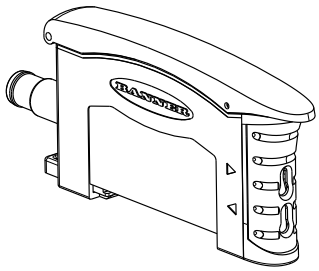
D10—Discrete Output

Datasheet

Low-cost, 10 to 30 V dc Sensor for use with Plastic Fiber Optics



- Models available with visible red (660 nm) or visible green (525 nm) LED light source
- Sleek, ultra-slim 10 mm housing, mounts to standard 35 mm DIN rail
- Solid-state, bipolar discrete outputs: one current sourcing (PNP) and one current sinking (NPN)
- High-speed models: 200-microsecond output response
- Standard models: 500-microsecond output response plus crosstalk-avoidance circuitry (for applications with multiple sensors)
- Selectable Light/Dark Operate and 40 millisecond pulse stretcher (OFF-delay), via two easy-to-operate slide switches
- 12-turn Sensitivity adjustment with relative position indicator
- LED status indicators for Power ON and Light Sensed (AID™) indication
- Models available with integral cable or Pico-style quick-disconnect

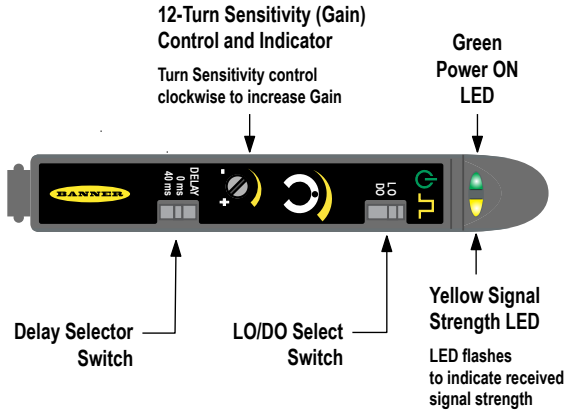
WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

Models

Red Beam (660 nm)	Green Beam (525 nm)	Response Time	Cable[1]	Output Type
D10AFP	D10AFPG	500 microseconds	4-conductor 2 m (6.5 ft) Cable	Bipolar NPN/PNP Solid-state
D10AFPQ	D10AFPGQ		4-pin Pico-style QD	
D10AFPY	D10AFPGY	200 microseconds	4-conductor 2 m (6.5 ft) Cable	
D10AFPYQ	D10AFPGYQ		4-pin Pico-style QD	

Features

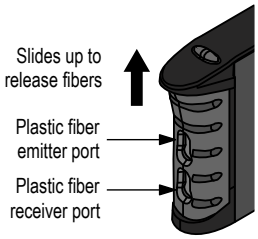


[1] To order the 9 m (30 ft) PVC cable model, add the suffix "W/30" to the cabled model number. For example, D10AFP W/30. Models with a quick disconnect require a mating cordset.

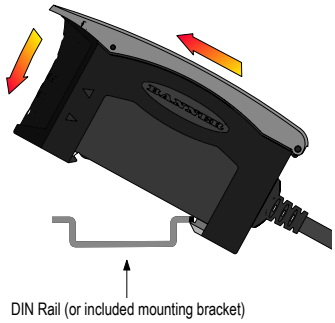
Installation

Installing Fibers and Housing

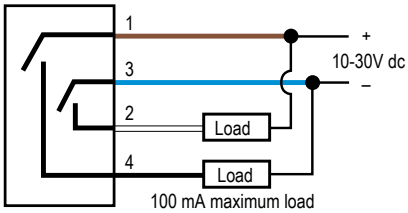
Installing Fibers



Mounting the D10 on a DIN Rail or the Mounting Bracket



Wiring Diagram



Key

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

NOTE: Quick disconnect (QD) wiring diagrams are functionally identical.

Specifications

Sensing Beam
Visible red, 660 nm or Visible green, 525 nm , depending on model

Supply Voltage
10 to 30 V dc (10% max. ripple) at less than 25 mA, exclusive of load

Supply Protection Circuitry
Protected against reverse polarity and transient voltages

Output Configuration
Bipolar: 1 current sourcing (PNP) and 1 current sinking (NPN)

Output Rating
100 mA per output with short circuit protection
OFF-state leakage current: < 10 µA sourcing; 200 µA sinking
ON-state saturation voltage:

NPN: 1.6 V at 100 mA
PNP: 2.0 V at 100 mA

Output Protection
Protected against output short-circuit and false pulse on power up

NOTE: Maximum 100 ms delay on power up; outputs do not conduct during this time

Output Response Time
Standard models (with crosstalk avoidance circuitry): 500 microseconds
High-speed models: 200 microseconds

Repeatability
Standard models: 95 microseconds
High-speed models: 50 microseconds

Adjustments
12-turn Sensitivity potentiometer with relative position indicator; LO/DO Selection switch; 0 or 40 ms off delay switch

NOTE: Use proper ESD techniques while making adjustments under cover.

Indicators
Two LEDs: Green and Amber
Green ON steady: Power ON
Amber flashing: Light Sensed Signal strength indicator (Banner's AID™ Alignment Indicating Device—the faster the flash, the more light is received)

Construction
Black ABS/polycarbonate alloy (UL94 V-0 rated) housing, clear polycarbonate cover

Environmental Rating
IEC IP50, NEMA 1

Connections
2 m or 9 m (6.5 ft or 30 ft) attached cable, or 4-pin Pico-style quick-disconnect fitting; cables for QD models are purchased separately

Operating Conditions
Operating Temperature: −10 °C to +55 °C (+14 °F to +131 °F)
Storage Temperature: −20 °C to +85 °C (−4 °F to +185 °F)
90% at +55 °C maximum relative humidity (non-condensing)

Required Overcurrent Protection

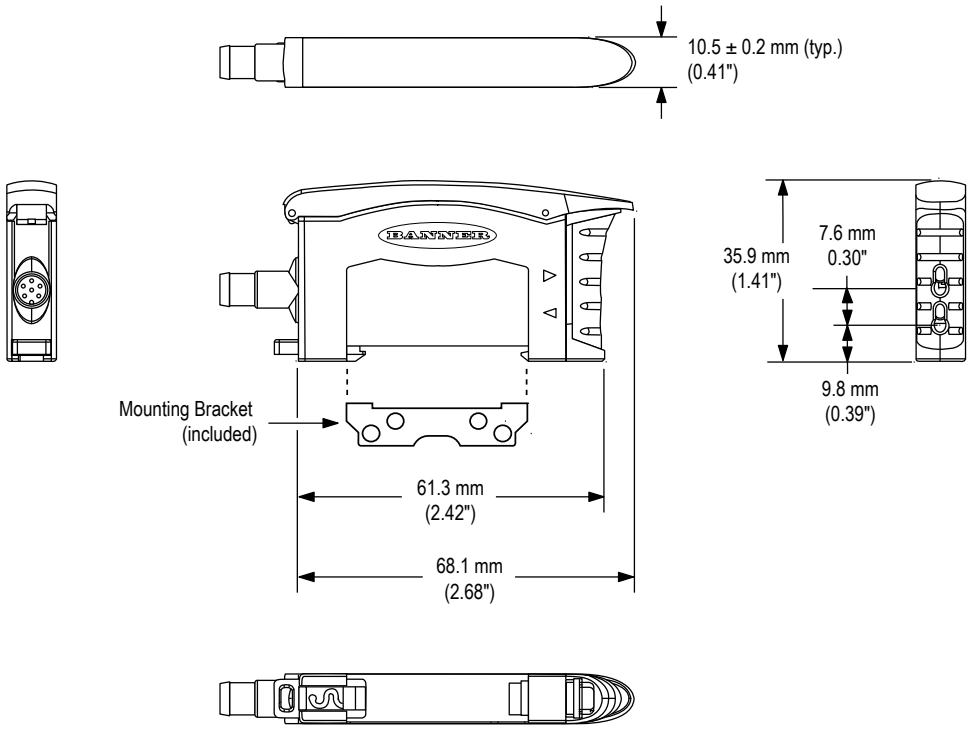
WARNING: Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

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*.

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

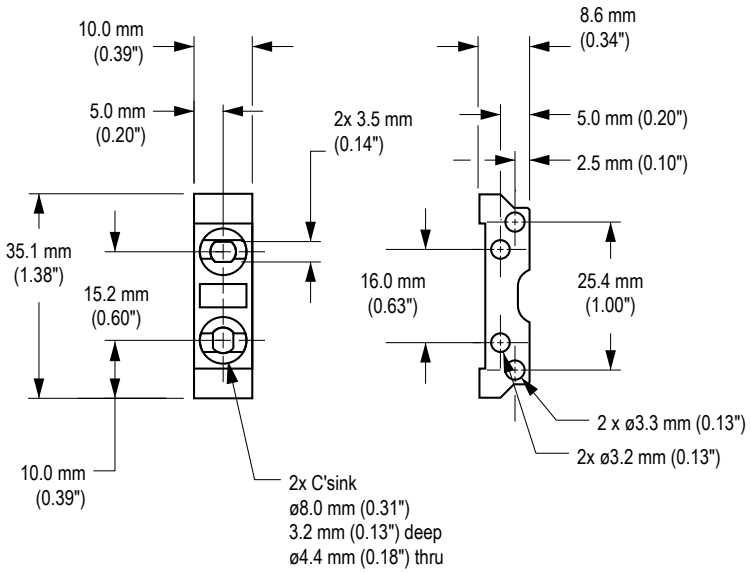
Certifications

Dimensions



All measurements are listed in millimeters [inches], unless noted otherwise.

Included Bracket Dimensions

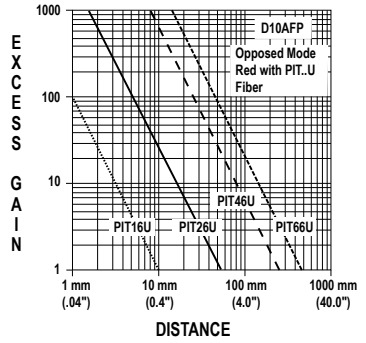


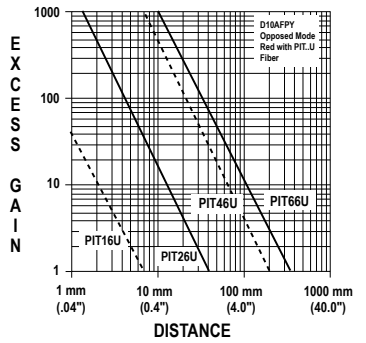
M3 Hardware included:
- Lock Washer (2)
- Flat Washer (2)
- Screws (2)
- Hex Nuts (2)

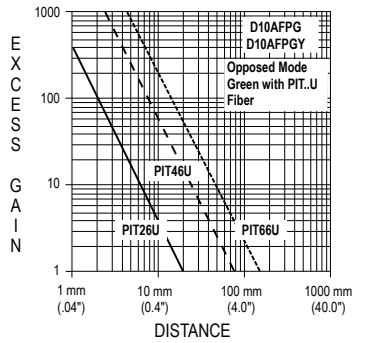
Performance Curves

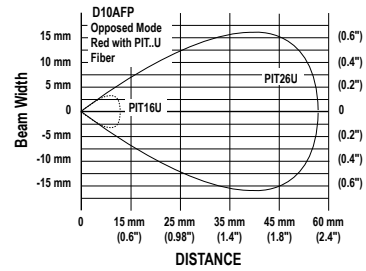
Opposed Mode

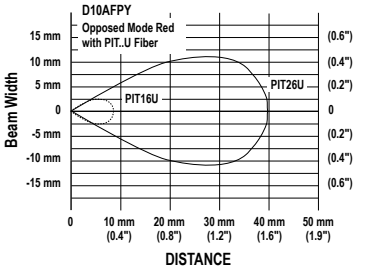
Red Beam Models	High-Speed Red Beam Models	Green Beam Models

