

# WORLD-BEAM QS18 Expert with IO-Link

## Instruction Manual

Original Instructions  
196872 Rev. F  
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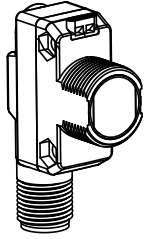
196872

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# 1 Product Description

Expert™ Sensor with IO-Link



- **Self-Contained Models:**
  - IO-Link communication for sensor health monitoring and remote configuration
  - Easy-to-use Expert-style Two-Point Static and Dynamic TEACH methods, plus Window, Light, and Dark SET, using IO-Link, push button or remote input
  - Smart power-control algorithm to maximize performance in low-contrast applications
- **Opposed-Mode Models:**
  - Infrared and visible beam emitter/receiver pairs with a range of 20 m (66 ft)
  - Robust ambient light immunity to prevent unintentional triggering
  - Optical synchronization provides crosstalk avoidance with three frequency channels for side by side sensor mounting
  - Two-Point Static and Dynamic TEACH methods, plus Window, Light, and Dark SET and Opaque mode for reliable long range detection of very dark objects
  - Health data available over IO-Link
- Auto compensation algorithm provides long and reliable operation by compensating for dust build up and ambient temperature changes.
- Fast response speed for high-speed applications
- User-selectable threshold offset percentage to optimize performance for the type of object being detected
- Easy configuration of the sensor by IO-Link, remote input or push button
- Convenient mounting options available for 18 mm barrel or side mount
- Bright indicator LEDs show operating status from 360°
- IEC IP67 rated ABS housing

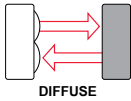
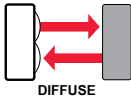
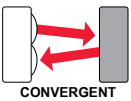
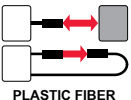


## **WARNING:**

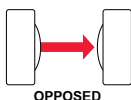
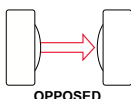
- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.

## 1.1 Models

### Self-Contained Models

| Model         | Sensing Mode                                                                                                   | Range                                | Output                                                   |
|---------------|----------------------------------------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------|
| QS18EK6LPQ8   | <br>POLAR RETRO               | 3.5 m (12 ft) <sup>1</sup>           | IO-Link push/pull output and multi-function input/output |
| QS18EK6DQ8    | <br>DIFFUSE                   | 800 mm (31.5 in) <sup>2</sup>        |                                                          |
| QS18EK6DVQ8   | <br>DIFFUSE                   | 600 mm (23.6 in) <sup>2</sup>        |                                                          |
| QS18EKCV15Q8  | <br>CONVERGENT<br>VISIBLE RED | 16 mm (0.65 in) <sup>2</sup>         |                                                          |
| QS18EK6CV45Q8 |                                                                                                                | 43 mm (1.7 in) <sup>2</sup>          |                                                          |
| QS18EK6FPQ8   | <br>PLASTIC FIBER            | Varies by mode and fiber optics used |                                                          |

### Opposed-Mode Models

| Model                              | Opposed-Mode                                                                                   | Range                                                                      | Teachable Range                                                                            | Output                                                   |  |  |
|------------------------------------|------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|----------------------------------------------------------|--|--|
| QS18EK6EVQ8 (Visible red, 625 nm ) | <br>OPPOSED | High Power Emitter<br>Setting: 20m<br><br>Low Power Emitter<br>Setting: 4m | High Power Emitter<br>Setting: 1 m to 20 m<br><br>Low Power Emitter<br>Setting: 0 m to 4 m | IO-Link and multi-function input                         |  |  |
| QS18EK6RVQ8                        |                                                                                                |                                                                            |                                                                                            | IO-Link push/pull output and multi-function input/output |  |  |
| QS18EK6EQ8 (Infrared, 940 nm)      | <br>OPPOSED |                                                                            |                                                                                            | IO-Link and multi-function input                         |  |  |
| QS18EK6RQ8                         |                                                                                                |                                                                            |                                                                                            | IO-Link push/pull output and multi-function input/output |  |  |

4-Pin M12/Euro-style integral quick disconnect models listed.

- To order the 150 mm (6 in) PVC cable model with a 4-pin M12/Euro-style quick disconnect, replace the suffix "Q8" with "Q5" in the model number. For example, QS18EK6LPQ5.
- To order the 4-in M8/Pico-style integral quick disconnect model, replace the suffix "Q8" with "Q7" in the model number. For example, QS18EK6LPQ7.
- To order the 150 mm (6 in) PVC cable model with a 4-Pin M8/Pico-style quick disconnect model, replace the suffix "Q8" with "Q" in the model number. For example, QS18EK6LPQ.

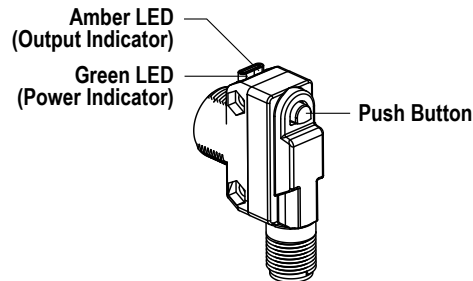
<sup>1</sup> With the use of a BRT-84 reflector.

<sup>2</sup> Based on 90% reflectance white test card.

- Models with a quick disconnect require a mating cordset.

## 1.2 Overview

The Banner QS18E sensor is a high performance photoelectric sensor with IO-link and configurable multifunction input/output. For opposed-mode models, the receiver has a configurable multifunction input/output and the emitter has a configurable multifunction input.



| Self-Contained Models and Opposed-Mode Receivers                                                                                                                                                                                                                                                                 |                                                               |           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|-----------|
| Sensor Condition (Run Mode)                                                                                                                                                                                                                                                                                      | Green LED                                                     | Amber LED |
| Output OFF                                                                                                                                                                                                                                                                                                       | ON                                                            | OFF       |
| Output ON                                                                                                                                                                                                                                                                                                        | ON                                                            | ON        |
| <b>Self-Contained Models</b><br>Notification—Sensor needs to be reconfigured for reliable detection<br><b>Opposed-Mode Models</b><br>Notification—Sensor needs to be reconfigured for reliable detection<br>OR<br>The emitter is set to High Power, and the receiver is saturated. Set the emitter to Low Power. | Flashing                                                      | ON/OFF    |
| Notification—Push button has been locked out                                                                                                                                                                                                                                                                     | Flashes four times and returns to solid On after button press | ON/OFF    |

| Opposed-Mode Emitter                         |                                                               |           |
|----------------------------------------------|---------------------------------------------------------------|-----------|
| Sensor Condition                             | Green LED                                                     | Amber LED |
| Power On                                     | ON                                                            | OFF       |
| Notification—Push button has been locked out | Flashes four times and returns to solid On after button press | OFF       |

## 1.3 Opposed-Mode Models: Noise and Crosstalk Immunity

Optical synchronization between the emitter and receiver provides ambient light immunity and crosstalk avoidance not typically available in opposed-mode sensing. The sensor is highly resistant to light detection due to ambient light from high efficiency light sources or from other light emitting industrial sensors. In addition, there are three user-selectable frequency channels (A, B, or C) for crosstalk avoidance in side by side sensor mounting. The factory default channel is Frequency A.

## 2 Installation

### 2.1 Mount the Device

1. If a bracket is needed, mount the device onto the bracket.
2. Mount the device (or the device and the bracket) to the machine or equipment at the desired location. Do not tighten the mounting screws at this time.
3. Check the device alignment.
4. Tighten the mounting screws to secure the device (or the device and the bracket) in the aligned position.

### 2.2 Wiring Diagrams

Follow the wiring diagram that is appropriate for your application.

**Opposed-Mode Models:** The following wiring diagrams apply to the receivers. The three wiring diagrams that include remote input apply to the emitters.

Figure 1. Channel 1 = IO-Link, Channel 2 = PNP Output (factory default)

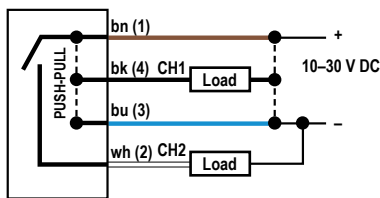
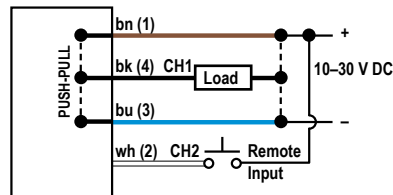


Figure 2. Channel 1 = IO-Link, Channel 2 = PNP Remote Input



#### Key

1. Brown
2. White
3. Blue
4. Black<sup>3</sup>



**Note:** NPN/PNP and Remote Input configurations are programmable using IO-Link.



**Note:** Enable the remote input wire function using IO-Link. The default for the remote input wire function is Detection Output.

Figure 3. Channel 1 = NPN Output, Channel 2 = NPN Output

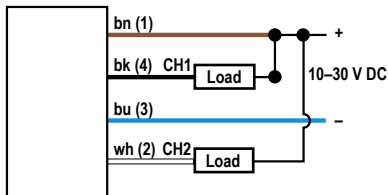


Figure 4. Channel 1 = PNP Output, Channel 2 = PNP Output

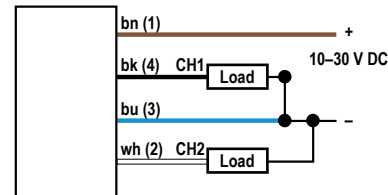


Figure 5. Channel 1 = NPN Output, Channel 2 = NPN Remote Input

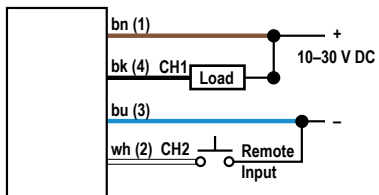
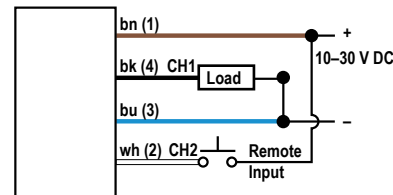


Figure 6. Channel 1 = PNP Output, Channel 2 = PNP Remote Input



<sup>3</sup> Opposed-Mode Models: IO-Link only on emitters.

