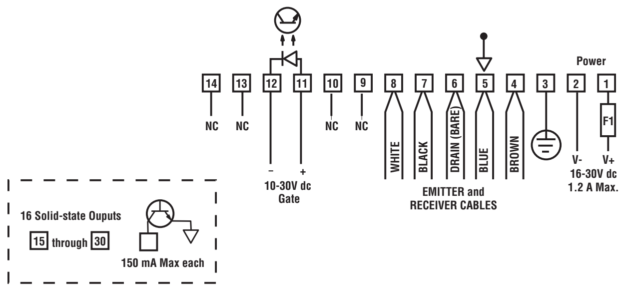
MI30 MINI-ARRAY with DeviceNet™ Sinking (NPN) MACNXDN-1



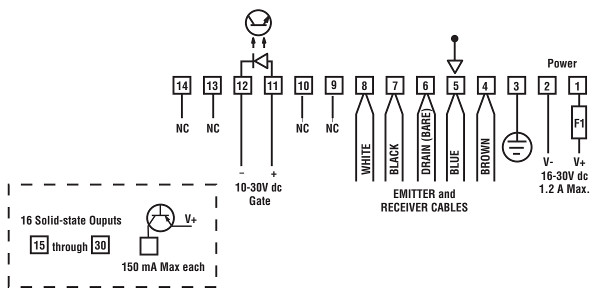
MINI-ARRAY with DeviceNet™ Sourcing (PNP) MACPXDN-1



MI31 MINI-ARRAY Discrete Sinking (16-NPN) MAC16N-1



MINI-ARRAY Discrete Sourcing (16-PNP) MAC16P-1

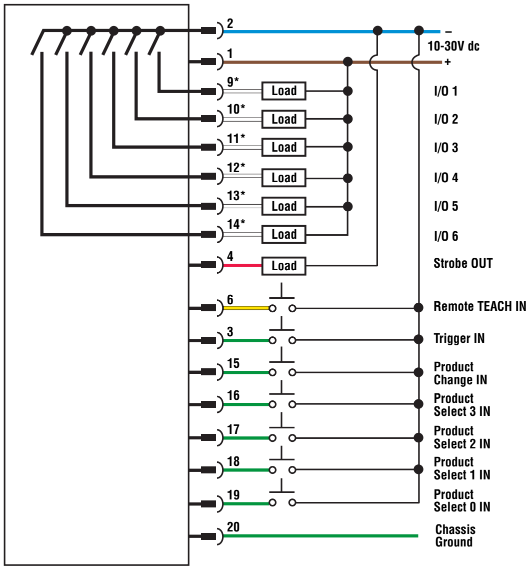


Key

Output 1 = Pin 16
Output 2 = Pin 17
Output 3 = Pin 18
Output 4 = Pin 19
Output 5 = Pin 20
Output 6 = Pin 21
Output 7 = Pin 22
Output 8 = Pin 23
Output 9 = Pin 24
Output 10 = Pin 25
Output 11 = Pin 26
Output 12 = Pin 27
Output 13 = Pin 28
Output 14 = Pin 29
Output 15 = Pin 30
Output 16 = Pin 15

*Presence*Plus® Vision Hookups

VS01 *Pro* NPN Outputs with NPN Inputs†

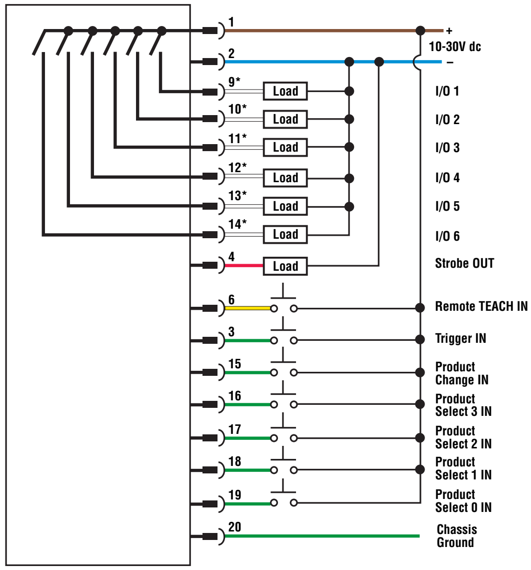


† Inputs can be either NPN or PNP.
* Can be independently configured as an output or input.
** Not used

Key

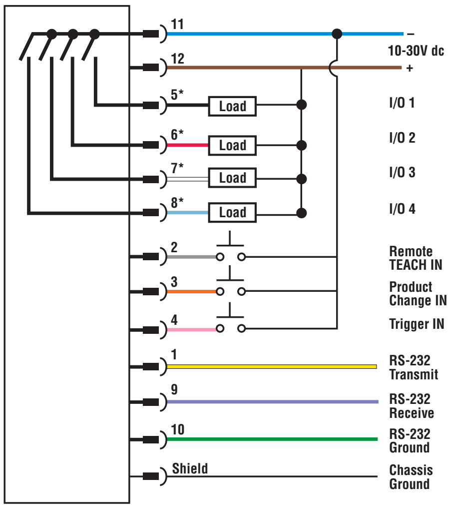
1 = Brown
2 = Blue
3 = Green
4 = Red
5 = Yellow**
6 = Yellow
7 = Yellow**
8 = Yellow**
9 = White*
10 = White*
11 = White*
12 = White*
13 = White*
14 = White*
15 = Green
16 = Green
17 = Green
18 = Green
19 = Green
20 = Green

VS02 *Pro* PNP Outputs with NPN Inputs†



† Inputs can be either NPN or PNP.
* Can be independently configured as an output or input.
** Not used

VS03 *P4* NPN Outputs with NPN Inputs†

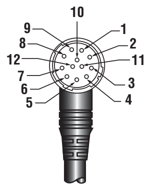


† Inputs can be either NPN or PNP.
* Can be independently configured as an output or input.

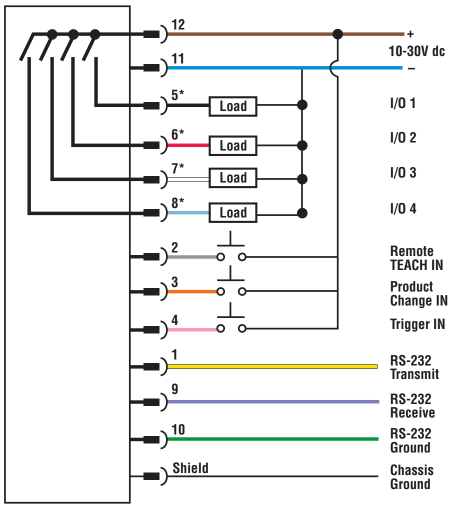
Key

1 = Yellow
2 = Gray
3 = Orange
4 = Pink
5 = Black*
6 = Red*
7 = White*
8 = Light Blue*
9 = Purple
10 = Green
11 = Blue
12 = Brown
Shield = Bare Metal

12-Pin QD



VS04 *P4* PNP Outputs with NPN Inputs†

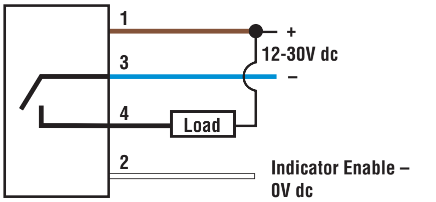


† Inputs can be either NPN or PNP.
* Can be independently configured as an output or input.