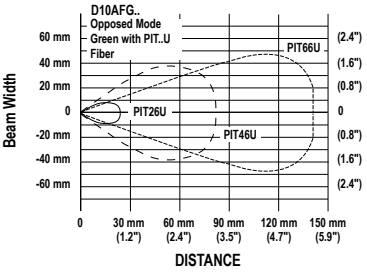


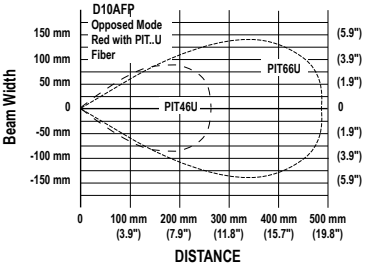


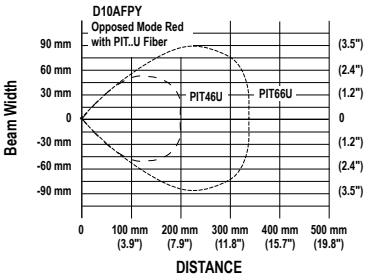






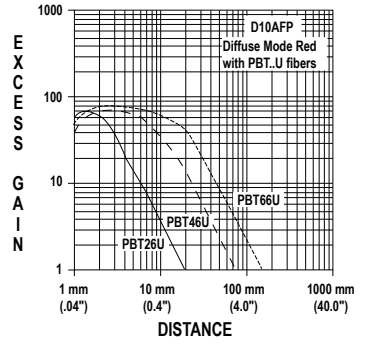


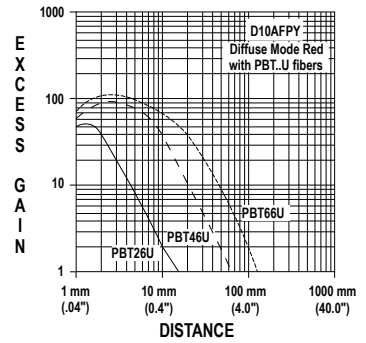


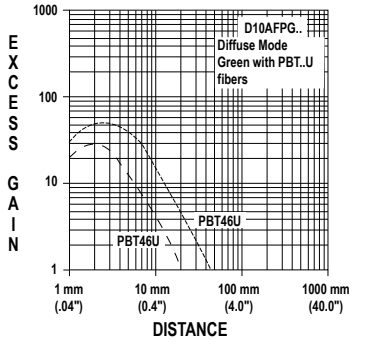


Diffuse Mode

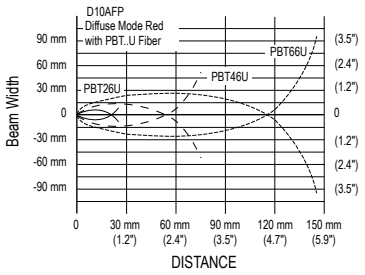
Red Beam Models	High-Speed Red Beam Models	Green Beam Models

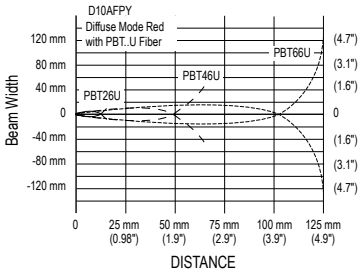


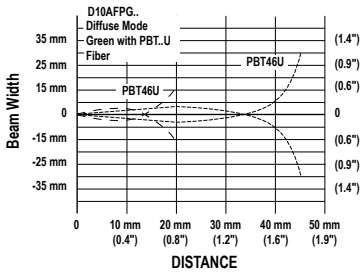




Red Beam Models	High-Speed Red Beam Models	Green Beam Models

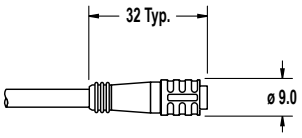
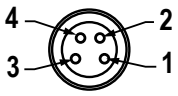
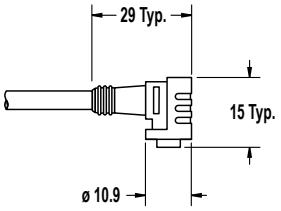






Accessories

4-Pin Snap-on M8/Pico-Style Cordsets

Model	Length	Style	Dimensions	Pinout (Female)
PKG4-2	2 m (6.56 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black
PKW4Z-2	2 m (6.56 ft)	Right-Angle		

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

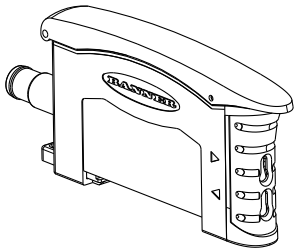
This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: *www.bannerengineering.com*.

D10 Expert™– Dual Discrete Outputs

Datasheet

Advanced sensor for use with plastic fiber optics



- Easy-to-set automatic Expert-style TEACH options[1] including static, dynamic, and single-point programming plus manual adjustment for fine-tuning
- 16-bit microcontroller and 12-bit Analog-to-Digital converter for high-performance, low-contrast sensing
- Easy-to-read 4-digit display for TEACH and signal strength readout, plus indicators for a continuous readout of operating status (user configurable)
- Two discrete outputs, PNP or NPN
- Four-mode power and speed selection with automatic cross-talk avoidance circuitry
- Selectable OFF-delay options
- Gate input wire can be used to selectively inhibit sensor outputs from switching
- Models available with visible red (680 nm) or visible green (525 nm) sensing beam
- Models available with 2 m or 9 m (6.5 ft or 30 ft) cable or integral Pico-style quick-disconnect
- Sleek, ultra-slim 10 mm housing, mounts to a standard 35 mm DIN rail

WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

Models

Red Beam Models	Green Beam Models	Cables[2]	Discrete Outputs
D10DNFP	D10DNFPG	2 m (6.5 ft) Cable	NPN
D10DNFPQ	D10DNFPGQ	6-pin Pico-style QD	
D10DPFP	D10DPFPG	2 m (6.5 ft) Cable	PNP
D10DPFPQ	D10DPFPGQ	6-pin Pico-style QD	

[1] U.S. Patent #5,808,296
[2] To order the 9 m (30 ft) PVC cable model, add the suffix "W/30" to the cabled model number. For example, D10DNFP W/30. Models with a quick disconnect require a mating cordset.

Overview

The D10 *Expert* Sensor is a high-performance plastic fiber-optic sensor whose many configuration (TEACH-mode) options make it suitable for demanding applications. Even with all its features, it is extremely easy to use. Advanced 16-bit microcontroller technology makes this possible.

The D10 *Expert* provides high-performance sensing in low-contrast applications. *Expert* TEACH and setup options provide static, dynamic and single-point programming plus manual fine adjustment, remote programming and push button lockout. Its slender, stylized housing has a large digital display visible beneath a clear cover for easy programming and status monitoring during operation. The sensor mounts directly to standard 35 mm DIN rail or using the supplied mounting bracket.

The sensor features two outputs with independent setpoints: either NPN or PNP, depending on model. Built-in crosstalk avoidance protocol provides trouble-free operation for multiple sensors in one area.

For emitter and receiver port locations, see *Installation* on page 3.

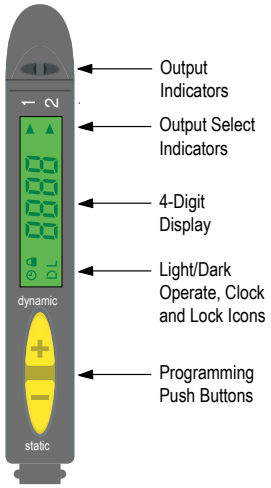


Figure 1. D10 Features

Programming Options

Light/Dark Operate Selection		Toggle to select the condition for which each output will conduct: when the target is present or when the target is absent.							
OFF-Delay Timing Selection		Programmable OFF-delay pulse stretcher: 0, 2, 5, 10, 15, 20, 30, 40, 60, 80, or 100 ms							
Display Selection		Discrete Output: Raw signal value or % excess signal							
Power Level/Speed Selection		Super High-Speed (SHS)[3]		High-Speed (HS)		High-Power (HP)		Super High-Power (SHP)	
Response[4]		50 µs		200 µs		1 ms		2.5 ms	
Repeatability		25 µs		50 µs		75 µs		100 µs	
Max Range[4]	Fiber	Red 680 nm	Green 525 nm	Red 680 nm	Green 525 nm	Red 680 nm	Green 525 nm	Red 680 nm	Green 525 nm
	PIT16U	20 mm	9 mm	30 mm	9 mm	55 mm	13 mm	90 mm	16 mm
	PIT26U	100 mm	40 mm	150 mm	40 mm	250 mm	55 mm	400 mm	70 mm
	PIT46U	300 mm	100 mm	550 mm	100 mm	1000 mm	160 mm	1200 mm	180 mm
	PIT66U	600 mm	180 mm	1000 mm	180 mm	1700 mm	280 mm	2400 mm	320 mm
	PBT16U	6 mm	[5]	10 mm	[5]	18 mm	3 mm	30 mm	3.5 mm
	PBT26U	30 mm	12 mm	50 mm	12 mm	100 mm	20 mm	150 mm	25 mm
	PBT46U	100 mm	30 mm	175 mm	30 mm	250 mm	42 mm	300 mm	60 mm
	PBT66U	175 mm	55 mm	250 mm	55 mm	400 mm	80 mm	475 mm	100 mm
Tracking Feature		Sets Output 2 to identical settings as Output 1; Output 2 settings can then be revised as desired (see *Advanced Setup* on page 12).							
Factory Default Settings		The following settings are preset at the factory; revert sensor to factory defaults using Advanced Setup procedure (see *Advanced Setup* on page 12). • Light operate (LO) • No OFF-delay (t 0) • Raw signal value (1234) • Output 1 displayed • High Speed (HS); 200 µs response • Maximum power setting • Discrete: switchpoint positioned at middle of range							

[3] See the Super High-Speed note under Sensor Setup.
[4] Diffuse mode performance based on 90% reflectance white test card.
[5] ø0.010-inch bifurcated fiber not recommended in these speed settings. Contact Banner Engineering for more information.

Sensor Programming

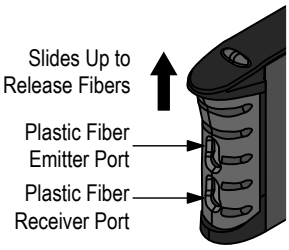
Programming Procedures: Two push buttons, Dynamic (+) and Static (-), may be used to access and set programming parameters. For remote programming, connect a switch or digital input to the gray wire; length of the individual pulses is equal to the value T: 0.04 seconds ≤ T ≤ 0.8 seconds

Returning to RUN mode: TEACH and SETUP modes each may be exited in one of two ways: by exercising the 60-second time-out, or by cancelling out of the process. In TEACH mode, the sensor will return to RUN mode without saving any of the new settings; in SETUP mode, the sensor will return to RUN mode but save all of the settings. To cancel out of TEACH mode, press and hold the Static (-) button for 2 seconds; to cancel out of SETUP mode, press and hold both the Static (-) and Dynamic (+) buttons for 2 seconds.

Output 2: The setpoint(s) for each output can be set independently of one another (see Super-High Speed Operation). However, the functional range available for output 2 is dictated by the automatic power and gain settings established for output 1. Whenever output 1 is taught, output 2 also must be retaught. Applications hint: teach the weakest signal on output 1 first.

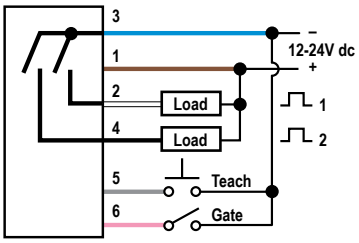
Installation

Install the product on a 35 mm DIN rail or the included mounting bracket.

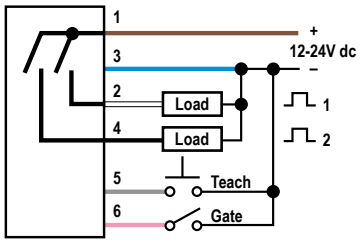


Wiring Diagrams

NPN Output Models



PNP Output Models



Key

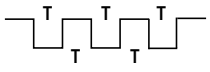
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray
6 = Pink

Quick disconnect (QD) wiring diagrams are functionally identical.

Configuration Instructions

Active Channel Select

- Selects which channel to teach
- Displays channel configuration information.

Method	Action	Result
Push Button[6]	Single-click both buttons simultaneously. 	Pointer icon: moves to the other channel indicator. 
Remote Input[7]	Triple-pulse the remote line. NOTE: Triple-pulse will change the display, but will not save. To save Channel Select, make an adjustment to that channel as a TEACH, SET, or Sensor Setup. 	