Figure 7. Sensor Pinout M12/Euro-style Models (Male)

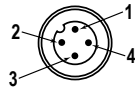
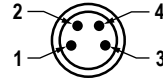


Figure 8. Sensor Pinout M8/Pico-Style Models (Male)



## 3 Sensor Configuration

Configure the sensor using the TEACH or SET methods to define the sensing limits. Use the setup procedure to enable a 30 ms OFF-delay or to change the Light/Dark Operate setting.

Sensing limit configuration options include:

- Two-Point Static TEACH: One switching threshold, determined by two taught conditions
- Dynamic TEACH: One switching threshold, determined by multiple sampled conditions
- Window SET: A sensing window, centered around a single sensing condition
- Light SET and Dark SET: One switching threshold, offset from a single sensing condition
- Opposed-Mode Models: Opaque Mode: One switching threshold set to maximum excess gain

The sensor's output is disabled during all TEACH and SET procedures, and is enabled upon return to Run mode.

See the Input Flowcharts for configuration information.

- Self-contained models: [Figure 9](#) on p. 9
- Opposed-mode emitters: [Figure 10](#) on p. 10
- Opposed-mode receivers: [Figure 11](#) on p. 11

Following any TEACH or SET procedure other than Two-Point Static TEACH, the Output ON condition (Light or Dark Operate setting) remains as it was last configured. To change that setting, or the OFF-delay setting, see the Input Flowchart.

### Push Button Configuration

Use the push button to configure the sensor. Click the push button according to the Input Flowchart.

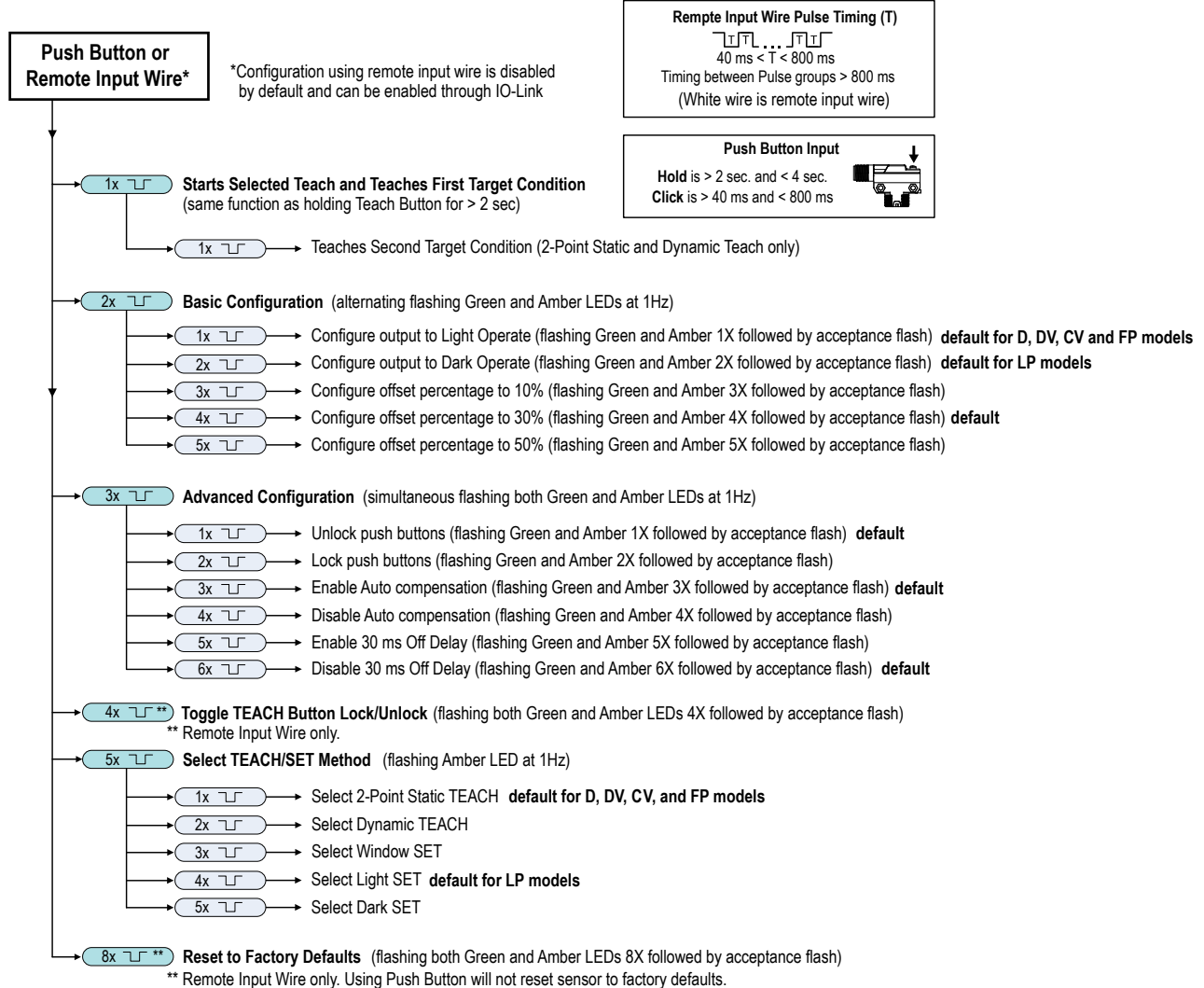
### Remote Input Configuration

The remote input wire is disabled by default. Enable the remote input wire using IO-Link. Use the remote input function to configure the sensor remotely. Connect the white wire of the sensor as shown in the wiring diagram. Pulse the remote line according to the Input Flowchart.