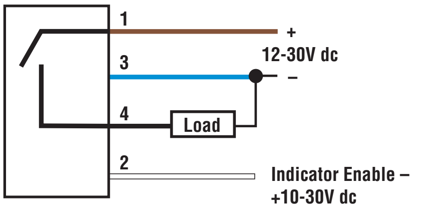
EZ-LIGHT™ Hookups

IN01

K50 and K80 Current Sinking (NPN) Hookup for Solid Job Light



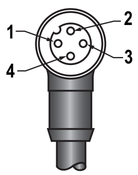
K50 and K80 Current Sourcing (PNP) Hookup for Solid Job Light



Key

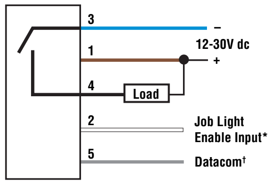
1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Euro



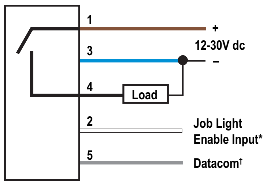
IN02

PVD with Switch-Selectable Output Current Sinking (NPN)



* See configuration information in data sheet for job light enable input requirements.
† For specialized applications requiring custom configuration options. See data sheet and contact your Banner representative for more information.

PVD with Switch-Selectable Output Current Sourcing (PNP)

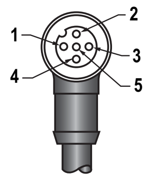


* See configuration information in data sheet for job light enable input requirements.
† For specialized applications requiring custom configuration options. See data sheet and contact your Banner representative for more information.

Key

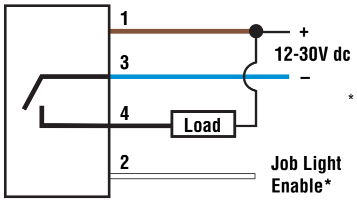
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



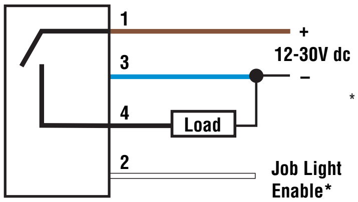
IN03

PVA Current Sinking (NPN)



* See data sheet for Programming information or job light enable requirements.

PVA Current Sourcing (PNP)

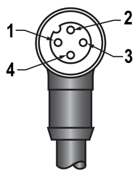


* See data sheet for Programming information or job light enable requirements.

Key

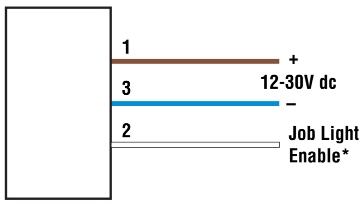
1 = Brown
2 = White
3 = Blue
4 = Black

4-Pin Euro



IN04

PVA Emitter



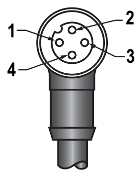
* See data sheet for Programming information or job light enable requirements.

Key

1 = Brown
2 = White
3 = Blue
4 = Black†

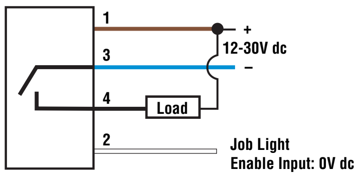
† Not Used

4-Pin Euro

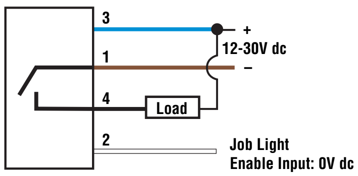


EZ-LIGHT Hookups

IN05 VTB Current Sinking (NPN) 1-Color for Solid Job Light



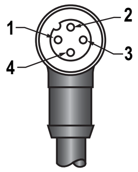
VTB Current Sinking (NPN) 1-Color for Flashing Job Light



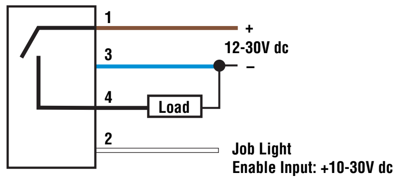
Key

1 = Brown
2 = White
3 = Blue
4 = Black

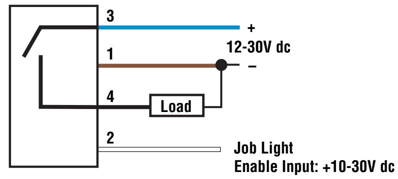
4-Pin Euro



IN06 VTB Current Sourcing (PNP) 1-Color for Solid Job Light



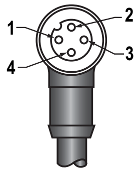
VTB Current Sourcing (PNP) 1-Color for Flashing Job Light



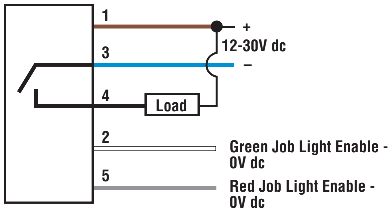
Key

1 = Brown
2 = White
3 = Blue
4 = Black

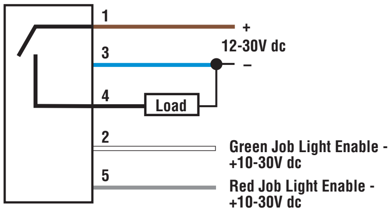
4-Pin Euro



IN07 VTB Current Sinking (NPN) 2-Color Job Light



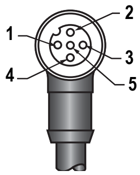
VTB Current Sourcing (PNP) 2-Color Job Light



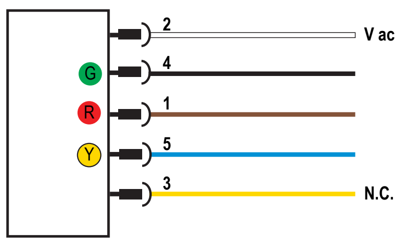
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro QD



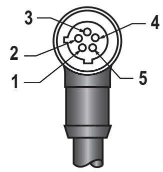
IN08 EZ-LIGHT General-Purpose AC Input



Key

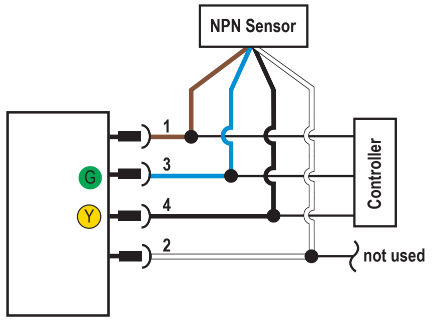
1 = Brown
2 = White
3 = Yellow
4 = Black
5 = Blue

5-Pin Micro



EZ-LIGHT™ Hookups

IN09 Sensor Emulator Sinking (NPN) Input

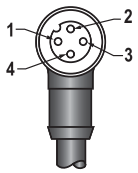


Key

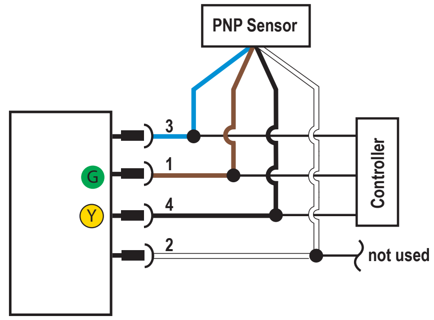
1 = Brown
2 = White†
3 = Blue
4 = Black

† Not Used

4-Pin Euro



IN10 Sensor Emulator Sourcing (PNP) Input

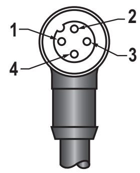


Key

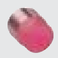
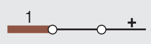
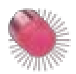
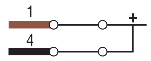
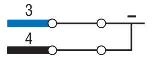
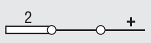
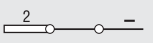
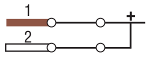
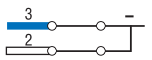
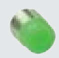
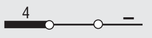
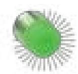
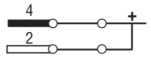
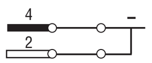
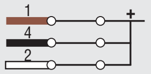
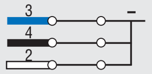
1 = Brown
2 = White†
3 = Blue
4 = Black