Two-Point Static TEACH (Threshold)

- Establishes a single switching threshold
- Threshold position is adjustable using "+" and "-" buttons (see *Manual Adjust* on page 10)

Static TEACH is the traditional setup method, used when two conditions can be presented by the user. The sensor locates a single sensing threshold (the switchpoint) midway between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other.

The first condition taught is the ON condition. The Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in Setup mode (see *Sensor Setup* on page 10).

Static TEACH and Manual Adjust

Using Manual Adjust with Static TEACH moves the switching threshold.

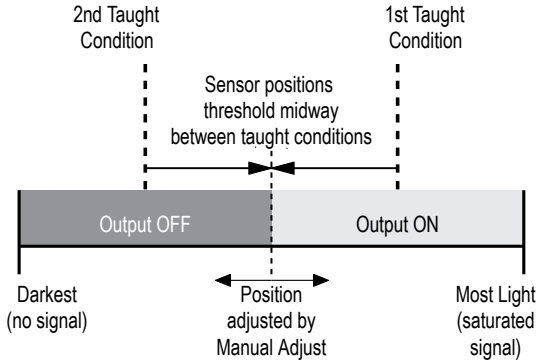


Figure 2. Static TEACH (Light Operate shown)

Contrast Values	
500+	Excellent: Very stable operation.
100-500	Good: Minor sensing variables will not affect sensing reliability.
32-99	Low: Minor sensing variables may affect sensing reliability.
0-31	Marginal: Consider an alternate sensing scheme.

Figure 3. Contrast Values

1. Access the Static TEACH Mode.

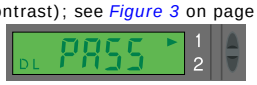
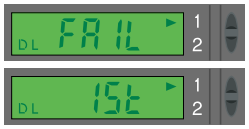
Method	Action	Result
Push Button[8]	Press and hold the Static (-) button > 2 seconds. 	• Display flashes "1St" • Arrow icon turns red 
Remote Input[9]	No action is required; the sensor is automatically ready for the 1st TEACH condition.	

2. TEACH the Output ON condition.

Method	Action	Result
Push Button	a. Present the Output ON condition. b. Click the Static button. 	Display flashes "2nd" 
Remote Input	a. Present the Output ON condition. b. Single-pulse the remote line. 	

6 0.04 seconds ≤ "Click" ≤ 0.8 seconds
7 0.04 sec. ≤ T ≤ 0.8 seconds
8 0.04 seconds ≤ "Click" ≤ 0.8 seconds
9 0.04 seconds ≤ T ≤ 0.8 seconds

3. TEACH the Output OFF condition.

Method	Action	Result
Push Button	a. Present the Output OFF condition. b. Click the Static button. 	TEACH conditions accepted • Display flashes "PASS," followed by a number (denoting contrast); see *Figure 3* on page 4.  • Sensor returns to RUN mode with new settings • Arrow icon turns green TEACH conditions not accepted • Display flashes "FAIL" and returns to "1St"  • Arrow icon remains red • After 60 seconds, sensor returns to RUN mode (Arrow icon turns green) without changing settings
Remote Input	a. Present the Output OFF condition. b. Single-pulse the remote line. 	

Dynamic TEACH and Adaptive Thresholds

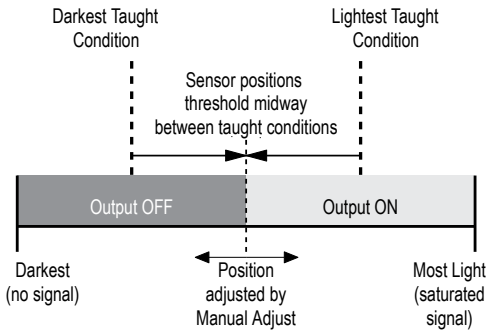


Figure 4. Dynamic TEACH (Light Operate shown)

Contrast Values	
500+	Excellent: Very stable operation.
100-500	Good: Minor sensing variables will not affect sensing reliability.
32-99	Low: Minor sensing variables may affect sensing reliability.
0-31	Marginal: Consider an alternate sensing scheme.

Figure 5. Dynamic Contrast Values

- TEACH on-the-fly
- Sets a single threshold
- Threshold position is adjustable using the "+" and "-" buttons (see *Manual Adjust* on page 10)

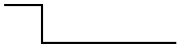
Dynamic TEACH is used to program sensitivity during actual machine run conditions. During Dynamic TEACH, the sensor takes multiple samples of the light and dark conditions and automatically sets the sensitivity at the optimum level. Dynamic TEACH activates the sensor's adaptive threshold system, which continuously tracks minimum and maximum signal levels, and automatically maintains centering of the switch point between the light and dark conditions. The adaptive threshold system remains in effect during RUN mode to automatically adjust for changes in the light or the dark conditions.

When Dynamic TEACH mode is used to program sensitivity, the output ON state (light or dark operate) will remain as it was last programmed. To change to either light or dark operate, use the SETUP mode (see *Sensor Setup* on page 10).

Dynamic TEACH and Manual Adjust

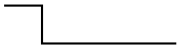
Sensitivity may be adjusted at any time when the sensor is in RUN mode by clicking the "+" and "-" buttons. However, when a manual adjustment is made, the adaptive threshold system is disabled (cancelled).

1. Access the Dynamic TEACH Mode.

Method	Action	Result
Push Button[10]	Press and hold the Dynamic (+) button. 	• Display flashes "dYn" • Arrow icon turns red 
Remote Input[11]	Hold the remote line low (to ground). 	

[10] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[11] 0.04 seconds ≤ T ≤ 0.8 seconds

2. TEACH the Sensing Conditions.

Method	Action	Result
Push Button	Present the Output ON/OFF conditions while continuing to hold the Dynamic button. 	
Remote Input	Present the Output ON/OFF conditions while continuing to hold the remote line low (to ground). 	

3. Return to RUN Mode.

Method	Action	Result
Push Button	Release the Dynamic button. 	TEACH conditions accepted • Display flashes “PASS,” followed by a number (denoting contrast); see *Figure 5* on page 5 • Sensor returns to RUN mode with new settings • Arrow icon turns green 
Remote Input	Release the remote line/switch. 	TEACH conditions not accepted • Display flashes “FAIL” • Arrow icon remains red • Sensor returns to RUN mode (Arrow icon turns green) without changing settings 

Single-Point Window Set

- Sets a single ON condition that extends 200 counts above and below the taught condition (including ±100 counts hysteresis)
- All other conditions (lighter or darker) result in OFF output
- Sensing window size (sensitivity) is adjustable using “+” and “-” buttons (see *Manual Adjust* on page 10)

Window Set is most useful when a product may not always appear in the same place, or when other signals may appear. Window Set designates a sensing window, with the Output ON condition inside the window, and the Output OFF conditions outside the window. The sensor accepts a single sensing condition, and adds switching thresholds and hysteresis above and below that condition to create a sensing window. Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in Setup mode.

Window Set and Manual Adjust

Using Manual Adjust with Window Set expands or contracts the size of the window.

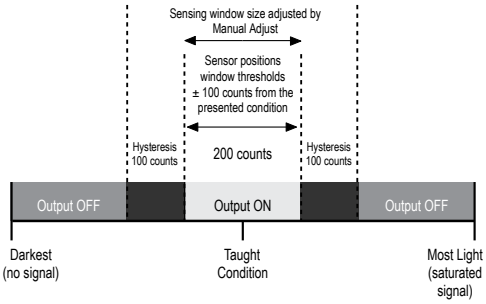
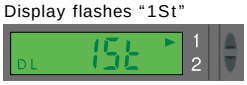


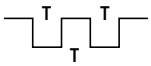
Figure 6. Single-Point Window SET and Hysteresis (Light Operate shown)

1. Access the SET Mode.

Method	Action	Result
Push Button	Press and hold the Static (-) button > 2 seconds. 	• Display flashes “1St”  • Arrow icon turns red

Method	Action	Result
Remote Input[12]	a. Present the sensing condition. b. Single-pulse the remote line. 	• Display flashes “2nd”  • Arrow icon turns red

2. SET the sensing condition.

Method	Action	Result
Push Button	a. Present the sensing condition. b. Double-click the Static button. 	TEACH conditions accepted • Display flashes “Sn6l,” then "Pt" twice  • Sensor returns to RUN mode with new settings • Arrow icon turns green TEACH conditions not accepted • Display flashes “FAIL” and returns to “1St”   • Arrow icon remains red • After 60 seconds, the sensor returns to RUN mode (the arrow icon turns green) without changing settings
Remote Input	Double-pulse the remote line. 	

Single-Point Light Set

- Sets a threshold slightly below the taught condition.
- Any condition darker than the threshold condition causes the output to change state
- Threshold position is adjustable using the “+” and “-” buttons (see *Manual Adjust* on page 10)
- Recommended for applications where only one condition is known, for example a stable light background with varying darker targets

A single sensing condition is presented, and the sensor positions a threshold slightly below the presented condition. When a condition darker than the threshold is sensed, the output either turns ON or OFF, depending on the Light/Dark Operate setting (see *Sensor Setup* on page 10).

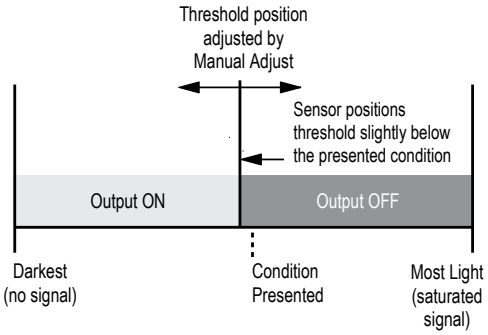


Figure 7. Single-Point Light Set (Light Operate shown)

Light SET and Light/Dark Operate Selection

Light Set teaches the Output OFF condition and forces the sensor into Dark Operate (DO) mode. The sensor can be reconfigured to Light Operate (LO) mode after the condition has been taught (see *Sensor Setup* on page 10).

Mode	Threshold Offset (counts below taught signal value)
Super High-Speed	30
High-Speed	22
High-Power	9

[12] 0.04 seconds ≤ T ≤ 0.8 seconds

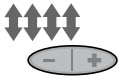
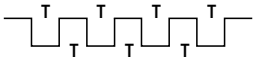
Mode	Threshold Offset (counts below taught signal value)
Super High-Power	6

Figure 8. Light Set Threshold Offset

1. Access the SET Mode.

Method	Action	Result
Push Button[13]	Press and hold the Static (-) button > 2 seconds. 	• Display flashes “1St” • Arrow icon turns red 
Remote Input[14]	Single-pulse the remote line. 	• Display flashes “2nd” • Arrow icon turns red 

2. SET the Output OFF condition.

Method	Action	Result
Push Button	a. Present the Output OFF condition. b. Four-click the Static button. 	Threshold condition accepted • Display flashes “Sn6l,” then "Lt" twice  • Sensor returns to RUN mode with new settings • Arrow icon turns green Threshold conditions not accepted • Display flashes “FAIL” and returns to “1St”  • Arrow icon remains red • After 60 seconds, the sensor returns to RUN mode (the Arrow icon turns green) without changing settings
Remote Input	a. Present the Output OFF condition. b. Four-pulse the remote line. 	

[13] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[14] 0.04 seconds ≤ T ≤ 0.8 seconds

Single-Point Dark Set

- Sets a threshold slightly above the taught condition
- Any condition lighter than the threshold condition causes the output to change state
- Threshold position is adjustable using the "+" and "-" buttons (see *Manual Adjust* on page 10)
- Recommended for applications where only one condition is known, for example a stable dark background with varying lighter targets

A single sensing condition is presented, and the sensor positions a threshold slightly above the taught condition. When a condition lighter than the threshold is sensed, the output either turns ON or OFF, depending on the Light/Dark Operate setting (see *Sensor Setup* on page 10).