Figure 9. Self-Contained Models Input Flowchart

## SELF-CONTAINED MODELS



**Note:** Reconfiguration is required before a new TEACH/SET method takes effect.

Figure 10. Opposed-Mode Models Emitter Input Flowchart

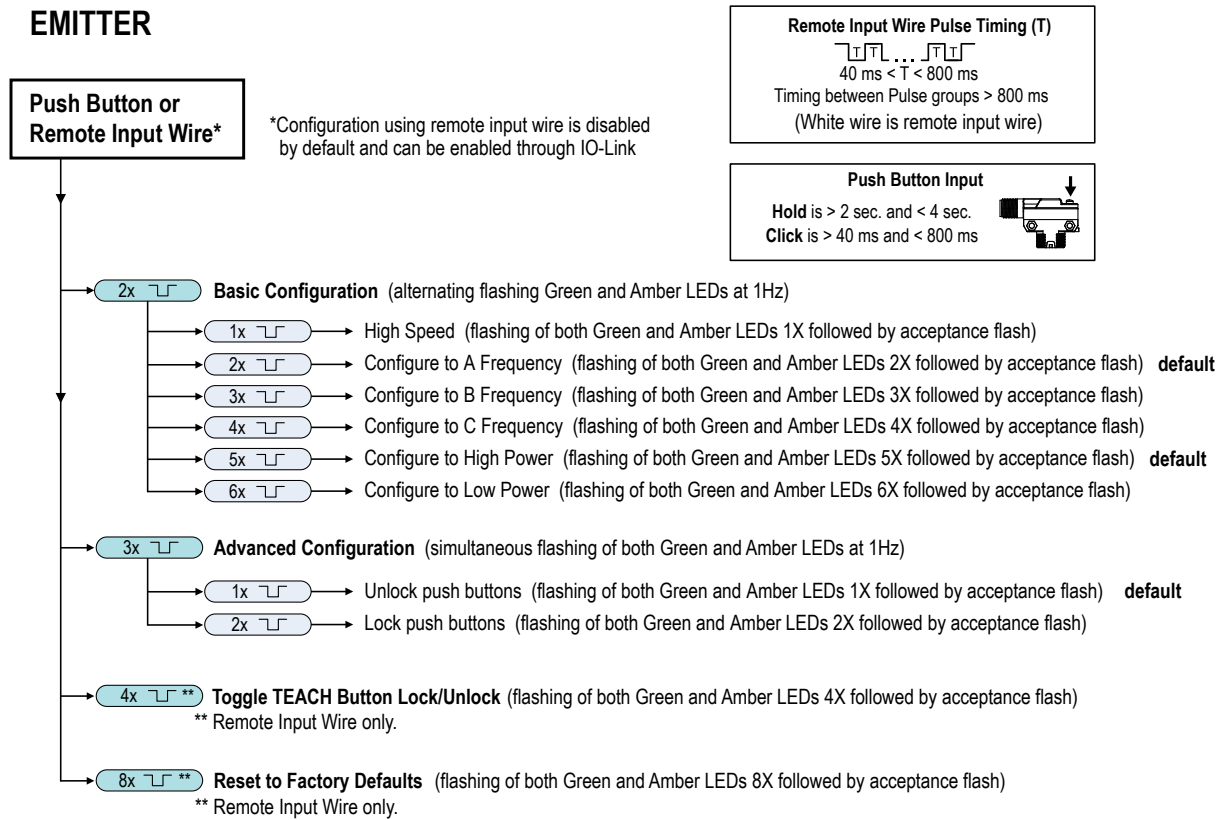
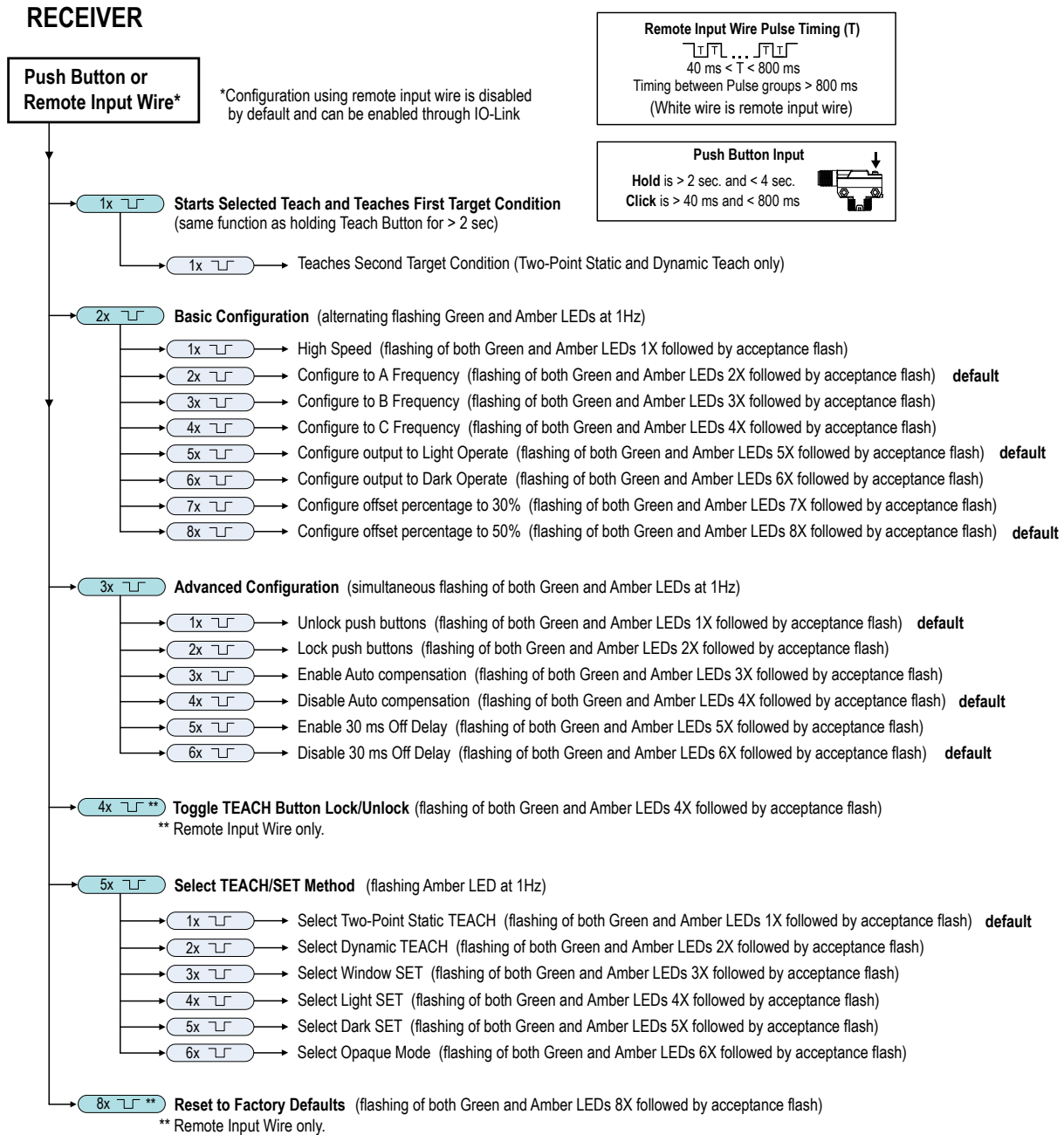


Figure 11. Opposed-Model Models Receiver Input Flowchart



### 3.1 IO-Link Interface

IO-Link is a point-to-point communication link between a master device and sensor. Use IO-Link to parameterize sensors and transmit process data automatically.

For the latest IO-Link protocol and specifications, see [www.io-link.com](http://www.io-link.com).

Each IO-Link device has an IODD (IO Device Description) file that contains information about the manufacturer, article number, functionality etc. This information can be easily read and processed by the user. Each device can be unambiguously identified via the IODD as well as via an internal device ID. Download the QS18E's IO-Link IODD package from Banner Engineering's website at [www.bannerengineering.com](http://www.bannerengineering.com).

IODD package part numbers:

- Self-contained models: 199851
- Opposed-mode emitter: 209310

- Opposed-mode receiver: 209311

Banner has also developed Add On Instruction (AOI) files to simplify ease-of-use between the QS18E, multiple third-party vendors' IO-Link masters, and the Logix Designer software package for Rockwell Automation PLCs. Three types of AOI files for Rockwell Allen-Bradley PLCs are listed below. These files and more information can be found at [www.bannerengineering.com](http://www.bannerengineering.com).

**Process Data AOIs**—These files can be used alone, without the need for any other IO-Link AOIs. The job of a Process Data AOI is to intelligently parse out the Process Data word(s) in separate pieces of information. All that is required to make use of this AOI is an EtherNet/IP connection to the IO-Link Master and knowledge of where the Process Data registers are located for each port.

**Parameter Data AOIs**—These files require the use of an associated IO-Link Master AOI. The job of a Parameter Data AOI, when working in conjunction with the IO-Link Master AOI, is to provide quasi-realtime read/write access to all IO-Link parameter data in the sensor. Each Parameter Data AOI is specific to a given sensor or device.

**IO-Link Master AOIs**—These files require the use of one or more associated Parameter Data AOIs. The job of an IO-Link Master AOI is to translate the desired IO-Link read/write requests, made by the Parameter Data AOI, into the format a specific IO-Link Master requires. Each IO-Link Master AOI is customized for a given brand of IO-Link Master.

Add and configure the relevant Banner IO-Link Master AOI in your ladder logic program first; then add and configure Banner IO-Link Device AOIs as desired, linking them to the Master AOI as shown in the relevant AOI documentation.

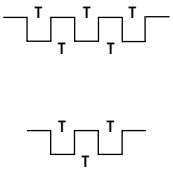
Banner has also developed Function Blocks to simplify ease-of-use between the QS18E, multiple third-party vendors' IO-Link masters, and the Siemens TIA Portal software package for Siemens PLCs. Two types of Function Blocks files for TIA Portal are listed below. The files and more information can be found at [www.bannerengineering.com](http://www.bannerengineering.com).

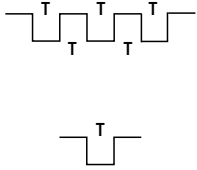
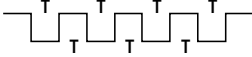
**Process Data Function Blocks**—These files can be used alone, without the need for any other IO-Link Function Blocks. A Process Data Function Block intelligently parses out the Process Data byte(s) in separate pieces of information. To make use of this Function Block, a Profinet connection to the IO-Link Master and knowledge of where the Process Data registers are located for each port is required.

**Parameter Data Function Blocks**—These files require the Siemens TIA Portal Function Block IO\_Link\_Device. This is available from the Siemens website. A Parameter Function Block provides quasi-realtime read/write access to all IO-Link parameter data in the sensor. Each Parameter Function Block is specific to a given sensor.

## 3.2 Push Button Enable/Disable

The push button can be disabled to prevent unauthorized adjustment. Perform the appropriate procedure below to enable or disable the feature.

| Action                     | Method                                                                                                                                                                                           | Result                                                                       |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|
| <b>Push Button—Disable</b> | <b>Push Button:</b> From Run mode, click the button three times, then click two times to disable the button.  | Green and amber LEDs flash two times in unison followed by acceptance flash. |
|                            | <b>Remote:</b> From Run mode, pulse the remote three time, then pulse two times to disable the button.       |                                                                              |
| <b>Push Button—Enable</b>  | <b>Push Button:</b> From Run mode, click the button three times then click one time to enable the button.     | Green and amber LEDs flash once in union followed by acceptance flash.       |

| Action                                   | Method                                                                                                                                                                                         | Result                                                                                                                                                              |
|------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                          | <p><b>Remote:</b> From Run mode, pulse the remote three time, then pulse one time to enable the button.</p>  |                                                                                                                                                                     |
| <b>Push Button—Disable/Enable Toggle</b> | <p><b>Remote:</b> From Run mode, pulse the remote line four times.</p>                                       | <p>Sensor toggles between enable/disable settings and returns to Run mode.</p> <p>Green and amber LEDs flash four times in unison followed by acceptance flash.</p> |

## 4 Select TEACH/SET Method

**Self-Contained Models:** To select Light SET, Dark SET, Window SET, Two-Point Static TEACH, or Dynamic TEACH, follow these steps.

**Opposed-Mode Models:** When using the receiver to select Light SET, Dark SET, Window SET, Two-Point Static TEACH, Dynamic TEACH, or Opaque mode, follow these steps.