† Not Used

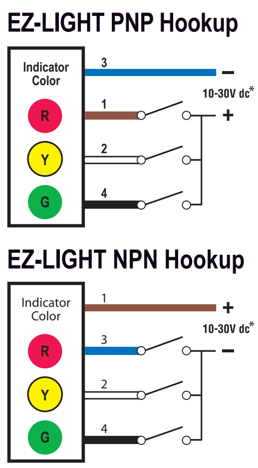
4-Pin Euro



IN11 EZ-LIGHT Indicators–General-Purpose and Multi-Function

Multi-Function	General	Light/ Flash	PNP Hookup	NPN Hookup	Function*
•	•				Red steady
•					Red flashes
•	•				Yellow steady
•					Yellow flashes
•	•				Green steady
•					Green flashes
•					Red, Green, Yellow flash cycle

Wiring Diagram



* K50L and K80L voltage 18-30V dc

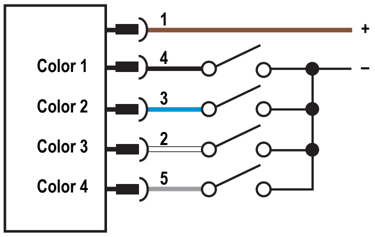
Wiring key: 1 = Brown; 2 = White; 3 = Blue; 4 = Black

* LED Function is for 3-color, multi-function models. See data sheets for 4- and 5-color LED function information. General-purpose models do not have flash function.

iKNOW®
PERFORMANCE CURVES
HOOKUP DIAGRAMS
GLOSSARY
INTERNATIONAL REPS

EZ-LIGHT™ Hookups

IN12 EZ-LIGHT K80L Segmented Sinking (NPN) Input†

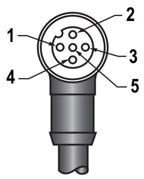


† Hookup is for 4 segment models. Depending on the number of segments, Pins 5, 2 and 1 may not be used.

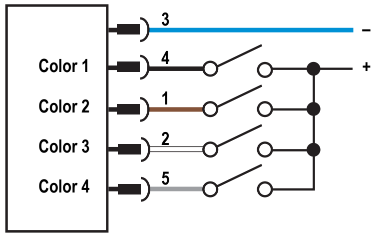
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



IN13 EZ-LIGHT K80L Segmented Sourcing (PNP) Input†

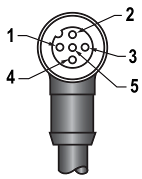


† Hookup is for 4 segment models. Depending on the number of segments, Pins 5, 2 and 1 may not be used.

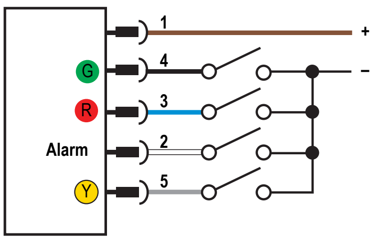
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



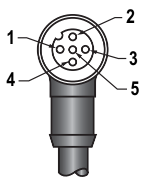
IN14 EZ-LIGHT Audible Sinking (NPN) Input



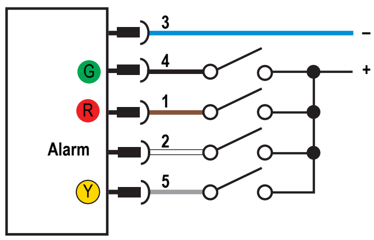
Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



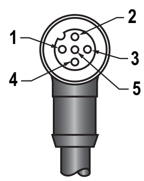
IN15 EZ-LIGHT Audible Sourcing (PNP) Input



Key

1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

5-Pin Euro



2-wire sensor

A sensor designed to wire in series with its load, exactly like a limit switch. A 2-wire sensor remains powered when the load is "off" by a residual "leakage current" that flows through the load.

2.4 GHz

One of the ISM bands in the radio spectrum that is recognized worldwide. Experiences more path loss than 900 MHz band.

902-928 MHz Band

One of the ISM bands in the radio spectrum recognized in North America, Australia, and Israel; characterized by lower throughput but better range and wall penetration.

A

A/D converter

(Analog to Digital Converter) An electronic device that converts data from analog form to digital, or binary code for a computer.

AC

(Alternating Current) A sinusoidal current rated at a given frequency.

Acceleration

The rate of change of velocity, with respect to time.

Accuracy (1)

1. The degree to which a measured value is similar to an actual value.
2. The extent to which vision sensors can correctly measure and obtain a true value of a feature.

Accuracy (2)

The difference between indicated value and actual value, at room temperature. In most cases, the accuracy of a measurement and inspection sensor is comprised of two main sources of error: the resolution and the linearity.

Acquisition

The manner in which outside information is brought into an analysis system; an image acquisition generally involves A/D conversion.

Adjustable-field mode

Adjustable-field sensors use two receivers and a comparator circuit to cancel sensing response whenever the intensity of the reflected light reaching the long-range receiver exceeds the intensity of the reflected light reaching the close-range receiver. As a result, any object lying beyond the sensor's "cutoff point" can be reliably ignored.

Alignment

Positioning of a sensor so that the maximum amount of the emitted energy reaches the receiver sensing element.

AM

Abbreviation for Amplitude Modulation. Type of modulations in which the data signal is "attached" to a carrier wave by varying the amplitude of the carrier wave.

Ampere

(Amp) A unit of measurement of electric current.

Amplifier

A device that accepts a small signal and outputs a larger signal generally matching the characteristics of the input signal. Amplifiers are available to boost electrical and optical signals.

Analog

Pertaining to a class of devices or circuits in which the output varies as a continuous function of the input.

Analog output

A sensor output that varies over a range of voltage (or current) and is proportional to some sensing parameter (as opposed to a digital output).

Analysis tools

Tool set included in vision software which uses information analyzed by the Vision Tools to create distance, size and count measurements and result tolerances for the vision tools.

AND logic

A logic function in which all of two or more defined input conditions must exist simultaneously before a load is energized (A and B and C = output).

Angle of acceptance

The included angle of the area of sensor response.

Angle of incidence

The angle at which light strikes a surface.

Angle of view

1) The angle formed between two lines drawn from the most widely separated points in the object plane to the center of the lens.
2) The angle between the axis of observation and perpendicular to the specimen surface.

Antenna

An electronic component used to transmit and receive radio waves, in a narrow frequency range.

Anti-glare

A lens attachment consisting of a pair of polarizing filters oriented so that planes of polarization are at 90 degrees to one another.

Aperture

1. The size of a lens opening.
2. A mechanical part attached to a lens used to restrict the size of a lens opening.

Architecture

Overall design or structure of a system or network, including all hardware and software.

Area light

An area light provides even illumination in a concentrated area.

ASCII

Acronym of American Standard Code for Information Interchange. Pronounced askee. An 8 bit coded character set used to represent alphanumeric, punctuation marks and certain special control characters.

ASIC

Acronym for Application Specific Integrated Circuit. A chip designed for a specific application rather than a general-purpose chip such as a microprocessor.

Aspect Ratio

The width to height of an object. The ratio states the relationship of one side to the other. A computer monitor is 4:3, meaning 4 units wide by 3 units high.

Asynchronous

Describes serial communication that does not use a receive and transmit synchronizing clock signal to transmit data.

Attenuation

Lessening or loss of signal intensity during transmission.

B

Background

The parts of a scene in and around the Feature of Interest (FOI) that are not "of interest" to the software.

Background suppression

A photoelectric proximity sensing mode with response that is similar to a diffuse sensor, but with a defined range limit. Two background suppression modes are fixed-field and adjustable-field.

Backlight

Lighting option that provides even, low-intensity light. It is placed behind the target and aimed directly back towards the camera. The resulting silhouette can be inspected for proper size and shape.

Backlighting

A condition where the light reaching the image sensor is not reflecting from the surface of the object, but is provided behind the objects or area of interest.

Band

A section of the RF spectrum.