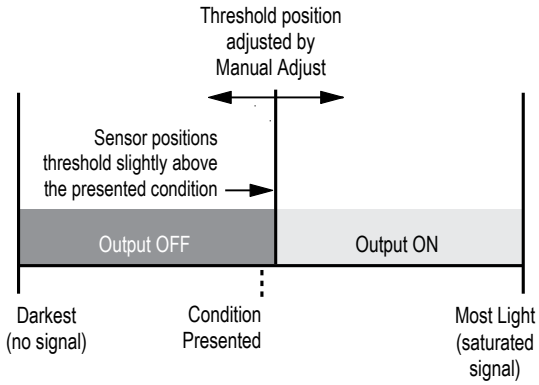


Figure 9. Single-Point Dark Set (Light Operate shown)

Dark Set and Light/Dark Operate Selection

Dark Set teaches the Output OFF condition and forces the sensor into Light Operate (LO) mode. The sensor can be reconfigured to Dark Operate (DO) mode after the condition has been taught (see *Sensor Setup* on page 10).

Mode	Threshold Offset (counts above taught signal value)
Super High-Speed	30
High-Speed	22
High-Power	9
Super High-Power	6

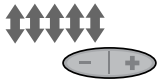
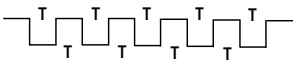
Figure 10. Dark Set Threshold Offset

1. Access the Set Mode.

Method	Action	Result
Push Button	Press and hold the Static button > 2 seconds. 	• Display flashes "1St" • Arrow icon turns red 
Remote Input[15]	Single-pulse the remote line. 	• Display flashes "2nd" • Arrow icon turns red 

2. Set the Output OFF condition.

[15] 0.04 seconds ≤ T ≤ 0.8 seconds

Method	Action	Result
Push Button	a. Present the Output OFF condition. b. Five-click the Static button. 	Threshold condition accepted • Display flashes “Sn6l,” then "dr" twice  • Sensor returns to RUN mode with new settings • Arrow icon turns green Threshold condition not accepted • Display flashes “FAIL” and returns to “1St”  • Arrow icon remains red • After 60 seconds, the sensor returns to RUN mode (the Arrow icon turns green) without changing settings
Remote Input	a. Present the Output OFF condition. b. Five-pulse the remote line. 	

Manual Adjust

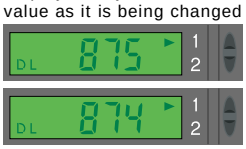
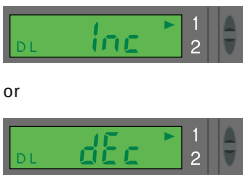
Manual Adjust is used during Run mode and is accomplished using the push buttons only. Its behavior depends on whether a switching threshold or a sensing window is used.

Switching Threshold:

- Fine-tunes sensing sensitivity
- Press “+” to increase; press “-” to decrease

Sensing Window:

- Adjusts sensing window size (tolerance) for the single-point target condition
- Press “+” to increase; press “-” to decrease

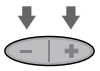
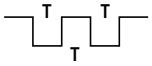
Method	Action	Result
Push Button[16]	Click "+" to increase, or click "-" to decrease. 	Display briefly flashes the threshold setpoint value as it is being changed  OR Display flashes"inc" or "dEc" as the window size is adjusted 
Remote Input[17]	Not available with remote programming.	n/a

Sensor Setup

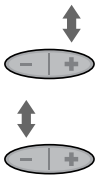
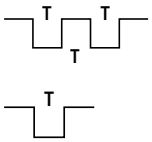
- Configures sensor display and operating parameters
- Changes are updated instantly
- Click Dynamic (+) or double-pulse remote line to select an option
- Click Static (-) or single-pulse remote line to advance

[16] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[17] 0.04 seconds ≤ T ≤ 0.8 seconds

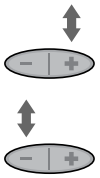
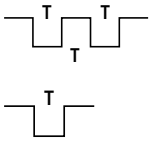
1. Access SETUP Mode.

Method	Action	Result
Push Button[18]	Press and hold both buttons concurrently for > 2 seconds. 	The indicator arrow icon 1 is ON red.
Remote Input[19]	Double-pulse the remote line. 	

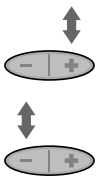
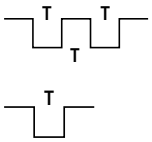
2. Select Light/Dark Operate.

Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to save selection and advance to "OFF-Delay." 	Light Operate • Display flashes "lo" • L icon  Dark Operate • Display flashes "do" • D icon 
Remote Input	a. Double-pulse remote line to toggle between selections. b. Single-pulse remote line to save selection and advance to "OFF-Delay." 	

3. Select OFF-Delay Timing Enable.

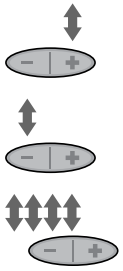
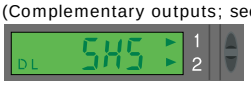
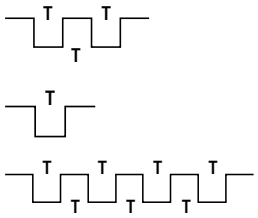
Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to save selection and advance to "Display." 	Off (No OFF-Delay) • "t 0" • Clock icon OFF  2 to 100 ms OFF-Delay • "t 2," "t 5," "t 10," "t 15," "t 20," "t 30," "t 40," "t 60," "t 80," or "t100" • Clock icon ON 
Remote Input	a. Double-pulse remote line to toggle between selections. b. Single-pulse remote line to save selection and advance to "Display." 	

4. Select Display Parameters.

Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to save selection and advance to "Power/Speed." 	Raw Signal Value "1234"  Percent of excess signal "123P" 
Remote Input	a. Double-pulse remote line to toggle between selections. b. Single-pulse remote line to save selection and advance to "Power/Speed." 	

5. Select Speed and Power Combination.

[18] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[19] 0.04 seconds ≤ T ≤ 0.8 seconds

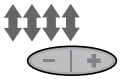
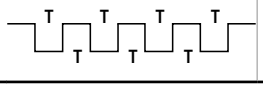
Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to save selection and return to RUN mode. OR c. Press Static (-) four times to proceed to Advanced Setup. 	Indicator Arrow Icons 1 and 2 ON Red Super-high-speed (50-µs response) "SHS" (Complementary outputs; see note below)  High-speed (200-µs response) "HS"  High-power (1-ms response) "HP"  Super-high-power (2.5-ms response) "SHP"  OR See *Advanced Setup* on page 12.
Remote Input	a. Double pulse the remote line to toggle between selections. b. Single-pulse the remote line to save selection and return to RUN mode. OR c. Four-pulse the remote line to proceed to Advanced Setup. 	

Super-High-Speed Operation Note: Under most conditions, the sensor's two discrete outputs operate independently. However, the outputs become complementary when operating at Super-High-Speed, due to its extremely fast response time. Only channel 1 is taught/adjusted; channel 2 is complementary to it (output 1 conducts for the taught ON condition, and output 2 conducts for the OFF state). To invert these conditions (output 1 – OFF condition, output 2 – ON), change light/dark operate setting.

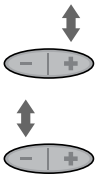
Advanced Setup

- Advanced adjustments to previously configured sensor display and operating parameters
- Quad-click Static (-) or quad-pulse remote line before exiting "Power and Speed" settings to enter this mode
- Click Dynamic (+) or double-pulse remote line to select an option
- Click Static or single-pulse remote line to advance
- Changes are updated instantly

1. Enter SETUP Mode.

Method	Action	Result
Push Button[20]	From the Power and Speed mode, quad-click the Static (-) button. 	• Indicator Arrow Icons 1 and 2 remain red • Display shows "Tracking Enabled" option 
Remote Input[21]	From the Power and Speed mode, quad-pulse the remote line. 	

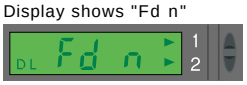
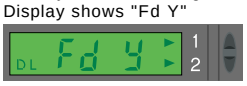
2. Set tracking, if desired.

Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to save selection and advance to "Factory Default." 	Sets output 2 identical to output 1 Tracking Disabled: Display shows "tr n"  Tracking Enabled: Display shows "tr Y" 

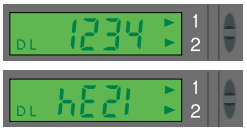
[20] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[21] 0.04 seconds ≤ T ≤ 0.8 seconds

Method	Action	Result
Remote Input	a. Double-pulse the remote line to toggle between selections. b. Single-pulse the remote line to save selection and advance to "Factory Default."	

3. Return the sensor to the factory default settings, if desired.

Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to save selection and advance to "Display Orientation."	Returns to factory default factory settings Factory Default Settings Not Selected: Display shows "Fd n" 
Remote Input	a. Double-pulse the remote line to toggle between selections. b. Single-pulse the remote line to save selection and advance to "Display Orientation."	Factory Default Settings Selected: Display shows "Fd Y" 

4. Change the display orientation, if desired.

Method	Action	Result
Push Button	a. Click Dynamic (+) to toggle between selections. b. Click Static (-) to return to RUN mode.	Inverts display to read "upside-down" Normal For example: 1234 Inverted For example: 1234
Remote Input	a. Double-pulse the remote line to toggle between selections. b. Single-pulse the remote line to return to RUN mode.	 NOTE: Icons do not invert.

Push Button Lockout

- Prevents unwanted adjustments or tampering of the push buttons
- Push buttons can be enabled or disabled only from the remote line and only during normal RUN mode

Method	Action	Result
Push Button[22]	Not available with push-button programming.	Push buttons Disabled • Display flashes "loc" • Padlock icon appears • Sensor remains in RUN mode  Push Buttons Enabled • Display flashes "uloc" • Padlock icon disappears • Sensor remains in RUN mode 
Remote Input[23]	From RUN mode, quad-pulse the remote line to toggle between selections.	

[22] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[23] 0.04 seconds ≤ T ≤ 0.8 seconds

Self-Diagnostic Error Modes

In the unlikely event that the setup parameters are lost or become corrupt, the display will continuously scroll: “USEr PSF Error.” Reteach the sensor to recover. If the problem persists, contact your Banner representative for further information.

Gate Input

The pink wire is configured as a gate input. When this wire is pulled low (for example, to the sensor ground; 0–0.5 V dc), it inhibits the outputs from switching, while all other sensor functions continue to be enabled. This feature is useful for controlling when the outputs are allowed to change states. Gate input function response time is 1 millisecond.

Specifications

Required Fiber-Optic Cable
Banner P-Series plastic fibers

Sensing Beam
Visible red, 680 nm or Visible green, 525 nm , depending on model

Supply Voltage and Current
12 to 24V dc (10% maximum ripple) at less than 65 mA, exclusive of load

Supply Protection Circuitry
Protected against reverse polarity and transient voltages

Output Configuration
2 NPN or 2 PNP, depending on model

Output Rating
150 mA maximum load
OFF-state leakage current: < 10 µA at 24 V dc
ON-state saturation voltage:

NPN < 1.5 V at 150 mA load
PNP < 2.5 V at 150 mA load

Output Protection Circuitry
Protected against false pulse on power-up and continuous short-circuit

Output Response Time
Programmable, 50 microseconds, 200 microseconds, 1 millisecond, 2.5 milliseconds

NOTE: < 1 second delay on power-up; outputs do not conduct during this time.