1. Initiate select TEACH/SET Method.

| Method       | Action                                 | Result                                                     |
|--------------|----------------------------------------|------------------------------------------------------------|
| Push Button  | Click the button five times            | The green LED turns off and the amber LED flashes at 1 Hz. |
| Remote Input | Pulse the remote input line five times |                                                            |

2. Select TEACH/SET Method.

| Method       | TEACH/SET Method                    | Action                            | Result                                    |
|--------------|-------------------------------------|-----------------------------------|-------------------------------------------|
| Push Button  | Two-Point Static TEACH              | Click the button one time         | The selected TEACH/SET method is enabled. |
|              | Dynamic TEACH                       | Click the button two times        |                                           |
|              | Window SET                          | Click the button three times      |                                           |
|              | Light SET                           | Click the button four times       |                                           |
|              | Dark SET                            | Click the button five times       |                                           |
|              | Opposed-Mode Models:<br>Opaque Mode | Click the button six times        |                                           |
| IO-Link      | Two-Point Static TEACH              | Set BDC1 Mode using IO-Link       |                                           |
|              | Dynamic TEACH                       |                                   |                                           |
|              | Window SET                          |                                   |                                           |
|              | Light SET                           |                                   |                                           |
|              | Dark SET                            |                                   |                                           |
|              | Opposed-Mode Models:<br>Opaque Mode |                                   |                                           |
| Remote Input | Two-Point Static TEACH              | Pulse the remote line one time    |                                           |
|              | Dynamic TEACH                       | Pulse the remote line two times   |                                           |
|              | Window SET                          | Pulse the remote line three times |                                           |
|              | Light SET                           | Pulse the remote line four times  |                                           |
|              | Dark SET                            | Pulse the remote line five times  |                                           |
|              | Opposed-Mode Models:<br>Opaque Mode | Pulse the remote line six times   |                                           |

## 5 Configure TEACH/SET

**Self-Contained Models:** By default, the sensor TEACH/SET method is Two-Point Static TEACH. To perform a TEACH/SET, use the following procedures for your preferred method.

**Opposed-Mode Models:** By default, the receiver TEACH/SET method is Two-Point Static TEACH. To perform a TEACH/SET, use the following procedures for your preferred method.

### Push Button

| Action                           |                                                                                                                                                                                                                                                                                                                                                                             | Result                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Two-Point Static TEACH           | <ol style="list-style-type: none"><li>1. Present the output ON target condition.</li><li>2. Press and hold the button for longer than 2 seconds to enter TEACH mode and configure the output ON light level.</li><li>3. Present the output OFF target condition.</li><li>4. Click the button once to configure the output OFF light level and return to Run mode.</li></ol> | <p><b>Accepted</b></p> <ol style="list-style-type: none"><li>1. The amber LED indicator is off and the green indicator LED flashes three times.</li><li>2. The green and amber LED indicators flash six times rapidly in unison (acceptance flash).</li><li>3. The sensor returns to Run mode with valid thresholds.</li></ol> <p><b>Invalid Teach Condition</b></p> <ol style="list-style-type: none"><li>1. The green and amber indicator LEDs flash two times in unison.</li><li>2. The green and amber LED Indicators flash six times rapidly in unison (acceptance flash).</li><li>3. The sensor returns to Run Mode with coerced thresholds.</li></ol> |
| Dynamic TEACH                    | <ol style="list-style-type: none"><li>1. Press and hold the Push Button for greater than 2 seconds to start the Dynamic TEACH process.</li><li>2. Run the target application to configure the ON and OFF conditions.</li><li>3. Click the Push Button once to stop the Dynamic TEACH process and return to Run mode.</li></ol>                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Window SET                       | <ol style="list-style-type: none"><li>1. Present the target condition.</li><li>2. Press and hold the button for greater than 2 seconds to configure the target condition and return to Run mode.</li></ol>                                                                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Light SET                        |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Dark SET                         |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Opposed-Mode Models: Opaque Mode |                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

### IO-Link

| Action                 |                                                                                                                                                                                                                                                                                                                                                                                                         | Result                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Two-Point Static TEACH | <ol style="list-style-type: none"><li>1. Present the output ON target condition.</li><li>2. Send SP1 Two Value Teach TP1 command using IO-Link to enter TEACH mode and learn the output ON light level.</li><li>3. Present the output OFF target condition.</li><li>4. Send the SP1 Two Value Teach TP2 command using IO-Link to configure the output OFF light level and return to Run mode.</li></ol> | <p><b>Accepted</b></p> <ol style="list-style-type: none"><li>1. The amber LED indicator is off and the green indicator LED flashes three times.</li><li>2. The green and amber LED indicators flash six times rapidly in unison (acceptance flash).</li><li>3. The sensor returns to Run mode with valid thresholds.</li></ol> <p><b>Invalid Teach Condition</b></p> <ol style="list-style-type: none"><li>1. The green and amber indicator LEDs flash two times in unison.</li><li>2. The green and amber LED Indicators flash six times rapidly in unison (acceptance flash).</li><li>3. The sensor returns to Run Mode with coerced thresholds.</li></ol> |
| Dynamic TEACH          | <ol style="list-style-type: none"><li>1. Send SP1 Dynamic Teach Start command using IO-Link to start the Dynamic TEACH process.</li><li>2. Run the target application to configure the ON and OFF conditions.</li><li>3. Send SP1 Dynamic Teach Stop command using IO-Link to stop the Dynamic TEACH process and return to Run mode.</li></ol>                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Window SET             | <ol style="list-style-type: none"><li>1. Present the target condition.</li><li>2. Send the SP1 Single Value Teach command using IO-Link to configure the target condition and return to Run mode.</li></ol>                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Light SET              |                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Action                           |  | Result |
|----------------------------------|--|--------|
| Dark SET                         |  |        |
| Opposed-Mode Models: Opaque Mode |  |        |

## Remote Input

| Action                           |                                                                                                                                                                                                                                                                                                                                                          | Result                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Two-Point Static TEACH           | <ol style="list-style-type: none"><li>1. Present the output ON target condition.</li><li>2. Pulse the remote line once to enter TEACH mode and configure the output ON light level.</li><li>3. Present the output OFF target condition.</li><li>4. Pulse the remote line again to configure the output OFF light level and return to Run mode.</li></ol> | <b>Accepted</b> <ol style="list-style-type: none"><li>1. The amber LED indicator is off and the green indicator LED flashes three times.</li><li>2. The green and amber LED indicators flash six times rapidly in unison (acceptance flash).</li><li>3. The sensor returns to Run mode with valid thresholds.</li></ol> <b>Invalid Teach Condition</b> <ol style="list-style-type: none"><li>1. The green and amber indicator LEDs flash two times in unison.</li><li>2. The green and amber LED Indicators flash six times rapidly in unison (acceptance flash).</li><li>3. The sensor returns to Run Mode with coerced thresholds.</li></ol> |
| Dynamic TEACH                    | <ol style="list-style-type: none"><li>1. Pulse the remote line once to start the Dynamic TEACH process.</li><li>2. Run the target application to configure the ON and OFF conditions.</li><li>3. Pulse the remote line again to stop the Dynamic TEACH process and return to Run mode.</li></ol>                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Window SET                       | <ol style="list-style-type: none"><li>1. Present the target condition.</li><li>2. Pulse the remote line once to configure the target condition and return to Run mode.</li></ol>                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Light SET                        |                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Dark SET                         |                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Opposed-Mode Models: Opaque Mode |                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

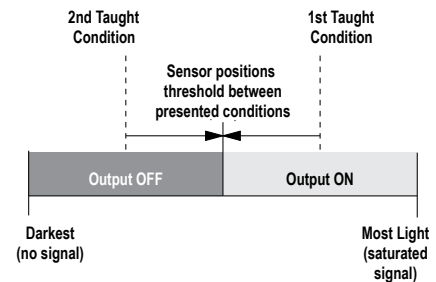


## 6 TEACH/SET

### Two-Point Static TEACH

- Two-Point Static TEACH locates a single switching threshold (switchpoint) centered between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other.
- During Two-Point Static TEACH, the first condition taught is the ON condition. Output ON and OFF conditions may be reversed by switching the TEACH order or by changing the Light/Dark Operate setting.
- Two-Point Static TEACH is recommended for applications where two conditions can be presented individually.

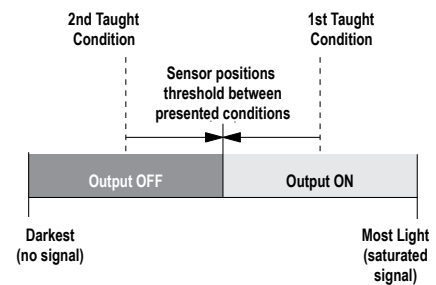
Figure 12. Two-Point Static TEACH



### Dynamic TEACH

- Dynamic TEACH locates a single switching threshold (switchpoint) centered between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other.
- During Dynamic TEACH, the Output ON state (Light or Dark Operate setting) remains as it was last configured. Self-Contained Models: Output ON and OFF conditions may be reversed by switching the TEACH order or by changing the Light/Dark Operate setting.
- Dynamic TEACH is recommended for applications where a machine or process may not be stopped for configuration.

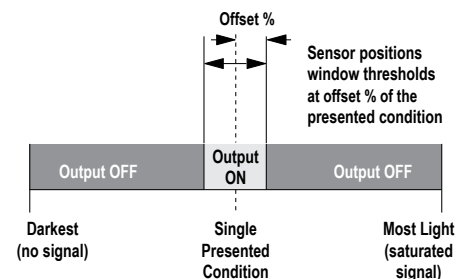
Figure 13. Dynamic TEACH



### Window SET

- In Window SET, the single ON condition window extends above and below the presented condition by the user selectable offset percentage :
  - Self-contained models: 30% default
  - Opposed-mode models: 50% default
- Output ON and OFF conditions may be reversed by changing the Light/Dark Operate setting.
- Lighter or darker conditions outside of the window cause the output to change state.
- Window SET is recommended for applications where the target to be sensed may not always appear in the same place, or when other unwanted signals may appear.