Bandwidth

Width of radio frequency band. For analog signals, this is measured in Hertz. With digital signals, bandwidth describes the amount of data that can be transferred through a signal connection in a given time, measured in bits or bytes per second.

Bar code

A coding system designed to be read and decoded by optical scanners. One dimensional or linear bar codes are made up of black bars and white spaces, representing a string of numbers or letters. Two-dimensional bar codes are read on two axes and typically contain more data in a smaller space.

Baud Rate

Data rate in bits per second.

Beam angle

The cone of sonic energy emitted by an ultrasonic sensor that diverges with distance.

Beam pattern

A two-dimensional graph of a sensor's response. Beam patterns are helpful in predicting the performance of the sensor.

Bend radius

The radius below which an optical fiber should not be bent. Usually bend radius is a function of tensile strength.

Bifurcated fiber

A fiber optic assembly that is branched to combine emitted light with received light in the same assembly.

BiModal output

An exclusive Banner output circuit design that offers either sinking (NPN) or sourcing (PNP) output, depending upon the polarity with which the two DC supply leads are connected.

Binding

Locking a Node to a specific Gateway by teaching the Node the Gateway's unique serial number. After a Node is bound, the Node only accepts data from the Gateway to which it is bound.

Bipolar output

The dual output configuration of a DC sensing device, where one output switch is a sinking device (NPN) and the other output switch is a sourcing device (PNP). The solid-state equivalent of a DPST relay (for most loads).

Blind spot

The area close to a sensor lens, where light energy is returned to the emitter rather than the receiver, rendering the sensor effectively blind. This effect is most pronounced with some retroreflective sensors.

BLOB

A connected region in an image in which all pixels have the same gray-level value.

Bright-field

Lighting of objects or surfaces at an angle close to perpendicular so that the light is reflected back into the optics directly.

Broadband

A high-speed data transmission rate, where two or more signals may share the cable.

Burn-through

Describes the ability of high-powered modulated opposed mode sensors to "see" through paper, thin cardboard, opaque plastics, and materials of similar optical density.

Bus

A common pathway or circuit between multiple devices. One of the primary network configurations or topologies.

Bus Network

A network architecture in which multiple devices are connected by a shared communication line.

C

C-mount

Threaded lens mount developed from 16 mm movie work; used extensively for closed-circuit television.

Cable assembly
An optical fiber cable that has connectors installed on one or both ends.

Carrier Wave
A high-frequency waveform that can be modulated in amplitude, phase or frequency to carry a signal from a transmitter to a radio receiver.

CCD
Abbreviation for Charge Coupled Device. An analog device that captures light for conversion to electricity.

Character
A single letter, digit or punctuation mark requiring one byte storage.

Channel
A path for communications. A range of radio frequencies used by a transceiver during communication.

Circuit
1. An electronic path between two or more components capable of providing a number of channels.
2. Interconnection of conductors to carry an electrical current.

Cladding
The material surrounding the core of an optical fiber. The cladding has a lower refractive index (faster speed) to keep the light in the core.

Clean air
An operating environment in which no dirt build-up occurs on lenses or reflectors.

CMOS
Acronym for Complementary Metal Oxide Semiconductor. A CMOS-based chip that records the intensities of light as variable charges similar to a CCD chip.

CNC
Abbreviation for Complementary Normally Closed

Coating
A protective layer applied over the fiber cladding to protect it from the environment.

Collimated source
A light source that emits light in parallel beams.

Collimation
The process by which a lens converts a divergent beam into a parallel beam of light.

Color marks
Also known as registration marks or index marks, color marks are used extensively in packaging applications for registering the cutoff of wrapping or bagging materials so that product names and other information always appear in the same location.

Color sensitivity
The change in output when the color of a target changes.

Communication tool
A tool included in vision software which exports inspection results to an external device.

Complementary Normally Closed
(CNC) An auxiliary (non-safety) output that is always in an opposite state to its associated normally open safety output, even in the event of a single failure.

Complementary output
The dual output configuration of a sensing device, where one output is normally open and the other is normally closed.

Contact
One of the current-carrying parts of a relay, switch, or connector that open and close to complete associated electrical circuits.

Contact configuration
Refers to the construction of a relay or a switch, in many configurations, for example, SPDT (Form C), with one normally open, one normally closed, and one common between the two.

Contamination
Dirt, dust, smoke, or fog in the sensing path; plus dirt, dust, fog, oil, grease, or soot build-up on the face of a sensor can all contribute to attenuation of the light energy available for sensing.

Continuous trigger
Functionality that allows a sensor to take pictures continuously without being triggered by an external device.

Contrast
The ratio of the amount of light falling on the receiver in the “light” condition as compared to the “dark” condition. Optimizing contrast in any sensing situation will increase the reliability of the sensing system.

Control relay
Type of relay used to perform logic functions in a machine control circuit.

Convergent mode
A special variation of diffuse mode photoelectric proximity sensing which uses additional optics to create a small, intense, and well-defined image at a fixed distance from the front surface of the sensor lens.

Core
The central region of an optical fiber through which light is transmitted. It has a higher refractive index (slower speed) than the surrounding cladding.

Corner-cube prisms
A prism having three mutually perpendicular surfaces and a hypotenuse face. Used in retroreflectors.

Coupler
A device that combines two or more fiber optic signals into one, or divides one fiber optic signal into two or more.

Coupling
1. Transfer of energy from one circuit to another.
2. Transfer of light energy using a fiber optic cable. This term does not imply that a coupler is used.

Critical angle
The maximum angle from the central axis of a fiber optic cable at which light can be confined within the core.

Crosstalk
Optical crosstalk occurs when a photoelectric receiver responds to light from an adjacent emitter.

Current
The flow of electrons through a circuit. Measured in “amperes.”

Current sinking output
The output of a DC device that switches ground (DC common) to a load. The load is connected between the output of the device and the positive side of the power supply. The switching components is usually an open collector NPN transistor, with its emitter tied to the negative side of the supply voltage.

Current sourcing output
The output of a DC device that switches positive DC to a load. The load is connected between the output of the device and the ground (DC common) side of the power supply. The switching component is usually an open collector PNP transistor, with its emitter tied to the positive side of the supply voltage.

Cutoff distance
See cutoff point.

Cutoff point
Definable point at which the a sensor will actuate or will cease to operate. All objects beyond the cutoff point are ignored by the sensor. Cutoff point can be influenced by the range of the sensor and by its other physical specifications.

Cyclic Reporting
The Gateway polls the Node at user-defined intervals.

D

Dark condition
One of two sensing conditions in a sensing application which is characterized by a lower level of received sensing energy, or in some case, no energy.
See also Light Condition.

Dark operate
(D/O) The initiation of a photoelectric sensor’s output (or of timing logic) when the receiver goes sufficiently dark. See also light operate.

Dark-field
Lighting of object or surfaces at very shallow or low angles so that the light does not enter the optics directly.

DC (Direct Current)
A current that flows only in one direction through a circuit.

Deadband
The region where the sensor cannot make measurements.

Demod (Demodulation) Falling
A discrete input point must detect a specific number of inputs low before the input in considered to have changed state.

Demod (Demodulation) Rising
A discrete input point must detect a specific number of inputs high before the input in considered to have changed state.

Depth-of-field (1)
The range of distance within which a sensor has a response. Used to define the response pattern of proximity-mode sensors, especially ultrasonic and photoelectric convergent, fixed-field and adjustable-field sensors.

Depth-of-field (2)
The in-focus range of an imaging system. Measured from the distance behind an object to the distance in front of the object with all objects appearing in focus.

Depth-of-focus
The range of lens to image plane distance having the image formed by the lens appearing in focus.

Device Address
Unique identifier for each wireless device on a network.

DeviceNet
The bus-type wiring scheme, specifically for automation sensors, that allows sensors and controllers to exchange data over a single cable.