Adjustments
Push-button or remote programming of response time, OFF-delay, light/dark operate, and display

Indicators
Four-digit digital display plus LED indicators for active channel, push-button lockout, OFF-delay and light/dark operate selection; 2 yellow output indicators

Construction
Black ABS/polycarbonate alloy (UL94 V-0 rated) housing, clear polycarbonate cover

Environmental Rating
NEMA 1, IEC IP50

Connections
PVC-jacketed 2 m or 9 m (6.5' or 30') 6-wire integral cable or integral 6-pin Pico-style quick-disconnect

Operating Conditions
Temperature: −20 °C to +55 °C (−4 °F to +131°F)
Storage Temperature: −20 °C to +80 °C (−4 °F to +176 °F)
90% at +50 °C maximum relative humidity (non-condensing)

Number of Devices, Stacked	Ambient Temperature Rating	Load Specification
3	55 °C	150 mA
7	50 °C	50 mA
10	45 °C	50 mA

Required Overcurrent Protection

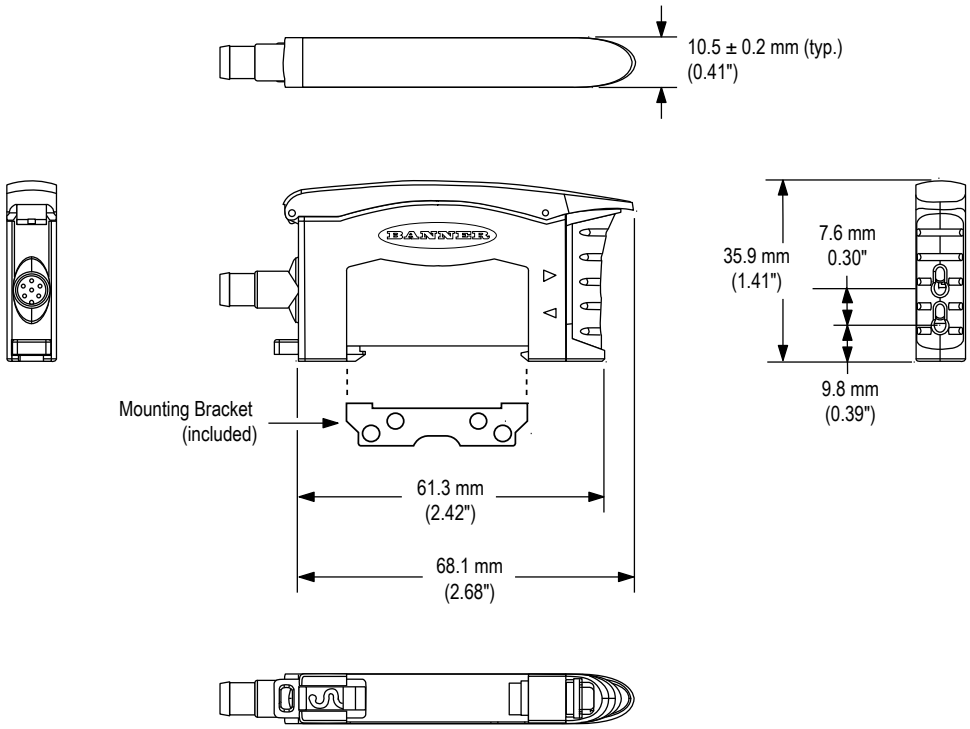
WARNING: Electrical connections must be made by qualified personnel in accordance with local and national electrical codes and regulations.

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*.

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

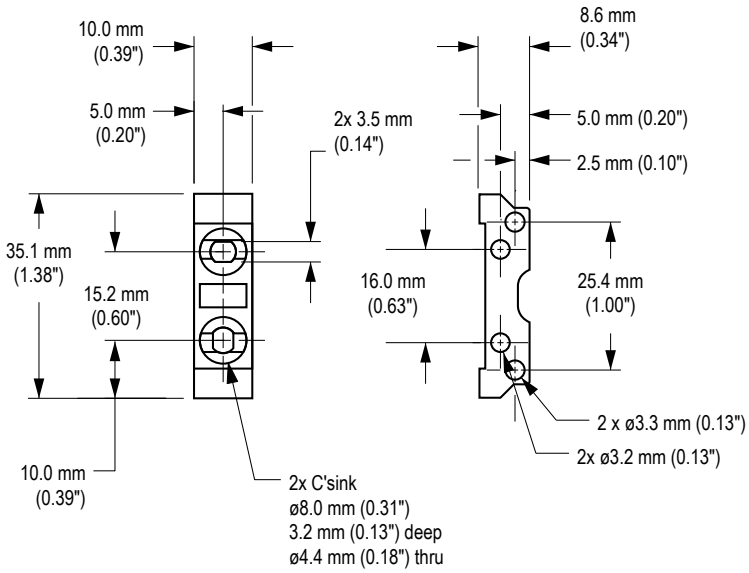
Certifications

Dimensions



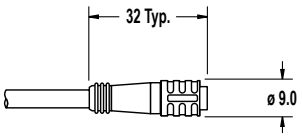
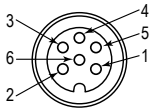
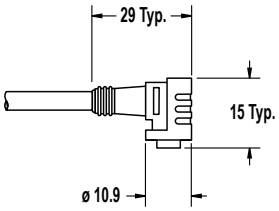
All measurements are listed in millimeters [inches], unless noted otherwise.

Included Bracket Dimensions



M3 Hardware included:
- Lock Washer (2)
- Flat Washer (2)
- Screws (2)
- Hex Nuts (2)

Accessories

6-Pin Snap-on M8/Pico-Style Cordsets				
Model	Length	Style	Dimensions	Pinout (Female)
PKG6Z-2	2 m (6.5 ft)	Straight		 1 - brown 2 = White 3 = Blue 4 = Black 5 = Gray 6 = Pink
PKW6Z-2	2 m (6.5 ft)	Right-angle		
PKW6Z-9	9 m (30 ft)			

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

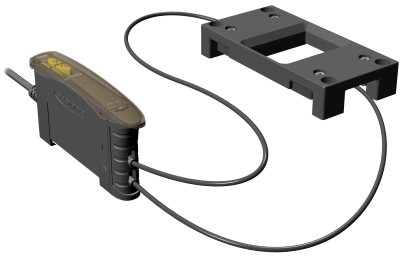
This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: *www.bannerengineering.com*.

D10 Expert Series - Small Object Counter

Datasheet

Advanced sensor for small object counting



- Easy-to-set selectable threshold with automatic compensation algorithm
- Automatic compensation algorithm compensates for dust or contamination on the fiber optic array and for ambient temperature changes
- 16-bit microcontroller and 12-bit Analog-to-Digital converter (ADC) for high-performance, low-contrast sensing
- Easy-to-read 4-digit display for Health Mode, Percentage Blocked, Signal Level, or Counter Mode readout, plus indicators for a continuous readout of operating status (user configurable)
- Sleek, ultra-slim 10 mm housing, mounts to a standard 35 mm DIN rail
- Single discrete output plus Health Mode output to indicate preventative maintenance is required
- Three-mode power and speed selection to optimize detection reliability
- Dynamic event stretcher to ensure one output per event — especially for gel-cap style pills
- Visible red (680 nm) sensing beam
- Models available with 2 m or 9 m (6.5 ft or 30 ft) cable or integral Pico-style quick-disconnect

Sensors		
Models	Cables	Discrete Outputs
D10DNCFP	2 m (6.5 ft) Cable	NPN
D10DNCFPQ	6-pin Pico-style QD	
D10DPCFP	2 m (6.5 ft) Cable	PNP
D10DPCFPQ	6-pin Pico-style QD	

Fiber Optic Arrays			
Models [1]	Detection Window Dimensions	Fiber Exit	Minimum Object Size [2]
PFCVA-10X25-S	10 mm x 25 mm	Side exit	1.5 mm
PFCVA-10X25-E		End exit	
PFCVA-25X25-S	25 mm x 25 mm	Side exit	3 mm
PFCVA-25X25-E		End exit	
PFCVA-34X25-S	34 mm x 25 mm	Side exit	4 mm
PFCVA-34X25-E		End exit	

To order the 9 m (30 ft) cable model, add suffix "W/30" to the cabled model number. For example: D10DNCFP W/30. Models with a QD connector require a mating cable.

1 Custom fiber arrays and mounting configurations are possible. Consult factory for assistance with your small object counting application.
2 With 2% threshold offset percentage

WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

Overview

The D10 Expert Small Object Counter sensor is a high-performance plastic fiber optic amplifier that has been optimized for small object counting using through-beam fiber optic arrays. Fiber optic arrays emit and receive light over an area instead of a narrow beam. Having an area of light makes alignment and positioning control of the object less critical than using single point emitter and receiver fiber optic assemblies. Because the object only breaks part of the fiber optic array, reliable detection requires very precise thresholds, an auto compensation tracking algorithm, and high speed electronics to make split-second decisions.

The setup and configuration of the advanced D10D sensor has been reduced to the act of applying power to the device with the fiber optic assemblies rigidly mounted in position. The user also has access to a comprehensive collection of setup and configuration parameters through the sensor's advanced setup menu, but for most applications the default options provide superb performance and reliability.

Upon power-up, the clear-state light level is measured and appropriate switching thresholds are established, making the fiber optic sensor system a stable, fast, and reliable small object counter. The clear-state light level can be reset by performing a 2 second hold on the dynamic (+) push button or single-clicking the remote line.

Continued reliable operation is ensured as the thresholds adapt to changing signal levels over time using Banner Engineering's auto compensation tracking algorithm. The sensor continuously tracks the clear-state light level and makes fine adjustments to the switching thresholds as required because of dust or contamination building up on the fiber optic array and for ambient temperature changes.

The sensor features either two NPN or two PNP outputs, depending on your model. Each output serves a different purpose. The discrete output 1 (white wire) switches whenever an object breaks the fiber optic array and can be used for counting. The Health Mode output 2 (black wire) switches when the fiber optic array becomes contaminated to a point that the auto compensation tracking algorithm cannot sufficiently adjust the thresholds to ensure reliable detection (see *Health Mode Alarm* on page 3).

The duration of the discrete output 1 (white wire) can be increased (stretched) to ensure accurate counting. The amount of increase is a user configurable percentage of the detection event duration; the default increase time is 50% more than the event duration. Banner calls this feature a Dynamic Event Stretcher (DES), and it prevents errant double counts of translucent gel-caps and other small objects of that type. The DES provides a "smart" OFF-delay that is independent of application speed and can be adjusted from 0% to 100% of the detection event duration.

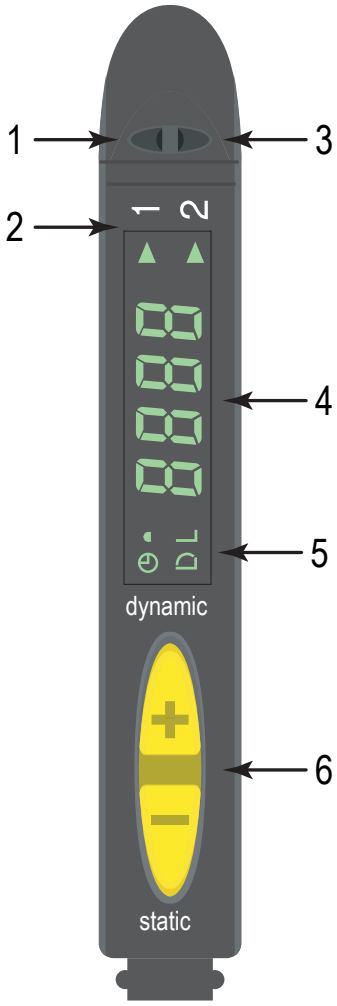


Figure 1. D10D Features

1. Counting output indicator
2. Arrow icons
3. Health mode output indicator
4. 4-digit display
5. Light/dark operate, clock, and lock icons
6. Programming push buttons

Health Mode Alarm

The Health Mode Alarm alerts you when preventative maintenance becomes necessary to ensure reliable sensing. The Health Mode output 2 is Active when the system is OK and operating normally. Health Mode output 2 becomes Inactive when the system is in a marginal state because of contamination. The system still operates normally and can detect small objects, but is nearing the alarm state. When the system is completely contaminated and unable to ensure reliable sensing, the system goes into the alarm state. In the alarm state, the discrete output 1 is forced to the blocked state and can no longer be used to detect small objects.

The sensor may enter Health Mode Alarm for any of these reasons:

1. When first powered up; the fiber optic array may already be contaminated
2. If the Window SET procedure fails, indicating the fiber optic array is contaminated and the sensor could not set a valid clear-state light level for reliable detection
3. If the fiber optic array is contaminated enough that the auto compensation tracking algorithm cannot sufficiently adjust the thresholds to ensure reliable detection
4. If the fiber optic array is blocked for more than 2 seconds

Return the system to normal operation by cleaning the fiber optic array and performing a Window SET to reset the clear-state light level (see *Single-Point Window SET* on page 7).

Health Model Display [3]		
Display Value	Outputs and Indicators	System Status
25 to 100	Discrete output 1: Operational Health Mode output 2: Active Indicators: Arrow Icons 1 & 2 GREEN	OK: system operating normally
1 to 20	Discrete output 1: Operational Health Mode output 2: Inactive Indicators: Arrow Icon 1 Green; Arrow Icon 2 Red	Marginal: System operating normally; preventative maintenance recommended
0	Discrete output 1: Forced to Blocked State (i.e. in dark operate, the output is conducting) Health Mode output 2: Inactive Indicators: Arrow Icons 1 & 2 Red	Alarm: System not operational; system maintenance required

Programming Options

Light/Dark Operate Selection. Toggle to select the condition for which the output will conduct: when the object is present or when the object is absent.