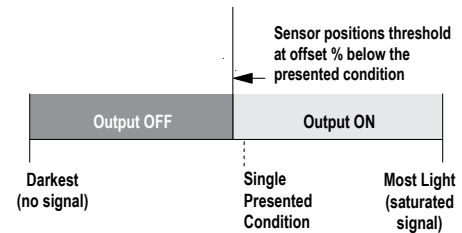
Figure 14. Window SET



## Light SET

- Light SET sets a threshold below the presented condition by the user selectable offset percentage:
  - Self-contained models: 30% default
  - Opposed-mode models: 50% default
- Any condition darker than the threshold causes the output to change state.
- In Light Operate mode, the presented condition is the Output ON condition. In Dark Operate mode, the presented condition is the Output OFF condition. Reverse the Output ON and OFF conditions by changing the Light / Dark Operate setting.
- Light SET is recommended for applications where only one condition is known, for example a stable light background with varying darker targets, or in retroreflective applications.

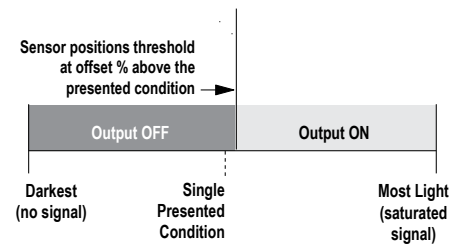
Figure 15. Light SET



## Dark SET

- Dark SET sets a threshold above the presented condition by the user selectable offset percentage
  - Self-contained models: 30% default
  - Opposed-mode models: 50% default
- Any condition lighter than the threshold causes the output to change state.
- In Light Operate mode, the presented condition is the Output OFF condition. In Dark Operate mode, the presented condition is the Output ON condition. Reverse the Output ON and OFF conditions by changing the Light / Dark Operate setting.
- Dark SET is recommended for applications where only one condition is known, for example a stable dark background with varying lighter targets, or when maximum excess gain is required.

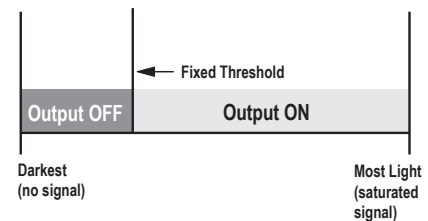
Figure 16. Dark SET



## Opposed-Mode Models: Opaque Mode

Opaque mode is recommended for long range detection of opaque (light blocking) targets. When Opaque mode is used, the sensor operates at maximum sensing range regardless of the taught condition.

Figure 17. Opaque Mode



# 7 Specifications

## 7.1 Self-Contained Models: Specifications

### Supply Voltage and Current

10 V DC to 30 V DC (10% maximum ripple within specified limits) at 30 mA

### Supply Protection Circuitry

Protected against reverse polarity and transient overvoltages

### Output Protection Circuitry

Protected against false pulse on power-up and continuous overload or short-circuit of output

### Output Configuration

**Channel 1:** IO-Link, Push/pull output, configurable PNP or NPN output  
**Channel 2:** Multi-function remote input/output, configurable PNP or NPN  
 Rating: 50 mA maximum each output at 25 °C

### Output Response Time

Momentary delay on power-up, < 0.5 s, output does not conduct during this time  
 350 microseconds ON & OFF for high speed response time  
 1 millisecond ON & OFF for standard response time  
 2 millisecond ON & 1 millisecond OFF for robust response time

### Repeatability

140 microseconds for high speed  
 175 microseconds for standard and robust

### IO-Link Interface

**Supports Smart Sensor Profile:** Yes

**Baud Rate:** 38400 bps

**Process Data Widths:** 32 bits In, 8 bits Out

**IO-Link Files:** Provides all programming options of push button and remote input wire, plus additional functionality. See the IO-Link Data Reference Guide for more details.

### Emitter LED

DV, CV, FP, and LP: Visible red, 625 nm  
 D models: Infrared, 940 nm

### Indicators

Two LEDs (1 green, 1 amber)

**Green On:** Indicates power applied and sensor ready

**Green Flashing:** Indicates sensor operating in marginal state, in need of reconfiguration

**Amber On:** Indicates output conducting

### Factory Default Settings

| Setting              | Factory Default                                                          |
|----------------------|--------------------------------------------------------------------------|
| TEACH/SET            | D, DV, CV, and FP Models: Two-point Static TEACH<br>LP Models: Light SET |
| Output Logic         | D, DV, CV, and FP Models: Light Operate<br>LP Models: Dark Operate       |
| Output Response Time | Standard                                                                 |
| Offset Percentage    | 30%                                                                      |
| Push Button          | Unlocked                                                                 |
| Auto Compensation    | Enabled                                                                  |
| OFF Delay            | Disabled                                                                 |
| Pin 4 Output         | IO-Link Enabled Detection Output (Push-pull)                             |
| Pin 2 Output         | Detection Output: High-speed output when using IO-Link on Pin 4          |

### Required Overcurrent Protection



**WARNING:** Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

Overcurrent protection is required to be provided by end product application per the supplied table.  
 Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.  
 Supply wiring leads < 24 AWG shall not be spliced.  
 For additional product support, go to [www.bannerengineering.com](http://www.bannerengineering.com).

| Supply Wiring (AWG) | Required Overcurrent Protection (Amps) |
|---------------------|----------------------------------------|
| 20                  | 5.0                                    |
| 22                  | 3.0                                    |
| 24                  | 2.0                                    |
| 26                  | 1.0                                    |
| 28                  | 0.8                                    |
| 30                  | 0.5                                    |

### Construction

Housing: ABS  
 Window: PMMA

### Mounting Torque

**Nose Mount:** 18 mm mounting nut, 20 lbf-in (2.3 N·m)

**Side Mount:** Two M3 screws, 5 lbf-in (0.6 N·m)

### Connections

PVC-jacketed 4-conductor 2 m (6.5 ft) or 9 m (30 ft) unterminated cable, or 4-pin M12/Euro-style or 4-pin M8/Pico-style quick-disconnect, either integral or 150 mm (6 in) cable, are available.  
 Models with a quick disconnect require a mating cordset

### Operating Conditions

−40 °C to +70 °C (−40 °F to +158 °F)  
 95% at +50 °C maximum relative humidity (non-condensing)

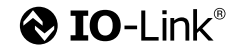
### Environmental Rating

IEC IP67

### Application Notes

If the push button does not appear to be responsive, perform the push button enable procedure

### Certifications



## 7.2 Opposed-Mode Models: Specifications

### Supply Voltage and Current

10 V DC to 30 V DC (10% maximum ripple within specified limits) at 30 mA

### Power and Current Consumption, exclusive of load

**Normal Run Mode:** 1.2W, Current consumption < 50 mA at 24 V DC

### Supply Protection Circuitry

Protected against reverse polarity and transient overvoltages

### Output Protection Circuitry

Protected against false pulse on power-up and continuous overload or short-circuit of output

### Output Configuration

**Channel 1:** IO-Link, Push/pull output, configurable PNP or NPN output

**Channel 2:** Multi-function remote input/output, configurable PNP or NPN  
Rating: 50 mA maximum each output at 25 °C

### Power Up Delay

Momentary delay on power-up, < 1.5 s, output does not conduct during this time

### Gain

The gain setting can be changed via IO-Link

Gain values are: **Auto** and the fixed modes **High**, **Mid**, and **Low**

### Response Time and Response Repeatability

When gain = **Auto**, the receiver optimizes the gain during Run mode for the current condition.

When gain = **Fixed**, the receiver optimizes the power for the presented configured condition(s).

| Frequency  | Gain Mode | Response Time ( µs) | Response Repeatability ( µs) |
|------------|-----------|---------------------|------------------------------|
| High Speed | Fixed     | 300                 | 140                          |
| High Speed | Auto      | 350                 | 212                          |
| A,B,C      | Fixed     | 1000                | 400                          |
| A,B,C      | Auto      | 1100                | 600                          |

### Emitter Power

High Power is Power 5.

Low Power is Power 0.

The following power levels are available via IO-Link to set intermediate power levels when looking for good contrast control with separation distances > 4 m: Power 5, Power 4, Power 3, Power 2, Power 1, and Power 0

### Emitter LED

EV model: Visible red, 625 nm

E models: Infrared, 940 nm

### Indicators

Two LEDs (1 green, 1 amber)

**Green On:** Indicates power applied and sensor ready

**Green Flashing:** Indicates sensor operating in marginal state, in need of reconfiguration

**Amber On:** Indicates output conducting

### Factory Default Settings—Receiver

| Setting              | Factory Default                                                 |
|----------------------|-----------------------------------------------------------------|
| Basic Configuration  | Frequency A                                                     |
| TEACH/SET            | Two-Point Static TEACH                                          |
| Output Logic         | Light Operate                                                   |
| Output Response Time | Standard                                                        |
| Offset Percentage    | 50%                                                             |
| Push Button          | Unlocked                                                        |
| Auto Compensation    | Disabled                                                        |
| OFF Delay            | Disabled                                                        |
| Pin 4 Output         | IO-Link Enabled Detection Output (Push-pull)                    |
| Pin 2 Output         | Detection Output: High-speed output when using IO-Link on Pin 4 |
| Gain                 | Auto                                                            |

### Factory Default Settings—Emitter

| Setting             | Factory Default              |
|---------------------|------------------------------|
| Basic Configuration | Frequency A                  |
| Power Setting       | High Power                   |
| Push Button         | Unlocked                     |
| Pin 4 Output        | IO-Link (Push-pull)          |
| Pin 2 Input         | Detection Input: Deactivated |
| Power               | High                         |

**IO-Link Interface****Supports Smart Sensor Profile:** Yes**Baud Rate:** 38400 bps**Process Data Widths:** 32 bits In, 8 bits Out**IODD Files:** Provides all programming options of push button and remote input wire, plus additional functionality. See the IO-Link Data Reference Guide (p/n 209308) for more details.**Required Overcurrent Protection**

**WARNING:** Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

Overcurrent protection is required to be provided by end product application per the supplied table.

Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.

Supply wiring leads < 24 AWG shall not be spliced.

For additional product support, go to [www.bannerengineering.com](http://www.bannerengineering.com).

| Supply Wiring (AWG) | Required Overcurrent Protection (Amps) |
|---------------------|----------------------------------------|
| 20                  | 5.0                                    |
| 22                  | 3.0                                    |
| 24                  | 2.0                                    |
| 26                  | 1.0                                    |
| 28                  | 0.8                                    |
| 30                  | 0.5                                    |

**Construction**

Housing: ABS

Window: PMMA

**Mounting Torque****Nose Mount:** 18 mm mounting nut, 20 lbf-in (2.3 N·m)**Side Mount:** Two M3 screws, 5 lbf-in (0.6 N·m)**Vibration and Mechanical Shock**

All models meet MIL-STD-202G, Method 201A (Vibration: 10 Hz to 60 Hz, 0.06 inch (1.52 mm) double amplitude, 2 hours each along X, Y and Z axes) requirements. Also meets IEC 60947-5-2 (Shock: 30G 11 ms duration, half sine wave) requirements.

**Connections**

PVC-jacketed 4-conductor 2 m (6.5 ft) or 9 m (30 ft) unterminated cable, or 4-pin M12/Euro-style or 4-pin M8/Pico-style quick-disconnect, either integral or 150 mm (6 in) cable, are available.

Models with a quick disconnect require a mating cordset

**Operating Conditions**

–20 °C to +70 °C (–4 °F to +158 °F)

95% at +50 °C maximum relative humidity (non-condensing)

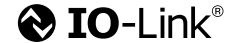
Storage Temperature: –65 °C to +125 °C (–85 °F to 257 °F)

**Environmental Rating**

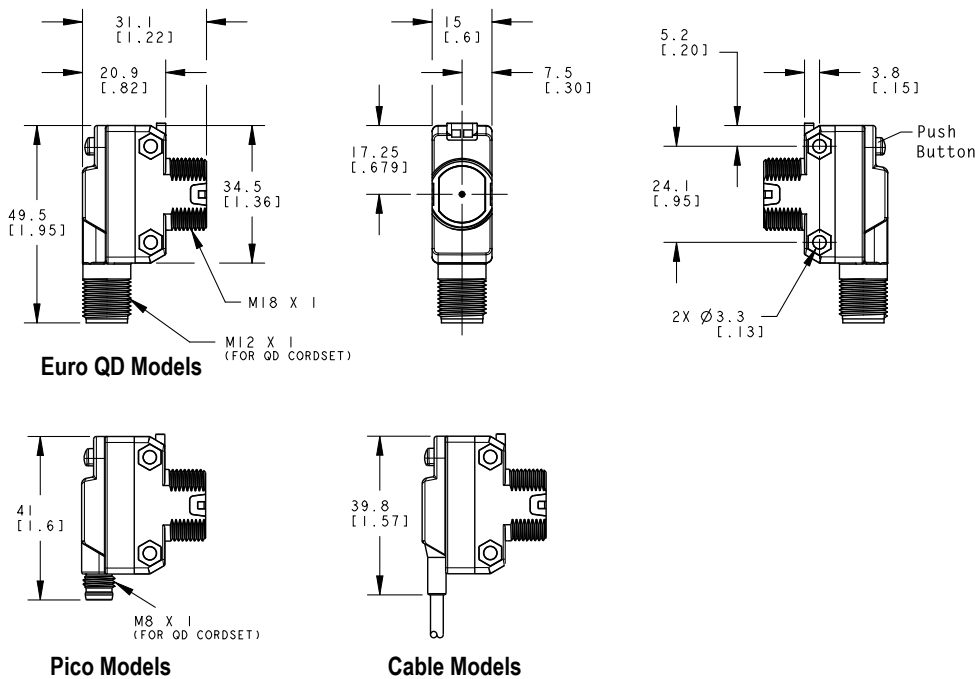
IEC IP65, IEC IP67

**Application Notes**

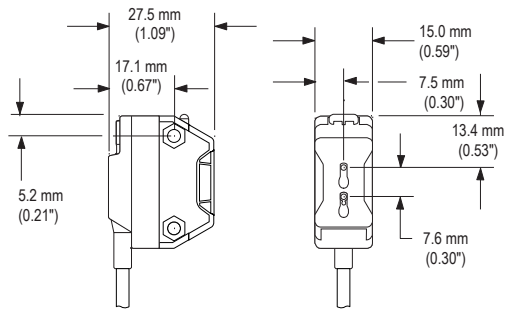
If the push button does not appear to be responsive, perform the push button enable procedure