Diffraction
The bending of light rays as they pass around corners or through holes smaller than their own wavelengths.

Diffuse light
Soft lighting that is scattered from a variety of angles in order to eliminate shadows and view highly specular surfaces.

Diffuse mode
A photoelectric proximity sensing mode in which light from the emitter strikes a surface of an object at some arbitrary angle and is diffused from the surface at all angles.

Diffuse Source
A light source that illuminates a target from many directions, eliminating shadows or glare.

Digital output
A sensor that exists in only one of two states: “on” or “off.” The outputs of most sensors and sensing systems is digital.

Digitization
Sampling and conversion of image or signal into a digital code by scanning or using an analog to digital converter.

DIN standard
(Deutsches Institut fur Normung) A collection of German industry standards.

Diode
A two-layer semiconductor that allows current to flow in only one direction.

Dispersion
The spreading or broadening of light rays as they travel through a fiber optic strand. The fiber property that causes this effect is also called dispersion.

Distortion
An undesired change in the shape of an image or waveform from the original object or signal.

Divergent mode
A variation of the diffuse photoelectric sensing mode in which the emitted beam and the receiver's field of view are both very wide.

DPDT
(Double-Pole Double-Throw) A relay with two sets of single-pole double-throw (Form C) contacts that are operated simultaneously by a single action.

DPST
(Double-Pole Single-Throw) A switch configuration that has four terminals. One pair is used to connect or disconnect to the other pair.

Driver
A type of software that enables communication between a computer and a peripheral device. Also known as device driver.

Dropping resistor
A precision resistor used to convert a 4 to 20 mA signal to a voltage signal.

DSSS
Abbreviation for Direct Sequence Spread Spectrum. A method for generating spread spectrum transmissions where the transmitted signal is sent at a much higher frequency than the original signal, spreading the energy over a much wider band. The receiver is able to de-spread the transmission and filter the original message. DSSS is useful for sending large amounts of data in low to medium interference environments.

E

Edge
A change in pixel values exceeding some threshold between two adjacent regions of relatively uniform values. Edges correspond to changes in brightness corresponding to a discontinuity in surface orientation, reflectance, or illumination.

Effective beam
The "working" part of a photoelectric beam. Not to be confused with the actual radiation pattern of the emitter, or with the field of view of the receiver.

Electromechanical
Any device using electrical energy to produce mechanical movements.

Electromechanical relay
Conventional switching relays consisting of "hard" contacts (metal-to-metal), switched to opened or closed position by applying voltage to an electromagnetic coil.

EMI
Abbreviation for electromagnetic interference. Electrical "noise" which may interfere with proper operation of sensors, programmable logic controllers, counters, data recorders, and other sensitive electronic equipment.

Emissivity
A measurement of the thermal signature and characteristics of different materials and surfaces.

Emitter
1. The sensor containing the source of sensing energy in opposed-mode sensing.
2. The emitting device within any sensor (e.g. LED, laser diode, ultrasonic transducer, etc.).

Ethernet
Access method for computer network (Local Area Networks) communications, defined by the IEEE as the 802.3 standard.

Excess gain
The measurement of the amount of light falling on the receiver of a sensing system over and above the minimum amount of light required to just operate the sensor's amplifier.

Extension tube
Spacers between the lens and the camera that allow the lens to focus at closer working distances.

F

F/stop
The ratio of the focal length of a system to the diameter of the entrance pupil.

False triggering
Refers to a change in a sensor's output, when there should be no change.

Fast response
Any response time that is faster than 1 millisecond.

Feature
Used in vision applications to describe any characteristic descriptive of an image or a region in an image.

Ferrule
A ceramic, plastic or stainless steel part of a fiber optic termination that holds the end of the fiber and aligns it to the sensor for fiber mounting.

FHSS
Abbreviation for Frequency Hopping Spread Spectrum. A method for generating spread spectrum transmissions where the signal is switched between different frequency channels in a pseudorandom sequence known by both the transmitter and the receiver pair. FHSS is useful for sending small, redundant packets of data in a high interference environment.

Fiber
A thin filament of glass or plastic consisting of a core (inner region) and a cladding (outer region) and a protective coating.

Fiber optics
Transparent fibers of glass or plastic used for conducting and guiding light energy. Used in photoelectrics as "light pipes" to conduct sensing light into and out of a sensing area.

Field of view (1)
The area of response of an optical sensor.

Field of view (2)
The area of object space imaged at the focal plane of a camera.

Filters
A device placed over a light source or a sensor to select or reject specific frequencies of light.

Fixed-field mode
Fixed-field sensors use two receivers and a comparator circuit to cancel sensing response whenever the intensity of the reflected light reaching the long-range receiver exceeds the intensity of the reflected light reaching the close-range receiver.

***Flex*Power™**
The ability of a device to take multiple types of power including battery, line, or solar.

Flutter
Bouncing or vibrating movement of a sensing target.

FM
Abbreviation for Frequency modulation. A type of modulation in which the data signal is "attached" to the carrier wave by varying the frequency of the carrier wave.

Focal length
The distance from a lens' principal point to the corresponding focal point. Also referred to as the equivalent focal length and the effective focal length.

Focal point
The point at which the lens focuses the image. The imager is located at the focal point.

FOI
Abbreviation for Feature of Interest. The crucial visual information within the imaged scene that the customer is trying to detect for an inspection.

FOV
Abbreviation for Field of View. The area of object space imaged at the focal plane of a camera.

Frequency
The number of recurrences of a periodic phenomenon in a unit of time. Electrical frequency is measured in Hertz (Hz).

Frequency response
The maximum frequencies an analog sensor can track. All analog sensors have an inherent response time that limits their ability to measure periodic motions at high frequencies.

Front lighting
An arrangement in which the object is illuminated and viewed from the same side.

G

Gain
An increase in signal power, voltage, or current by an amplifier.

Gain potentiometer
An electronic device used to set the gain or the switching threshold of a sensor. Also known as a sensitivity adjustment.

Gate
A combinational logic circuit having one or more input channels.

Gateway
A wireless network master communication device used to control and initiate commands to other devices in the system. Serves as a "portal" from one network to another and communicates between the wireless network and the central control process.

Geometry of Propagation
Describes the way a light beam leaves its source, examples include Collimated, Point Source or Diffuse.

GHz
Gigahertz. 1 GHz=1000 MHz.

Glass fibers
Glass fiber assemblies are constructed of a bundle of individual glass fibers, contained and protected by a sheath (typically a flexible armored cable).

Gray scale
Variations of values from white, through shades of gray, to black in a digitized image with black assigned the value of zero and white the value of one.

Ground
A conducting path between an electric circuit or equipment and the earth, or some conducting body serving in place of the earth.

GUI
Acronym for Graphical User Interface, a graphics-based interface through which a user may communicate with a computer.

H

Half Wave
Antenna type whose overall span is one half the length of the wave that can be transmitted.

Hermetic seal
An air-tight seal.

Hop
1. The act of changing from one frequency to another.

2. The device to device transmission link, such as from the Master device to the Slave device.

Housing

Describes several aspects of a sensor: body style, housing material, and sealing capacity.

Hysteresis

Intentional time lag added to a circuit to prevent false actuation or intermittent operation (chatter).

Hz

(Hertz) The international unit of frequency, equal to one cycle per second. Named after the German physicist, Heinrich Rudolph Hertz.

I

I/O

(Input-Output) Provides communication channels to system and to manufacturing process.

Image

Projection of an object or a scene onto an imager chip.

Image acquisition

The capture and generation of an image of an object or scene on the imager chip. Involves the use of illumination, optics, filters and the vision sensor.

Image quality

The degree to which an image shows contrast.

Imager chip

The physical device that replaces film in a digital camera system. Two common types are CCD and CMOS. Also known as imager or image sensor.

Incident light

The light falling directly on an object.

Index of Refraction

The ratio of the velocity of light in a vacuum to the velocity of light in a specific material. Using 1.0 as the base reference, the higher the number, the slower light travels.