Threshold Offset Percentage. 2%, 3%, 4%, 5%, 10%

Dynamic Event Stretcher (DES) Selection. The output is held ON (OFF in Light Operate) for a percentage of time longer than the detection event duration.
Options: 0%, 25%, 33%, 50%, 100%
(e.g., If the Dynamic Event Stretcher was set at 50%, a 1 ms event would be stretched to 1.5 ms)

Display Orientation. Normal or inverted

Display Mode. Health Mode (100%–0%); Percentage Blocked (0%–100%); Signal Level (ADC value); or Counter Mode (0–9999)

Power Level/Speed Selection. High-Speed (HS) (150 µs response, 50 µs repeatability); High-Power (HP) (225 µs response, 75 µs repeatability); or Super High-Power (SHP) (300 µs response, 100 µs repeatability)

[3] Sensor display must be in Health Mode (see *Sensor Setup* on page 4)

Factory Default Settings. The following settings are preset at the factory; revert sensor to factory defaults using Advanced Setup procedure (see *Advanced Setup* on page 6)

- Dark Operate (DO)
- 50% DES
- Health Mode Display
- 2% Threshold Offset Percentage
- Normal Display Orientation
- High Speed (HS)

Sensor Programming

Programming Procedures. Use the Dynamic (+) and Static (-) buttons to access and set programming parameters. For remote programming, connect a switch or digital input to the gray wire (remote line); the length of the individual pulses is equal to the value T when 0.04 seconds ≤ T ≤ 0.8 seconds.

Returning to RUN mode. Exit Setup mode by stepping through the entire Setup process (see *Sensor Setup* on page 4), by escaping out of the Setup process, or by exceeding the 60 second inactivity time-out. To escape out of the Setup process, press and hold both the Static (-) and Dynamic (+) buttons for 2 seconds. (For remote programming, press and hold the remote line for 2 seconds). The sensor always saves the selected settings and returns to Run mode.

Sensor Setup

- Configures sensor display and operating parameters.
- Changes are updated instantly.
- Click Dynamic (+) or double-pulse remote line to select an option.
- Click Static (-) or single-pulse remote line to advance.

Remote input pulse: 0.04 s ≤ T ≤ 0.8 s

1. Access Setup mode.

Method	Action	Result
Push Button	Press and hold both the Dynamic (+) and Static (-) buttons concurrently for more than 2 seconds	• Arrow Icon 1 ON Red • Arrow Icon 2 OFF • Display shows “Threshold Offset Percentage” option. 
Remote Input	Double-pulse the remote line	

2. Select the threshold offset percentage.

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections Click Static (-) to save selection and advance to “Light/Dark Operate”	2% to 10% Threshold Offset Percentage: “t 2,” “t 3,” “t 4,” “t 5,” “t 10” 
Remote Input	Double-pulse remote line to toggle between selections Single-pulse the remote line to save selection and advance to “Light/Dark Operate"	

3. Select light operate or dark operate.

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections Click Static (-) to save selection and advance to “Dynamic Event Stretcher (DES)”	Light Operate: • Display flashes “lo” • L icon ON
Remote Input	Double-pulse remote line to toggle between selections Single-pulse the remote line to save selection and advance to “Dynamic Event Stretcher (DES)”	 Dark Operate: • Display flashes “do” • D icon ON 

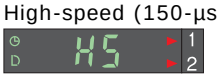
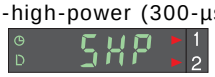
4. Select dynamic event stretcher (DES).

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections Click Static (-) to save selection and advance to “Display Mode”	OFF (No DES): • “d 0” • Clock icon OFF
Remote Input	Double-pulse remote line to toggle between selections Single-pulse the remote line to save selection and advance to “Display Mode”	 25%, 33%, 50%, or 100% DES: • “d 25,” “d 33,” “d 50,” “d 100,” • Clock icon ON 

5. Select display mode.

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections Click Static (-) to save selection and advance to "Power/Speed"	Health Mode: “HLth” 
Remote Input	Double-pulse remote line to toggle between selections Single-pulse the remote line to save selection and advance to “Power/Speed"	Percentage Blocked: “Pctb”  Signal Level: “1234”  Counter Mode: “Cntr” 

6. Select the speed and power combination.

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections To return to Run mode, click the Static (-) button OR To proceed to Advanced Setup, quad-click Static (-) button	Arrow Icons 1 and 2 ON Red High-speed (150-µs response): “HS” 
Remote Input	Double-pulse the remote line to toggle between selections Single-pulse the remote line to save selection and return to RUN mode OR Quad-click the remote line to proceed to Advanced Setup	High-power (225-µs response): “HP”  Super-high-power (300-µs response): “SHP”  See *Advanced Setup* on page 6.

Advanced Setup

- Advanced adjustments to previously configured sensor display and operating parameters.
- Quad-click Static (-) or quad-pulse remote line before exiting “Speed and Power Combination” selection to enter this mode
- Click Dynamic (+) or double-pulse remote line to select an option.
- Click Static (-) or single-pulse remote line to advance.
- Changes are updated instantly.

Remote input pulse: 0.04 s ≤ T ≤ 0.8 s

1. Enter Advanced Setup mode.

Method	Action	Result
Push Button	From “Power and Speed” mode, quad-click Static (-) button	• Arrow Icons 1 and 2 ON Red • Display shows “Factory Default Settings” option. 
Remote Input	From “Power and Speed” mode, quad-pulse the remote line	

2. Set to the factory default settings.

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections Click Static (-) to advance to “Display Orientation”	Returns to factory default settings Factory Default Settings Not Selected: Display shows “Fd n” 
Remote Input	Double-pulse the remote line to toggle between selections Single-pulse the remote line to advance to “Display Orientation”	Factory Default Settings Selected: Display shows “Fd y” 

3. Set the display orientation.

Method	Action	Result
Push Button	Click Dynamic (+) to toggle between selections Click Static (-) to return to RUN mode	Inverts display to read “upside-down” Normal: 
Remote Input	Double-pulse the remote line to toggle between selections Single-pulse the remote line to return to RUN mode	Inverted:  The icons do not invert.

Push Button Lockout

- Prevents unwanted adjustments or tampering of the push buttons.
- Push buttons can be enabled or disabled only from the remote line and only during normal RUN mode.

Remote input pulse: 0.04 s ≤ T ≤ 0.8 s

Method	Action	Result
Push Button	Not available with push-button programming	Push Buttons Disabled • Display flashes “loc” • Padlock icon appears • Sensor remains in RUN mode  Push Buttons Enabled • Display flashes “uloc” • Padlock icon disappears • Sensor remains in RUN mode 
Remote Input	From RUN mode, quad-pulse the remote line to toggle between selections	

Gate Input

The pink wire is configured as a gate input. When this wire is pulled low (e.g., to the sensor ground), it inhibits the outputs from switching while all other sensor functions continue to be enabled. This feature is useful for controlling when the outputs are allowed to change states. Gate input function response time is 1 millisecond.

Single-Point Window SET

A Window SET sets a single output condition that extends above and below the taught condition by a selectable offset percentage (2, 3, 4, 5, or 10%).

In Dark Operate, a Window SET sets a single OFF condition that extends above and below the taught condition. All other conditions (lighter or darker) result in ON output.

In Light Operate, a Window SET sets a single ON condition that extends above and below the taught condition. All other conditions (lighter or darker) result in OFF output.

Output ON and OFF conditions can be reversed by changing Light/ Dark Operate status in SETUP mode.

Remote input pulse: 0.04 s ≤ T ≤ 0.8 s

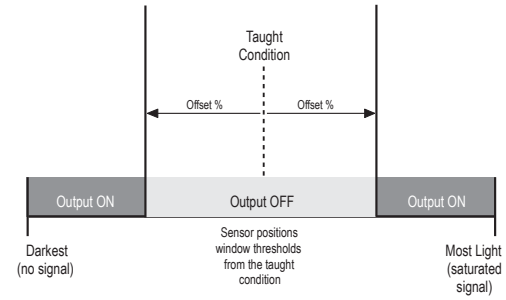
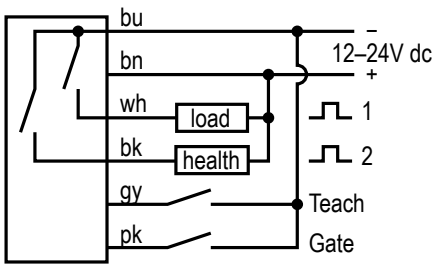
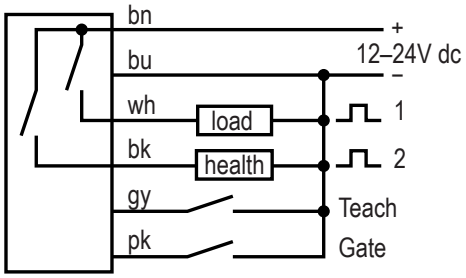


Figure 2. Single-point Window Set and Offset Percentage (Dark Operate Shown)

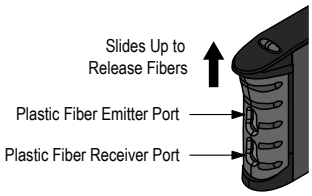
Set Clear-State Light Level of Single-Point Window		
Method	Action	Result
Push Button	1. Verify the fiber optic array is clean and clear of any objects. 2. Press and hold Dynamic (+) button for more than 2 seconds.	Display turns OFF and Arrow Icons 1 and 2 toggle 3 times green while the sensor is optimizing system settings. TEACH conditions acceptable: • Display flashes “PASS” • Sensor returns to Run mode with new settings. • Arrow Icons 1 and 2 turn ON Green • Health Mode output 2 Active  TEACH conditions unacceptable: • Display flashes “FAIL” • Arrow Icons 1 and 2 turn ON Red • Health Mode output 2 Inactive 
Remote Input	1. Make sure fiber optic array is clean and clear of any objects. 2. Single-pulse the remote line.	

Wiring Diagrams

Wiring for quick disconnect (QD) models are functionally identical.

NPN Output Models	PNP Output Models
	

D10D...Port Locations



Specifications

Required Fiber Optics
PFCVA models (Custom fiber arrays and mounting configurations are possible. Consult factory for assistance with your small object counting application.)

Sensing Beam
Visible red, 680 nm

Output Configuration
2 NPN or 2 PNP, depending on model

Output Rating
150 mA maximum load
OFF-state leakage current: < 10 µA at 24 V dc
ON-state saturation voltage: NPN < 1.5 V at 150 mA load; PNP < 2.5 V at 150 mA load

Output Response Time
Programmable, 150 µs, 225 µs, 300 µs
NOTE: < 1 second delay on power-up; outputs do not conduct during this time.