**Certifications**

## 7.3 Dimensions

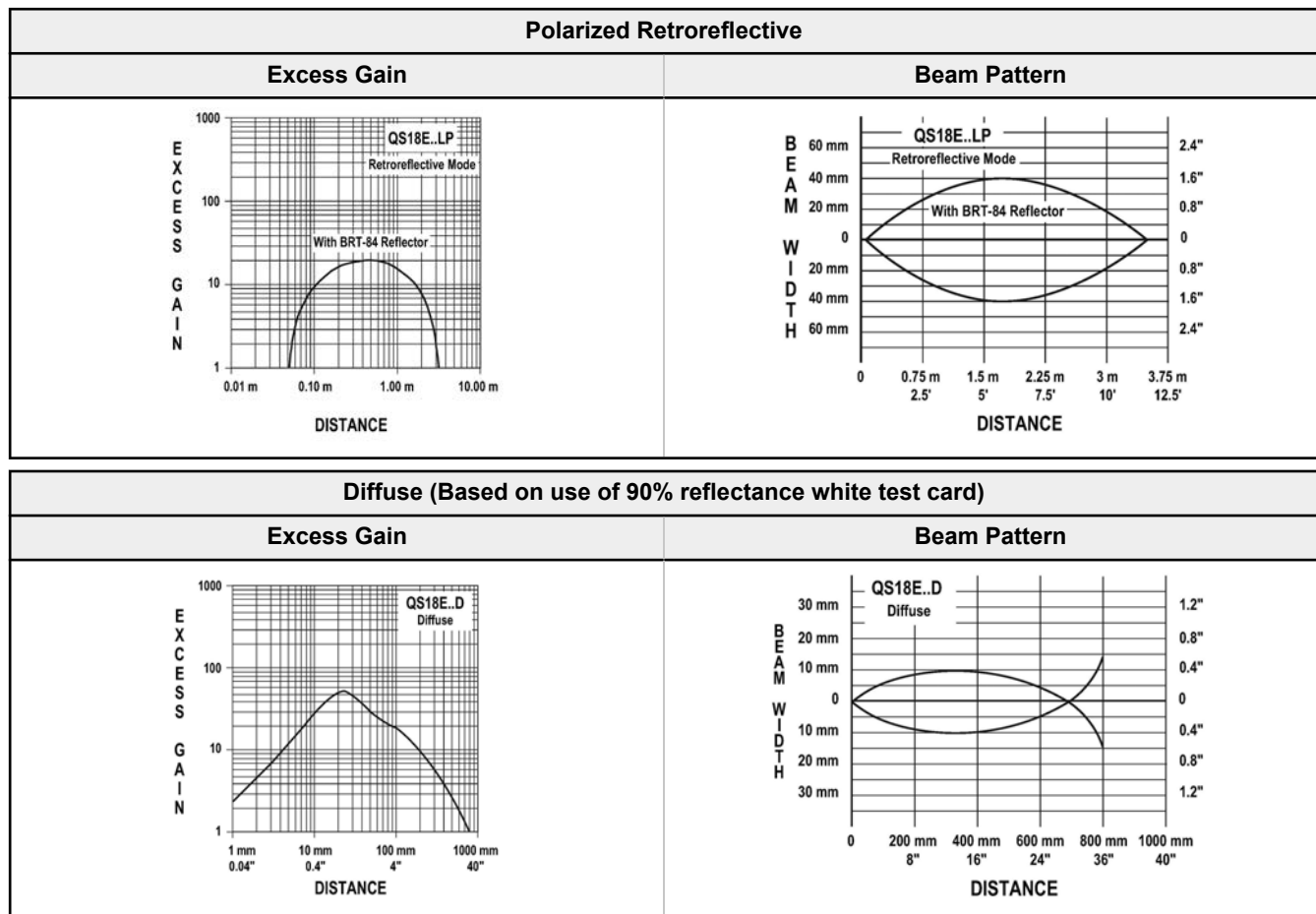


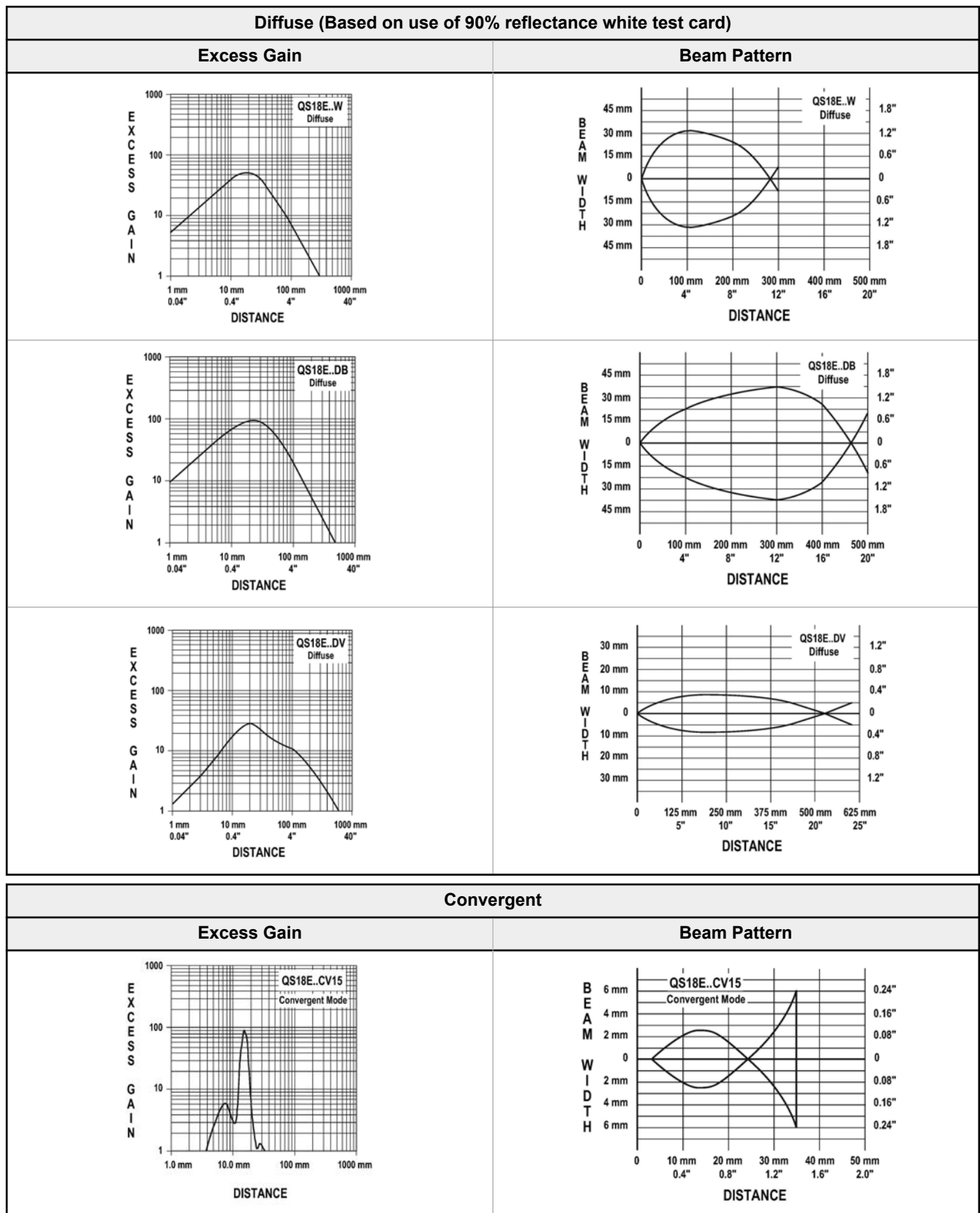
Model Suffix FP

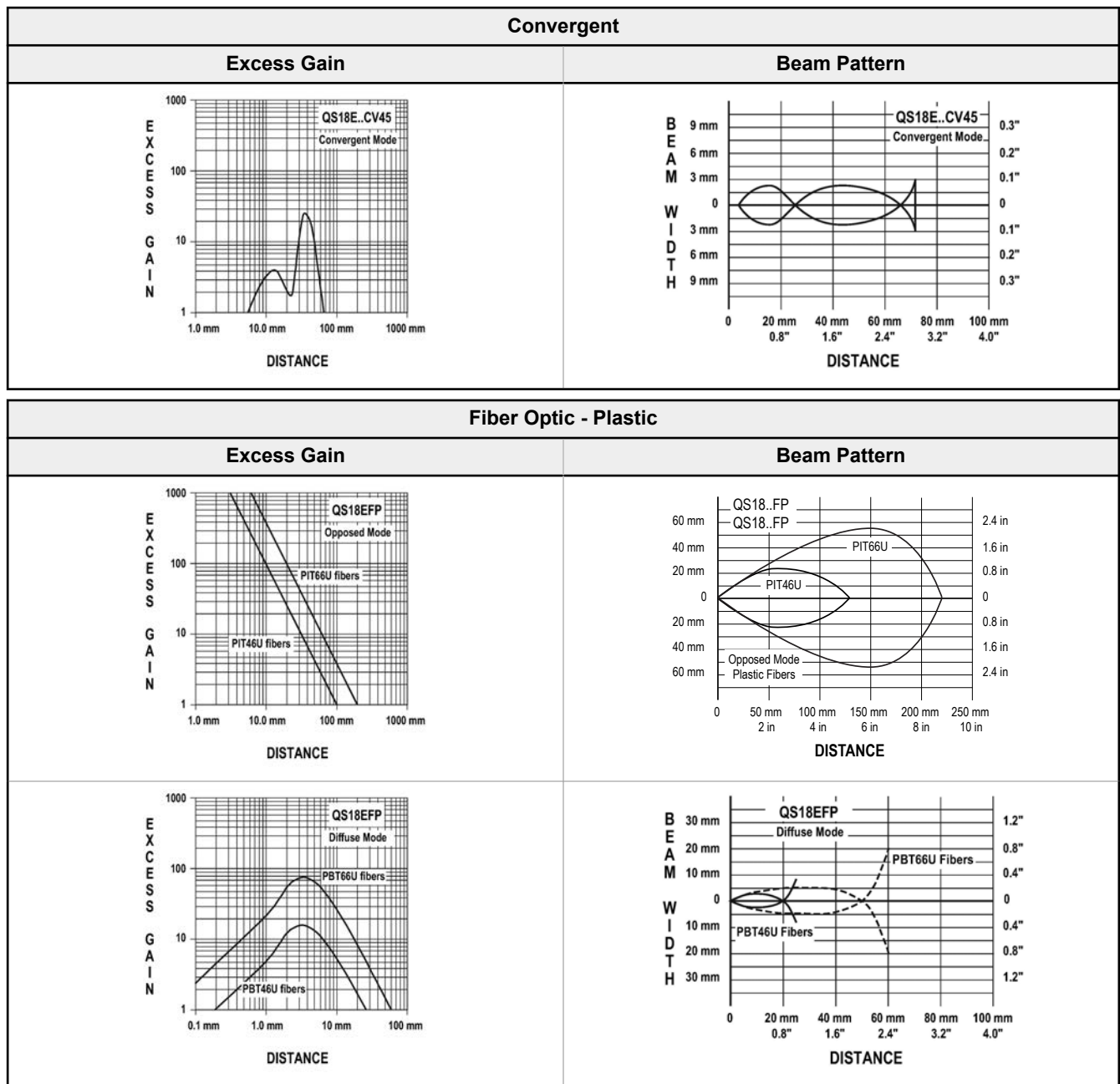


## 7.4 Self-Contained Models: Performance Curves

Performance using Dark SET, performed in no-light condition.