Individual fiber

A fiber optic assembly having one control end and one sensing end. Usually used in pairs in the opposed sensing mode.

Inductive proximity sensor

Sensors with an oscillator and coil which radiate an electromagnetic field that induces eddy currents on the surface of metallic objects approaching the sensor face.

Input

1. The signal (voltage or current) applied to a circuit to cause the output of that circuit to change state.
2. The terminals, jacks or receptacle provided for reception of the input signal.

Input voltage

The power source required by an electric or electronic device (e.g. a self-contained sensor) in order for the device to operate properly.

Inspection

1. The process of examining a part to match the part to a known “good” reference.
2. A specific file or program run in the vision software to look at a specific part. Also known as a recipe.

Intensity

Degree of strength of electricity, light, heat or sound per unit area or volume.

Intrinsic safety

A design technique applied to electrical equipment, such as sensors, switches, and wiring for hazardous locations. The technique involves limiting energy to a level below that required to ignite a specific hazardous atmosphere. Intrinsic safety design often eliminates the requirement for explosion-proof enclosures. (Also see “NAMUR”.)

Intrinsic safety barrier

A protective component designed to limit the voltage and current in an explosive area. The barrier functions outside of the explosive location to divert abnormal energy to ground.

Inverse Square Law

The intensity of radiated energy (such as light energy emitted from a photoelectric sensor, or sound energy emitted from an ultrasonic sensor) falls off by an amount equal to the square of the increase in distance from the source.

Inverting output

Analog photoelectric sensors provide a variable voltage or current output signal that is inversely related to and decreases with the strength of the light signal. Also known as negative slope.

IP address

(Internet Protocol address) Address of a computer attached to an IP network (TCP/IP network). Written as four sets of numbers separated by periods.

IP rating

A rating system established by the IEC standards 144 and 529 which defines the suitability of sensor and sensor system enclosures for various environments. Similar to NEMA ratings for enclosures.

ISM Band

Abbreviation for Industrial, Scientific, and Medical band. Part of the radio spectrum that does not require a license for use.

J

Jacket

The outer sheath on a wire or cable which provides protection from the environment and also additional insulation.

K

kHz

Abbreviation for kilohertz, 1000 hertz.

L

LAN

(Local Area Network) A computer network dedicated to sharing data among several single-user computers.

Laser

(Light Amplification by the Stimulated Emission of Radiation) A device that creates a narrow, intense and coherent light. Many lasers deliver light in an almost-perfectly parallel collimated beam that is very pure, approaching a single wavelength.

Latched

Setting in which an output will stay on until the inspection result from subsequent inspection changes.

Latency

Maximum acceptable delay between transmission and reception.

Leading edge

The leading edge of the sensing event is the first occurrence in a material flow.

Leakage current

An undesirable small value stray current which flows over or through an insulator.

LED

Abbreviation for Light Emitting Diode. A semiconductor that emits light when current flows through it.

Lens

The optical component of a sensor that collimates or focuses light rays onto a receiver optoelement (photoelectric sensing) or an imager chip (vision sensing).

Light condition

One of two sensing conditions in a sensing application which is characterized by a higher level of received sensing energy. This term is generally used in photoelectric sensing. See Dark Condition.

Light operate

(L/O) The program mode for a photoelectric sensor in which the output energizes (or the timing logic begins) when the receiver becomes sufficiently light.

Light screen

See Active Opto-electronic Protective Device.

Light source

Any device serving as a source of illumination.

Lighting geometry

The physical relationship between the light source, the target object and the vision sensor.

Lighting technique

The way a light source is physically positioned relative to the object it is illuminating.

Line of sight

An unobstructed radio path between a radio’s transmitter and receiver status.

Line voltage

The normal in-plant power line supply voltage which is usually 120 or 220/240 or 440V ac.

Linearity

The maximum deviation above or below the ideal output of the sensor.

Load

A general term for a device (or a circuit) that draws power when switched by another device or circuit.

Location tools

Tool set included in vision software used to locate the region of interest regardless of translational or rotational variations of the inspected part.

Log-log scale

A graph with logarithmic x and y scales. A logarithmic scale reveals percentage changes. A change from 100 to 200, for example, is presented in the same way as a change from 1,000 to 2,000.

Logic

Methods used to condition a sensor output signal by way of timing or counting, or to coordinate control of a process by comparing multiple sensor outputs.

Logic module

A sensing system accessory that interprets one or more input signals and modifies and/or combines those input signals for control of a process.

Low-Angle Light

Low-angle lighting enhances the contrast of surface features.

M

Machine vision

Computerized image measurement, analysis, and interpretation used to improve production processes and quality.

Master/Slave

Model for communication protocol between devices or processes, in which one device initiates commands (master) and other devices respond (slave). The Gateway is the Master device to the Nodes which are the Slave devices.

Micron

One micron = 0.000001 meter or 0.001 millimeter.

Microsecond

One millionth of a second. 1 microsecond = 0.000001 second or 0.001 millisecond.

Millisecond

One thousandth of a second. 1 millisecond = 0.001 second or 1000 microseconds.

Milliwatt (mW)

A unit of power equal to one thousandth (10^{-3}) of a watt.

Modbus

An openly-published, communication protocol that is a means of connecting almost any industrial electronic device. Runs at layer 7 of the OSI model. Defines message structure for a client/server environment. Often used with TCP/IP over Ethernet and runs on RS-232 or RS-485.

Modulation

In photoelectrics, modulation of an emitter means to turn it on and off at a high frequency (typically several kilohertz). A modulated sensor's receiver and amplifier are tuned to the frequency of modulation. Only the modulated light is amplified, and all other light which reaches the receiver is ignored.

Multiplexing

A scheme in which an electronic control circuit interrogates each sensor of an array in sequence. True photoelectric multiplexing enables each modulated emitter only during the time that it samples the output of the associated receiver. In this way, the chance of false response of any receiver to the wrong light source is eliminated.

N

NAMUR

Devices and sensors designed for use with certified switching amplifiers with intrinsically-safe circuits. NAMUR sensors are most commonly used in explosive environments.

Nanometer

Unit of length used to specify the wavelength of light energy. 1 nm = 0.000000001 meter.

NC

Abbreviation for Normally Closed.

Negative slope

Analog photoelectric sensors provide a variable voltage or current output signal that is inversely related to and decreases with the strength of the light signal. Also known as inverting output.

NEMA

The National Electrical Manufacturers Association (NEMA) has established guidelines for specifying the degree of sealing offered by any particular electrical enclosure design.

Network ID (NID)

A system-level parameter allowing multiple radio devices to operate as a complete wireless network. Enables multiple wireless networks to be co-located within range of each other.

NO

Abbreviation for Normally Open.

Node

A wireless network slave device used to provide sensing capability in a remote area or on the factory floor. This device aggregates and communicates data back to a gateway device for transmission back to a central control unit.

Noise

(Electrical) Describes undesirable energy that may cause false response of sensing system logic or may be falsely recognized as a received signal by a sensor amplifier. Includes EMI and RFI.

Non-inverting output

Analog photoelectric sensors provide a variable voltage or current output signal that is directly related to and increases with the strength of the light signal. Also known as positive slope.

Normally Closed

Designation which states that the contacts of a switch or relay are closed or connected when at rest (i.e. no energy applied). When activated, the contacts open or separate. Symbolized by NC.

Normally Open

Designation which states that the contacts of a switch or relay are normally open or not connected at rest (i.e. no energy applied). When activated, the contacts close or become connected. Symbolized by NO.

NPN output

A transistor available as an output switch in DC sensors and logic modules. Usually configured with its collector open and its emitter connected to ground (DC common). In this configuration, a load is connected between the output (collector) and the positive of the DC supply. This output configuration is also called a "sinking" output.

Null

Used in analog sensing and control to describe the minimum voltage (or current) in an analog output range. Analog sensors have an adjustment for setting the null value.