Adjustments
Push-button or remote programming of threshold offset percentage, light/dark operate, Dynamic Event Stretcher (DES), display, and power/speed

Installation
35 mm DIN rail or included mounting bracket

Indicators
Four-digit digital display, 2 arrow icons, push-button lockout, Dynamic Event Stretcher, light/dark operate selection, and 2 amber output LEDs

Certifications
CE

Supply Voltage and Current
12 to 24 V dc (10% maximum ripple) at less than 65 mA, exclusive of load

Supply Protection Circuitry
Protected against reverse polarity and transient voltage

Output Protection Circuitry
Protected against false pulse on power-up and continuous short-circuit

Construction
Black ABS/polycarbonate alloy (UL94 V-0 rated) housing, clear polycarbonate cover

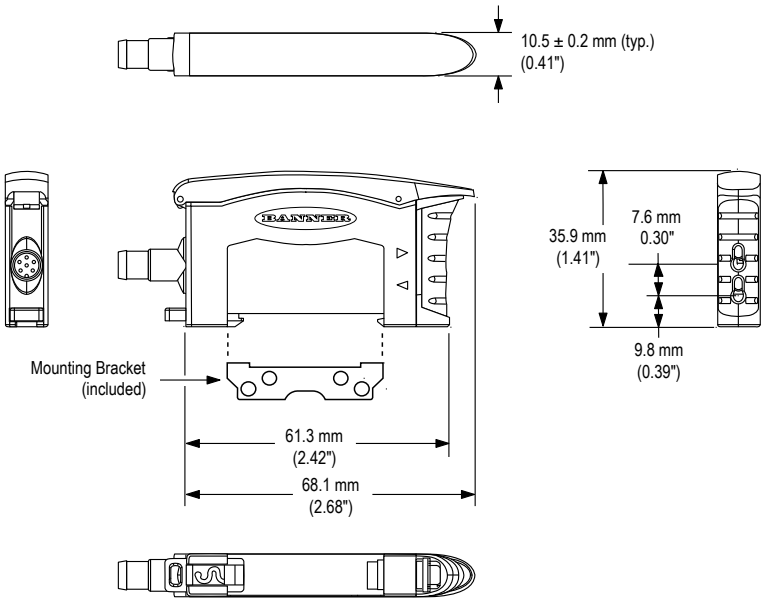
Environmental Rating
NEMA 1, IEC IP50

Operating Conditions
Temperature: –20 to 55 °C (–4 to 131 °F)
Storage Temperature: –20 to 80 °C (–4 to +75 °F)
Max. Rel. Humidity: 90% at 50 °C (non-condensing)

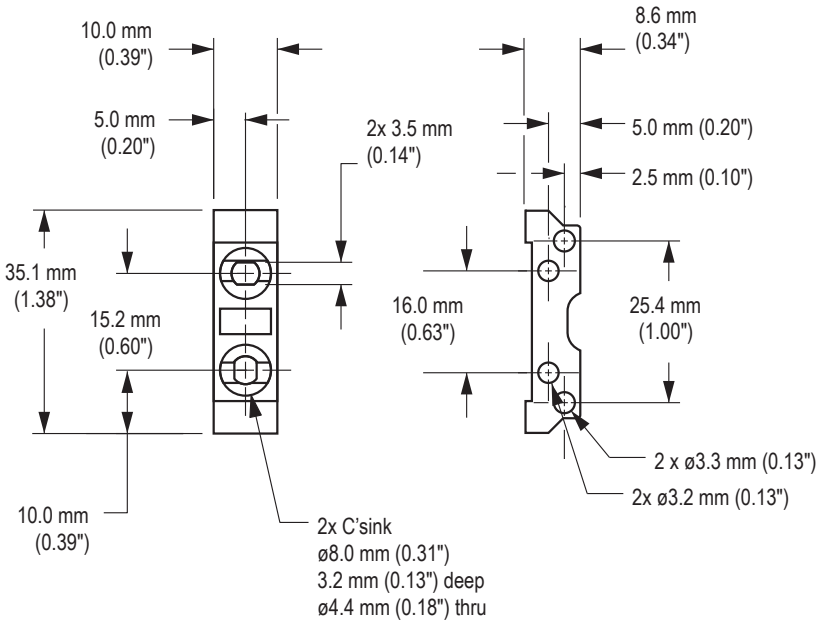
Number of Devices, Stacked	Ambient Temp Rating	Load Specification
3	55 °C	150 mA
7	50 °C	50 mA
10	45 °C	50 mA

Connections
PVC-jacketed 2 m or 9 m (6.5 ft or 30 ft) 6-wire integral cable or integral 6-pin Pico-style quick-disconnect

D10D...Sensor Dimensions



Included Bracket Dimensions



M3 Hardware included:
- Lock Washer (2)
- Flat Washer (2)
- Screws (2)
- Hex Nuts (2)

Fiber Optic Array Dimensions

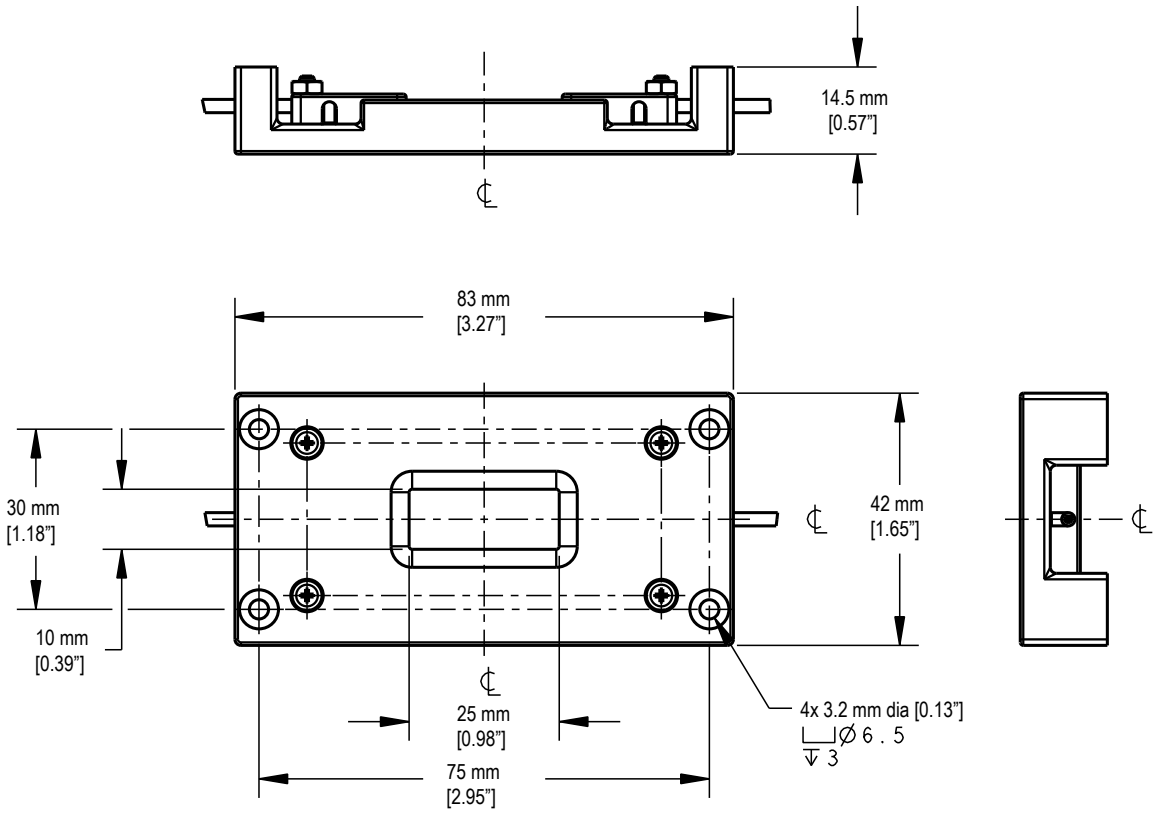


Figure 3. PFCVA-10X25-S and PFCVA-10X25-E

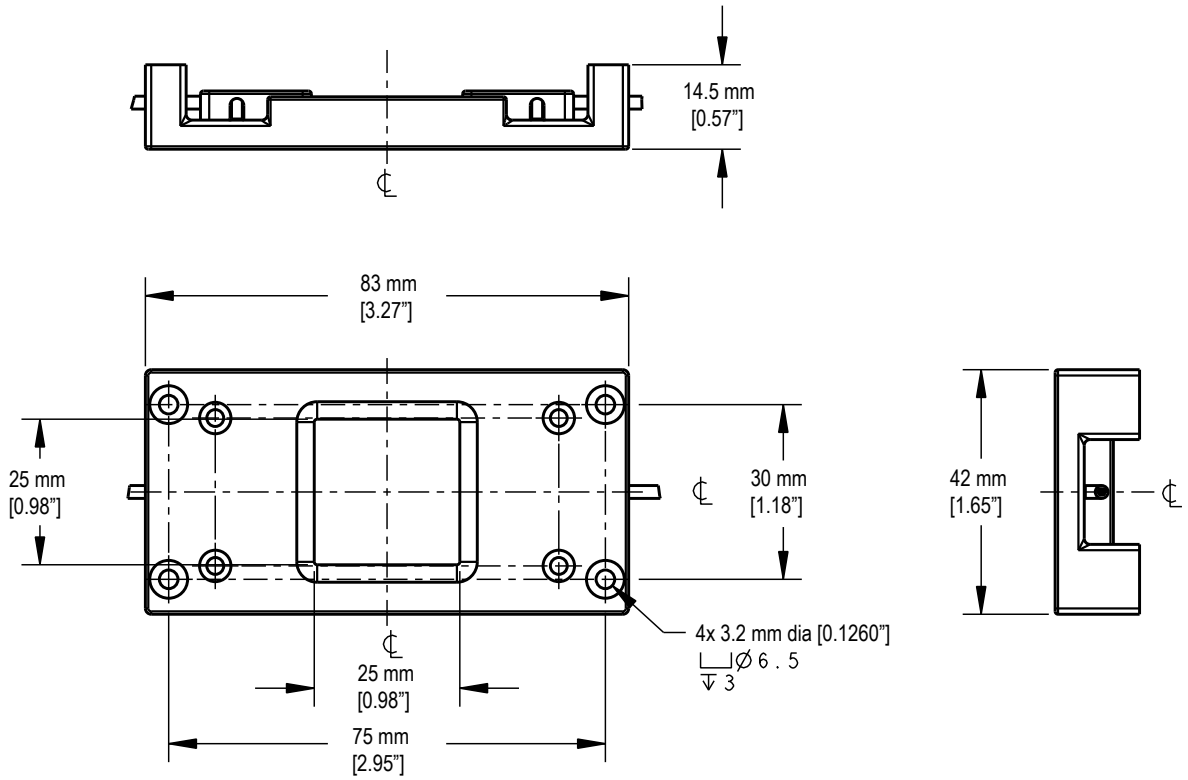


Figure 4. PFCVA-25X25-S and PFCVA-25X25-E

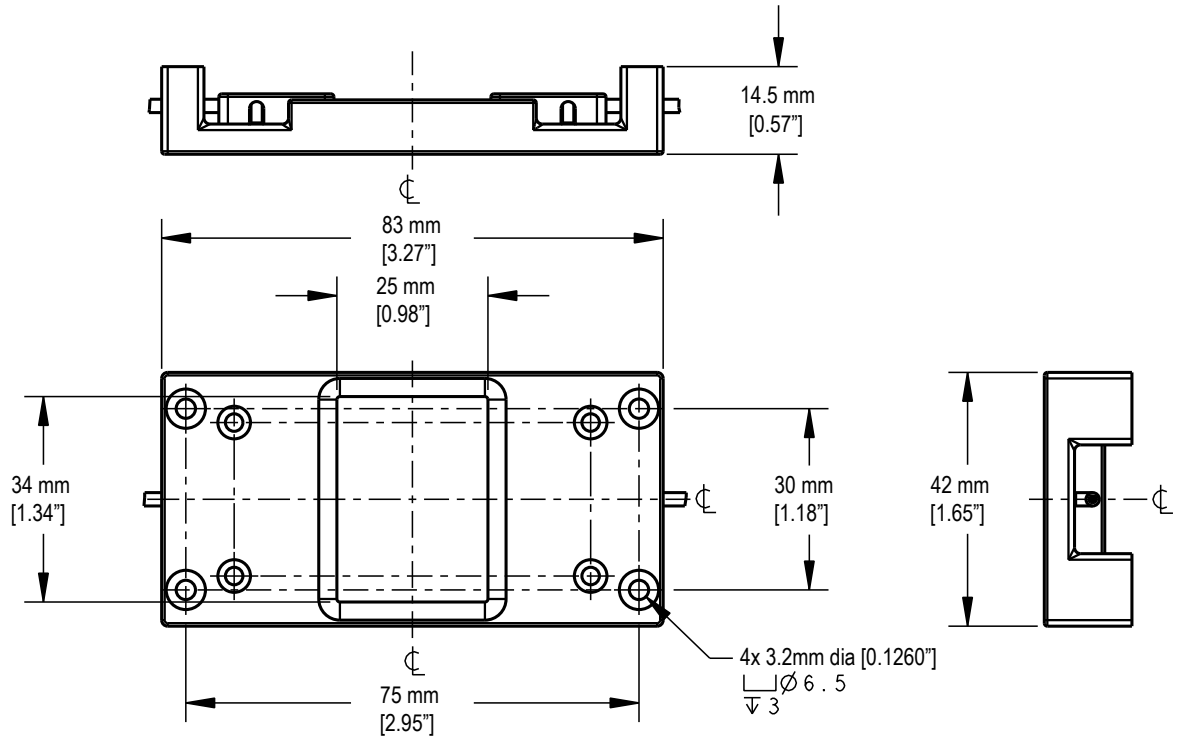
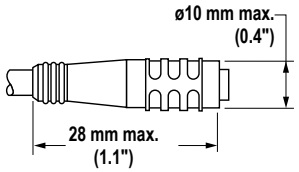
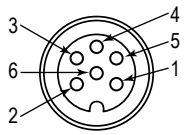
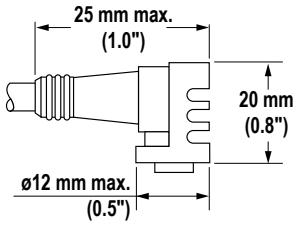


Figure 5. PFCVA-34X25-S and PFCVA-34X25-E

Accessories

6-Pin Snap-on M8/Pico-Style Cordsets				
Model	Length	Style	Dimensions	Pinout
PKG6Z-2	2 m (6.5 ft)	Straight		 1 - brown 2 = White 3 = Blue 4 = Black 5 = Gray 6 = Pink
PKG6Z-9	9 m (30 ft)			
PKW6Z-2	2 m (6.5 ft)	Right-angle		
PKW6Z-9	9 m (30 ft)			

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp.