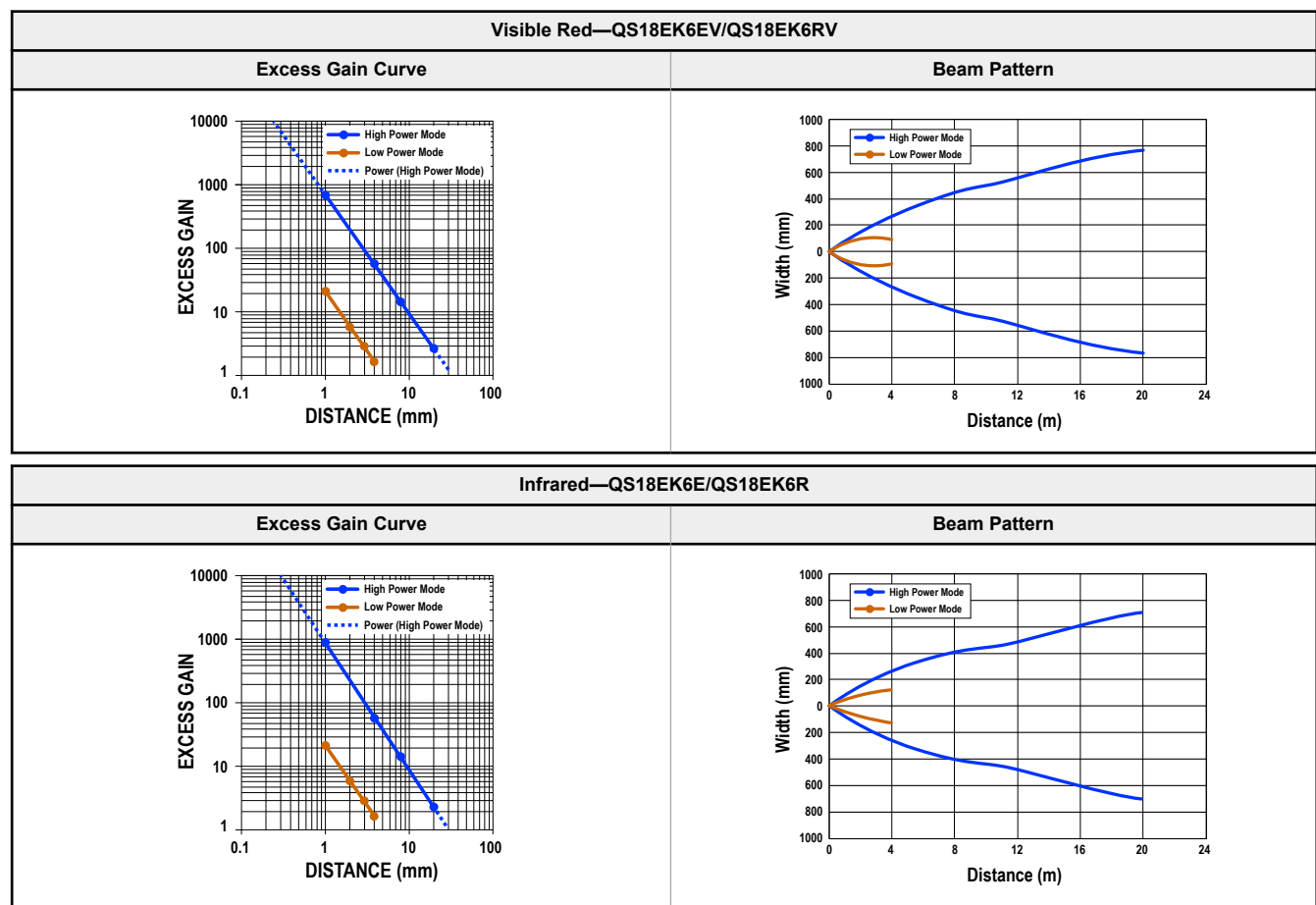






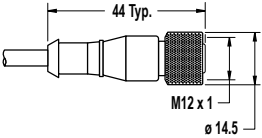
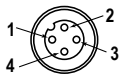
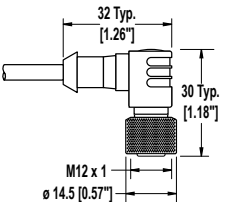


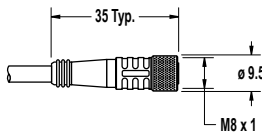
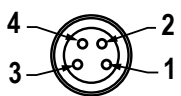
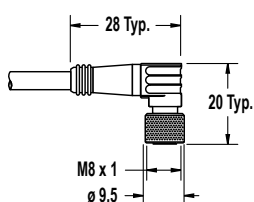
## 7.5 Opposed-Mode Models: Performance Curves



## 8 Accessories

### 8.1 Cordsets

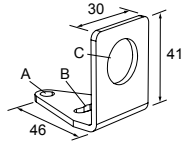
| 4-Pin Threaded M12/Euro-Style Cordsets—Single Ended |                |             |                                                                                    |                                                                                     |
|-----------------------------------------------------|----------------|-------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Model                                               | Length         | Style       | Dimensions                                                                         | Pinout (Female)                                                                     |
| MQDC-406                                            | 2 m (6.56 ft)  | Straight    |  |  |
| MQDC-415                                            | 5 m (16.4 ft)  |             |                                                                                    |                                                                                     |
| MQDC-430                                            | 9 m (29.5 ft)  |             |                                                                                    |                                                                                     |
| MQDC-450                                            | 15 m (49.2 ft) |             |                                                                                    |                                                                                     |
| MQDC-406RA                                          | 2 m (6.56 ft)  | Right-Angle |  | <p>1 = Brown<br/>2 = White<br/>3 = Blue<br/>4 = Black</p>                           |
| MQDC-415RA                                          | 5 m (16.4 ft)  |             |                                                                                    |                                                                                     |
| MQDC-430RA                                          | 9 m (29.5 ft)  |             |                                                                                    |                                                                                     |
| MQDC-450RA                                          | 15 m (49.2 ft) |             |                                                                                    |                                                                                     |

| 4-Pin Threaded M8/Pico-Style Cordsets—Single Ended |                  |             |                                                                                      |                                                                                       |
|----------------------------------------------------|------------------|-------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
| Model                                              | Length           | Style       | Dimensions                                                                           | Pinout (Female)                                                                       |
| PKG4M-2                                            | 2.04 m (6.68 ft) | Straight    |   |  |
| PKG4M-5                                            | 5 m (16.4 ft)    |             |                                                                                      |                                                                                       |
| PKG4M-9                                            | 9.04 m (29.6 ft) |             |                                                                                      |                                                                                       |
| PKW4M-2                                            | 2 m (6.56 ft)    | Right Angle |  | <p>1 = Brown<br/>2 = White<br/>3 = Blue<br/>4 = Black</p>                             |
| PKW4M-5                                            | 5 m (16.4 ft)    |             |                                                                                      |                                                                                       |
| PKW4M-9                                            | 9 m (29.5 ft)    |             |                                                                                      |                                                                                       |

## 8.2 Brackets

### SMB18A

- Right-angle mounting bracket with a curved slot for versatile orientation
- 12-ga. stainless steel
- 18 mm sensor mounting hole
- Clearance for M4 (#8) hardware



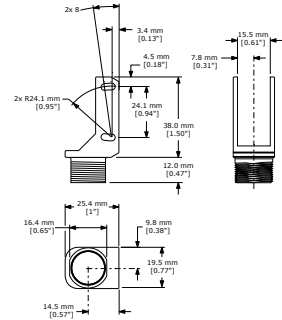
Hole center spacing: A to B = 24.2

Hole size: A =  $\varnothing$  4.6, B = 17.0  $\times$  4.6, C =  $\varnothing$  18.5

### SMBQS18Y

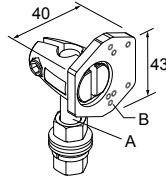
- Die-cast bracket for 18 mm holes
- Includes metal hex nut and lock washer
- Allows  $\pm 8^\circ$  for cabled sensors

Hole size: A =  $\varnothing$  15.3



### SMBQ4X..

- Swivel bracket with tilt and pan movement for precision adjustment
- Easy sensor mounting to extruded rail T-slots
- Metric and inch size bolts available
- Side mounting of some sensors with the 3 mm screws included with the sensor



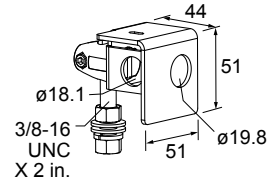
B = 7  $\times$  M3  $\times$  0.5

| Model       | Bolt Thread (A)                                               |
|-------------|---------------------------------------------------------------|
| SMBQ4XFAM   | 3/8 - 16 $\times$ 2 1/4 in                                    |
| SMBQ4XFAM10 | M10 - 1.5 $\times$ 50                                         |
| SMBQ4XFAM12 | n/a; no bolt included. Mounts directly to 12 mm (1/2 in) rods |

### SMB18AFA..

- Protective, swivel bracket with tilt and pan movement for precision adjustment
- Easy sensor mounting to extruded rail T-slots
- Metric and inch size bolts available
- Mounting hole for 18 mm sensors

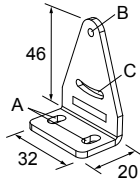
Hole size: B =  $\varnothing$  18.1



| Model       | Bolt Thread (A)        |
|-------------|------------------------|
| SMB18AFA    | 3/8 - 16 $\times$ 2 in |
| SMB18AFAM10 | M10 - 1.5 $\times$ 50  |

### SMB312S

- Stainless steel 2-axis, side-mount bracket



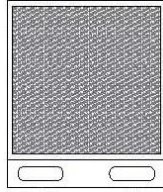
A = 4.3  $\times$  7.5, B = diam. 3, C = 3  $\times$  15.3

## 8.3 Retroreflectors

For use with self-contained LP models.

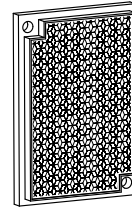
### BRT-51X51BM

- Square, acrylic target
- Reflectivity Factor: 1.5
- Temperature:  $-20^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$  to  $+122^{\circ}\text{F}$ )
- Micro-prism geometry
- Optional brackets are available
- Approximate size: 51 mm  $\times$  51 mm



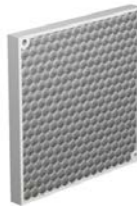
### BRT-60X40C

- Rectangular, acrylic target
- Reflectivity Factor: 1.4
- Temperature:  $-20^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$ )
- Optional brackets are available
- Approximate size: 40 mm  $\times$  60 mm



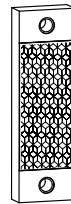
### BRT-92X92C

- Square, acrylic target
- Reflectivity Factor: 3.0
- Temperature:  $-20^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$ )
- Optional brackets are available
- Approximate size: 92 mm  $\times$  92 mm



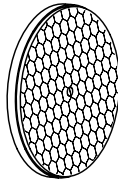
### BRT-40X19A

- Rectangular, acrylic target
- Reflectivity Factor: 1.3
- Temperature:  $-20^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$ )
- Approximate size: 19 mm  $\times$  60 mm overall; 19 mm  $\times$  40 mm reflector



### BRT-84

- Round, acrylic target
- Reflectivity Factor: 1.4
- Temperature:  $-20^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$  ( $-4^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$ )
- Optional brackets are available
- Size: 84 mm diameter
- Mounting Hole: 4.5 mm diameter



2-inch retroreflective tape, 2.5 m (100 in)

| Model         | Reflectivity Factor | Maximum Temperature                              | Size                                   |
|---------------|---------------------|--------------------------------------------------|----------------------------------------|
| BRT-THG-2-100 | 0.7                 | $+60^{\circ}\text{C}$ ( $+140^{\circ}\text{F}$ ) | 50 mm (2 in) wide, 2.5 m (100 in) long |

## 9 Product Support and Maintenance

### 9.1 Contact Us

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Banner Engineering Corp. headquarters is located at:

9714 Tenth Avenue North  
Minneapolis, MN 55441, USA  
Phone: + 1 888 373 6767

For worldwide locations and local representatives, visit [www.bannerengineering.com](http://www.bannerengineering.com).

### 9.2 Banner Engineering Corp. Limited Warranty

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