O

OCR

Abbreviation for Optical Character Recognition. Recognition of each character in a string by a vision system.

OEM

Abbreviation for Original Equipment Manufacturer.

OFF-delay

Timing logic in which the output energizes immediately when an input signal is received, and remains energized as long as the input signal is present.

Ohm

Unit of measurement for resistance and impedance.

Ohm's law

E=IxR. Current (I) is directly proportional to voltage (E) and inversely proportional to total resistance (R) of a circuit.

Omni

Omni-directional antenna. Antenna that radiates power equally in all directions and is equally receptive to signals from all directions.

On-axis light

On-axis lighting provides even, diffused illumination for flat, reflective surfaces.

ON-delay

Timing logic in which timing begins at the leading edge of an input signal, but the output is energized only after the preset ON-delay has elapsed.

Opaque

A term used to describe a material that blocks the passage of light energy.

Operating voltage

Refers to the range of voltage in which the sensor or device can operate.

Opposed mode

A photoelectric sensing mode in which the emitter and receiver are positioned opposite each other so that the light from the emitter shines directly at the receiver. An object is detected when it breaks the light beam that is established between the two.

Optical crosstalk

An unwanted situation which occurs when a photoelectric receiver responds to light from an adjacent emitter.

Oscillate

To swing back and forth between a minimum and maximum value. One complete oscillation is regarded as one cycle.

OSI Method

Open Systems Interconnection. A methodology used for communication and computer network protocol design, where the functions of the protocol are divided into seven layers.

Output

1. The section of a sensor or control circuit that energizes and/or de-energizes the attached load (or input).
2. The useful energy delivered by a circuit or device.

Output delay

The time from when the inspection is triggered until the sensor output turns on.

Output duration

The time from when an output turns on until it turns off. Also known as Pulsed Output.

P

Parallel

Connection of two or more parts of a circuit to the same pair of terminals, so that current divides between the parts.

Path Loss

Describes attenuation as a function of wavelength of the operating frequency and the distance between the transmitter and receiver.

Peer/Peer

Model for communication protocol in which any device in the network can send and receive data, and initiate communication.

Photocell

A resistive photosensitive device in which the resistance varies in inverse proportion to the amount of incident light.

Photodiode

A semiconductor diode in which the reverse current varies with illumination. Characterized by linearity of its output over several magnitudes of light intensity, very fast response time, and wide range of color response.

Photoelectric sensor

An electrical device that responds to a change in the intensity of light falling upon it.

Photosite

The smallest discrete physical unit on an imager chip. A pixel is a digital representation of a photosite.

Phototransistor

A phototransistor is a photojunction device in which current flow is directly proportional to the amount of incident light.

Pixel

Acronym for picture element. The smallest unit on a display screen.

PLC

Abbreviation for Programmable Logic Controller. A control device that employs the hardware architecture of a computer and relay ladder diagram language.

PNP output

A transistor available as an output switch in DC sensors. Usually configured with its collector open and its emitter connected to the positive of the sensor supply voltage. In this configuration, a load is connected between the output (collector) and ground (DC common). This output configuration is also called a "sourcing" output.

Point Source

A light source, such as a spot light, that illuminates a target from one direction.

Point-to-Point

Indicates a direct connection between two devices in a network.

Polarization

The alignment of the perpendicular electrical and magnetic fields that make up a light wave.

Polarized light

Light which has all component waves in the same direction of displacement. Natural light is made up of waves having a variety of displacements.

Polarizing filter

A filter that polarizes light passing through it.

Polycarbonate

Thermoplastics characterized by high-impact strength, light weight, and flexibility. Used as a shatter-resistant substitute for glass.

Positive slope
Analog photoelectric sensors provide a variable voltage or current output signal that is directly related to and increases with the strength of the light signal. Also known as non-inverting output.

Potentiometer
A variable resistor, primarily used as a voltage divider. Potentiometers are used to set sensor sensitivity (as a threshold adjustment).

Preprocessing
Enhancement, transformation, or filtering of images before processing.

Programmable I/O
A type of input/output that is not factory set and therefore can have its purpose changed. This I/O can be reprogrammed for general output, pass, fail, ready, error and general input.

Protocol Layering
Division of protocol design into smaller of parts, each of which accomplish smaller tasks. Layering keeps each design simple.

Proximity
(Sensing) Direct sensing of an object by its presence in front of a sensor.

Proxing
In retroreflective sensing, "proxing" is used to describe undesirable reflection of the sensing beam directly back from an object that is supposed to break the beam.

Pulsed output
The time from when an output turns on until it turns off. Also known as Output Duration.

Q

QD
Abbreviation for quick disconnect. A cable attachment scheme used on some Banner sensors in which a male connector in the base of the sensor mates with the female connector of an industrial-grade cable.

Quater Wave
Antenna type whose overall span is one quarter the length of the wave that can be transmitted.

R

Radiation pattern
The total area of sensing energy emission.

Radio
1. Transmission or reception of electromagnetic radiation in the radio frequency band, used to send information through a medium without the use of wires.
2. Equipment used to transmit and receive radio signals.

Range
The specified maximum operating distance of a sensor or sensing system.

Ratio
Relation in degree or number between two similar things.

Receiver
1. The transducer element that responds to the sensing energy.
2. The name for the half of an opposed pair of photoelectric or ultrasonic sensors that receives the sensing energy from the emitter.

Reflection
The return of light waves from surfaces on which they are incident.

Reflectivity
A measure of the efficiency of any material surface as a reflector of light, as compared to a Kodak white test card, which is arbitrarily rated at 90% reflectivity.

Refraction
The bending of light rays as they pass through a transmission medium of one refractive index into a medium with a different refractive index.

Region of Interest
The area inside defined boundaries that the user wants to analyze.

Reject
A mechanism used on a manufacturing line to remove defective or sample product from the main stream or conveyor.

Relay
A switching device, operated by variations in the conditions of one circuit, which serves to make or break one or more connections in the same or another circuit.

Remote sensor
Remote sensor describes the part of a photoelectric component system that contains only the optical elements. The circuitry for system power, amplification, logic, and output switching are all located at a central location, typically a control cabinet.

Repeatability
A measure of the repeat accuracy of a sensor and/or timer and/or control mechanism. Usually expressed as a distance or time.

Repeater
A communication device that extends the transmission range of a data signal by amplifying or regenerating the signal. Used in long-distance transmission.

Resolution (1)
The degree of sharpness of a displayed or printed character or image. On screen, resolution is expressed as a matrix of dots.

Resolution (2)
1. The smallest detectable change in position or size of an object.
2. The closest distance between two objects (points) in an image identifiable as two separate objects rather than one object.

Response time
The time required for the output of a sensor or sensing system to respond to a change of the input signal (e.g. a sensing event). Also known as response speed.

Retroreflective mode
A retroreflective photoelectric sensor contains both the emitter and receiver. A light beam is established between the sensor and a special retroreflective target. As in opposed sensing, an object is detected when it interrupts this beam.

Retroreflector
A reflector made out of highly reflective material is used in retroreflective sensing to return the emitted light directly back to the sensor.

RF
Radio Frequency. Electromagnetic signals in the radio band.

RFI
Abbreviation for Radio Frequency Interference. Interference caused by electromagnetic radiation at radio frequencies to sensors or other sensitive electronic circuitry. RFI may generate false signals or random triggering of equipment or processes.

Ring Light
A ring light provides diffused illumination over a smal area.

ROI
Abbreviation for Region of Interest. The area inside defined boundaries that the user wants to analyze.

RS-232
Industrial standard for serial transmission between computers and peripheral devices.

RSSI
Received Signal Strength Indication. The measurement of the strength of received signal strength in a wireless environment. See Site Survey.

S

SCADA
Supervisory Control And Data Acquisition. Process control system that collects data from sensors or machines in remote areas and sends them to a central computer for control and management.

Scene
The entire area under inspection by the camera. See also: Field of View

Self-contained
Describes a sensor that contains the sensing element, amplifier, power supply, and output switch in a single package.

Sensing mode
The method or way in which a sensor detects an object.

Sensitivity control
An adjustment made to a sensor's amplifier that determines the sensor's ability to discriminate between different levels of received sensing energy (e.g. between two light levels reaching a photoelectric receiver).

Sensor
A device that senses a change in a physical quantity, such as light intensity, and converts that change into a useful control signal.

Serial port
A socket that receives a standard connector and protocol connecting external devices to a computer's serial interface.

Series
The connection of components end to end in a circuit, that provide a single path for the current.

SET
An actuation or adjustment feature of some Banner sensors, which simplifies the process of setting the sensor's operating sensitivity. With a single user input, the sensor automatically sets the operating sensitivity below the threshold.

Set point
Condition initiated by the user to control a sensor's output(s) during sensing events. This condition may use one or two parameters (depending on the sensing technology being used) within which is an acceptable range for sensing events to occur.

Shape
An object's physical and optical characteristic, often refers to its spatial contours.

Sheathing
An outer covering that protects optical fibers. Can be made of stainless steel flexible conduit, PVC, or some other type of flexible tubing.

Signal-to-Noise Ratio
The ratio of the maximum value of an output signal to the standard deviation amplitude of the noise on the signal.

Sinking output
The output of a DC device that switches ground (DC common) to a load. The load is connected between the output of the device and the positive side of the power supply.

Skew angle
An alignment technique used in diffuse, retroreflective, and convergent-mode photoelectric sensing to increase the optical contrast ratio.

Slightly dirty
Describes an environment in which there is a slight build-up of dust, dirt, oil, moisture, etc. on lenses and reflectors. Lenses are cleaned on a regular basis.

Solenoid
A magnetic switch that closes a circuit, often used as a relay.

Solid-state
Any element that can control current without moving parts, heated filaments, or vacuum gaps.

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Solid-state switch
A solid-state device where switching is accomplished by a solid-state element such as a transistor or SCR.

Sourcing output
The output of a DC device that switches positive DC to a load. The load is connected between the output of the device and the ground (DC common) side of the power supply.

SPDT
Abbreviation for Single Pole Double Throw. Refers to a three terminal switch or a relay (electromechanical or solid-state) having one normally open (Form A) contact and one normally closed (Form B) contact that have an electrically common point (complementary switching). Also known as Form C.

Specular
Describing a mirror-like finish that returns light energy at an equal and opposite angle from the angle of incident light.

Spread Spectrum
A technique in which the transmitter sends (or spreads) a signal over a wide range of frequencies. The receiver then concentrates the frequencies to recover the information.

SPST
Abbreviation for Single Pole Single Throw. Refers to a switch or a relay contact (electromechanical or solid-state) with a single contact that is either normally open or normally closed.

Star Network
A network topology where all nodes are connected to a central node. This central node is responsible for gathering and distributing data among the other nodes.

Surface reflectivity
A measure of the efficiency of any material surface as a reflector of light, as compared to a Kodak white test card which is arbitrarily rated at 90% reflectivity.

Switch transistor type
The transistor, a solid-state device designed to switch DC current, can be either NPN or PNP. Some sensors offer Bipolar output, both NPN and PNP or BiModal output, either NPN or PNP.

Switchpoint
The signal level at which the sensor's output turns on or off. Often used interchangeably with threshold.

T

Target
1. Any object being sensed
2. A retroreflective material that returns light back to a sensor

TCP/IP
Abbreviation for Transmission Control Protocol/Internet Protocol. A protocol for communication between computers, used as a standard for transmitting data over networks and as the basis for standard Internet protocols.

TDMA
Time Division Multiple Access. A wireless network communication architecture that provides a given slot of time for each device on the network. Provides guaranteed opportunity for each device to transmit to the gateway.

TEACH
A feature on some Banner sensors which allows the sensor to "learn" the light and dark sensing conditions, based on user inputs. The sensor can then automatically adjust the sensitivity to place the operating threshold midway between threshold for the light and the dark condition.

Test tool
The tool, within the software GUI, used to set tolerance to the vision and analysis tools results, and to activate the discrete outputs.

Texture
An object physical and optical characteristic, often refers to the degree of smoothness of an object's surface. Texture affects light reflection.

Thermopile
A "thermometer" for measuring heat radiation consisting of several thermocouple junctions.

Threshold
In photoelectric sensing, threshold is the point at which adequate received signal level overcomes sensor circuit hysteresis and causes the sensor output to change state. It is also the point at which the light and dark condition are differentiated.

Through-beam sensing
See "opposed sensing mode."

Topology
The pattern of interconnection between devices in a communication network. Some examples include: Bus, Ring, or Star configurations.

Trailing edge
The trailing edge in a sensing event is the last occurrence in a material flow.

Transducer
A device that converts energy of one form into another form. The sensing element of a non-contact presence sensor that converts a change in incident sensing energy (e.g. light, sound, etc) into a proportional electrical quantity such as voltage or current.

Transistor
An active semiconductor device having three of more electrodes. The three main electrodes used are the emitter, base and collector.

Translation
Movement in the X and/or Y direction from a known point.

Translucent
Term used to describe materials that have the property of reflecting a part and transmitting a part of incident radiation.

Transparent
Permitting passage of electromagnetic radiation of specified frequencies, such as visible light or radio waves.

Trigger
A mechanism, usually a photoelectric sensor, that initiates the vision sensor to take action when a prespecified event occurs.

TTL
Abbreviation for Transistor Transistor Logic. A digital circuit composed of bipolar transistors wired in a certain manner. Indicates a digital rather than an analog circuit.

U

UL
Abbreviation for "Underwriters Laboratory, Inc.", a testing agency for products sold in the United States. A device that has "UL approval" has been type-tested and approved by Underwriter's Laboratory as meeting certain electrical and/or safety codes.

Ultrasonic
Sound energy at frequencies just above the range of human hearing, starting at about 20 kHz. Banner ultrasonic sensors function at between 75 to 400 kHz, depending on model.

UV
Abbreviation for ultraviolet. Invisible short wavelength light energy that lies immediately beyond the violet end of the color spectrum between approximately 100 and 380 nm.

V

Vibration
An oscillating change in displacement, with respect to a fixed reference.

Vignetting
A gradual darkening around the periphery of an image. Optical vignetting often occurs when the lens is too small for the imager.

Visible light
The wavelength range of 400-750 nm to which the human eye is sensitive.

Vision
Electronic imaging applied in manufacturing settings for the purpose of control, whether it is process control, machine tool control, robot control or quality control. Vision sensing is used to improve production processes and quality.

Vision tools
A tool set included in vision software used to analyze an image and extract information for judgment criteria.

Voltage
The force, or pressure, of electricity that exists between two points and is capable of producing a flow of current when a closed circuit is connected between the two points.

W

Wave
A physical activity that rises and falls, or advances and retreats periodically as it travels through a medium.

Wave amplitude
The maximum change from zero of the characteristic of the wave.

Wave angle
The angle at which a wave is propagated from one point to another.

Wavelength
In a periodic wave, the distance between points of corresponding phase of two consecutive wave cycles.

Wireless
Refers to radio wave transmission used to transfer data or signals between locations that have no physical connections.

Wireless Sensor Network
Network of low-power electronic devices combining sensing and processing ability. The devices communicate wirelessly to a gateway device, connecting remote areas to the central control process.

Working distance
The distance from the camera to the object under inspection.

X

X-ray
Electromagnetic radiation with high frequency, short wavelengths between .01-10 nm, able to penetrate solid objects.

Y

Yagi
Antenna type that is directionally sensitive to signals received from the front and less sensitive to those received from the sides or rear.

Z

Zoom
To electronically or optically enlarge or reduce the size of an image.