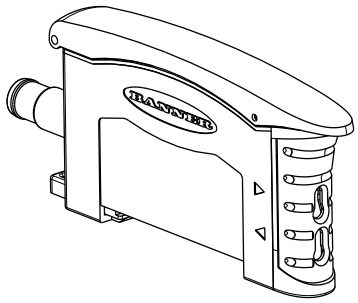
D10 Expert™ - Analog and Discrete Outputs

Datasheet

Advanced Sensor for use with Plastic Fiber Optics

To view or download the latest technical information about this product, including specifications, dimensions, accessories, and wiring, see *http://www.bannerengineering.com*.

Features



- Easy-to-set automatic *Expert*-style TEACH options* including static, dynamic, and single-point programming plus manual adjustment for fine-tuning
- 16-bit microcontroller and 12-bit Analog-to-Digital converter for high-performance, low-contrast sensing
- Easy-to-read 4-digit display for TEACH and signal strength readout, plus indicators for a continuous readout of operating status (user configurable)
- Models available with one scalable Analog output (4 to 20 mA or 0 to 10V) and one Discrete output (PNP or NPN)
- Four-mode power and speed selection with automatic cross-talk avoidance circuitry
- Selectable OFF-delay options
- Gate input wire can be used to selectively inhibit sensor outputs from switching
- Models available with visible red (680 nm) or visible green (525 nm) sensing beam
- Models available with 2 m or 9 m (6.5 ft or 30 ft) cable or integral Pico-style quick-disconnect
- Sleek, ultra-slim 10 mm housing, mounts to a standard 35 mm DIN rail

* U.S. Patent #5,808,296

Models

Models		Cables[1]	Discrete Outputs	Analog Output
Red Beam	Green Beam			
D10INFP	D10INFPG	2 m (6.5 ft) Cable	NPN	4 to 20 mA
D10INFPQ	D10INFPGQ	6-pin Pico-style QD		
D10IPFP	D10IPFPG	2 m (6.5 ft) Cable	PNP	
D10IPFPQ	D10IPFPGQ	6-pin Pico-style QD		
D10UNFP	D10UNFPG	2 m (6.5 ft) Cable	NPN	0 to 10V
D10UNFPQ	D10UNFPGQ	6-pin Pico-style QD		
D10UPFP	D10UPFPG	2 m (6.5 ft) Cable	PNP	
D10UPFPQ	D10UPFPGQ	6-pin Pico-style QD		

[1] To order the 9 m (30 ft) cable model, add the suffix "W/30" to the cabled model number. For example, D10xFP W/30. Models with a quick disconnect require a mating cordset. See Accessories.

Overview

The D10 *Expert* Sensor is a high-performance plastic fiber-optic sensor whose many configuration (TEACH-mode) options make it suitable for demanding applications. Even with all its features, it is extremely easy to use. Advanced 16-bit microcontroller technology makes this possible.

The D10 *Expert* provides high-performance sensing in low-contrast applications. *Expert* TEACH and setup options provide static, dynamic and single-point programming plus manual fine adjustment, remote programming and push button lockout. Its slender, stylized housing has a large digital display visible beneath a clear cover for easy programming and status monitoring during operation. The sensor mounts directly to standard 35 mm DIN rail or using the supplied mounting bracket.

The sensor features two outputs with independent setpoints: one of two analog choices, depending on model, and one discrete (NPN or PNP, also depending on model). Built-in crosstalk avoidance protocol provides trouble-free operation for multiple sensors in one area.

For emitter and receiver port locations, see *Installation* on page 13

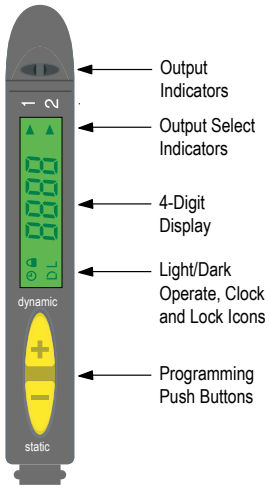


Figure 1. D10 Features

Programming Options

Light/Dark Operate Selection		Toggle to select the condition for which each output will conduct: when the target is present or when the target is absent.							
OFF-Delay Timing Selection		Programmable OFF-delay pulse stretcher: 0, 2, 5, 10, 15, 20, 30, 40, 60, 80, or 100 ms Analog Outputs: OFF-delay acts as a smoothing function							
Display Selection		Discrete Output: Raw signal value or % excess signal Analog Output: Raw signal value or analog value (0 to 10V dc or 4 to 20 mA)							
Power Level/Speed Selection		Super High-Speed (SHS)		High-Speed (HS)		High-Power (HP)		Super High-Power (SHP)	
Response*		50 µs		200 µs		1 ms		2.5 ms	
Repeatability		25 µs		50 µs		75 µs		100 µs	
Max Range*	Fiber	Red 680 nm	Green 525 nm	Red 680 nm	Green 525 nm	Red 680 nm	Green 525 nm	Red 680 nm	Green 525 nm
	PIT16U	20 mm	9 mm	30 mm	9 mm	55 mm	13 mm	90 mm	16 mm
	PIT26U	100 mm	40 mm	150 mm	40 mm	250 mm	55 mm	400 mm	70 mm
	PIT46U	300 mm	100 mm	550 mm	100 mm	1000 mm	160 mm	1200 mm	180 mm
	PIT66U	600 mm	180 mm	1000 mm	180 mm	1700 mm	280 mm	2400 mm	320 mm
	PBT16U	6 mm	**	10 mm	**	18 mm	3 mm	30 mm	3.5 mm
	PBT26U	30 mm	12 mm	50 mm	12 mm	100 mm	20 mm	150 mm	25 mm
	PBT46U	100 mm	30 mm	175 mm	30 mm	250 mm	42 mm	300 mm	60 mm
	PBT66U	175 mm	55 mm	250 mm	55 mm	400 mm	80 mm	475 mm	100 mm
Tracking Feature		Sets Output 2 to identical settings as Output 1; Output 2 settings can then be revised as desired (see *Advanced Setup* on page 11).							
Factory Default Settings		The following settings are preset at the factory; revert sensor to factory defaults using Advanced Setup procedure (*Advanced Setup* on page 11). • Light operate (LO) • No OFF-delay (t 0) • Raw signal value (1234) • Output 1 displayed • High Speed (HS); 200 µs response • Maximum power setting • Analog: full scale • Discrete: switchpoint positioned at middle of range							

* Diffuse mode performance based on 90% reflectance white test card.

** ø0.010" bifurcated fiber not recommended in these speed settings. Contact Banner Applications for more information.

Sensor Programming

Programming Procedures: Two push buttons, Dynamic (+) and Static (-), may be used to access and set programming parameters. For remote programming, connect a switch or digital input to the gray wire; length of the individual pulses is equal to the value T:

$$0.04 \text{ seconds} \leq T \leq 0.8 \text{ seconds}$$

Returning to RUN mode: TEACH and SETUP modes each may be exited in one of two ways: by exercising the 60-second time-out, or by cancelling out of the process. In TEACH mode, the sensor will return to RUN mode without saving any of the new settings; in SETUP mode, the sensor will return to RUN mode but save all of the settings. To cancel out of TEACH mode, press and hold the Static (-) button for 2 seconds; to cancel out of SETUP mode, press and hold both the Static (-) and Dynamic (+) buttons for 2 seconds.

Output 2: The setpoint(s) for each output can be set independently of one another. However, the functional range available for output 2 is dictated by the automatic power and gain settings established for output 1. Whenever output 1 is taught, output 2 also must be retaught. Applications hint: teach the weakest signal on output 1 first. Output 1 sets the emitter power. If only output 2 will be used, output 1 must be taught first. Or, enable tracking and teach only output 1, and then output 2 will be the same as output 1.

Dynamic TEACH and Adaptive Thresholds: Dynamic TEACH is used to program sensitivity during actual machine run conditions. During Dynamic TEACH, the sensor takes multiple samples of the light and dark conditions and automatically sets the sensitivity at the optimum level. For the discrete output, Dynamic TEACH activates the sensor's adaptive threshold system, which continuously tracks minimum and maximum signal levels, and automatically maintains centering of the switch point between the light and dark conditions. The adaptive threshold system remains in effect during RUN mode to automatically adjust for changes in the light or the dark conditions.

When Dynamic TEACH mode is used to program sensitivity, the output ON state (light or dark operate) will remain as it was last programmed. To change to either light or dark operate, use the SETUP mode (see *Sensor Setup* on page 10).

Sensitivity may be adjusted at any time when the sensor is in RUN mode by clicking the "+" and "-" buttons. However, when a manual adjustment is made, the adaptive threshold system is disabled (cancelled).

Configuration Instructions

Analog Outputs

Output 1 is configured for either 4 to 20 mA or 0 to 10V dc analog output, depending on the model. The sensor may be programmed using the two-point TEACH (either static or dynamic) or single-point window SET.

Two-point static or dynamic TEACH: The sensor sets the first taught condition to the highest output level (either 20 mA or 10V), and the second taught condition to the lowest level (either 4 mA or 0V), and scales between these points. If the first condition taught has more returned light, the sensor will be in Light Operate mode (LO). If the first taught condition is darker, the sensor will be in Dark Operate mode (DO). To change the slope of the analog output (refer to *Figure 2* on page 3), toggle LO/DO in *Sensor Setup* on page 10.

Single-point window SET: The sensor sets the taught condition to the mid-point of its range (12 mA or 5V, depending on the model). For Light Operate mode, the sensor will automatically scale up to 20 mA (or 10V) for maximum light condition (the maximum possible received signal) and down to 4 mA (or 0V) for maximum dark condition (no signal), and vice-versa for Dark Operate mode. To change the slope of the analog output (refer to *Figure 3* on page 3), toggle LO/DO in *Sensor Setup* on page 10.

An OFF-delay enabled for the analog output acts as an averaging function. During the OFF-delay period, the sensor will take multiple analog readings and average the result before changing the analog value. This acts to reduce the effects of major spikes in the analog system, in effect "smoothing" the output reading.

NOTE: Depending on the application configuration and fibers used, the analog function may or may not behave linearly. The received light intensity will be dictated by the inverse square properties of light.

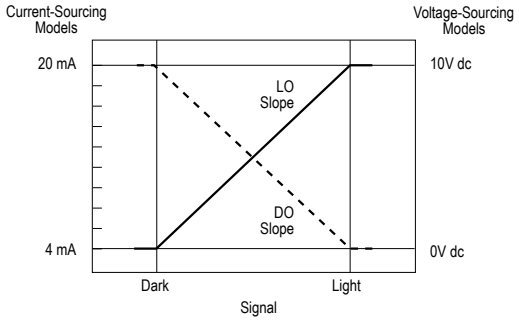


Figure 2. Analog output as a function of target position – two-point static or dynamic TEACH

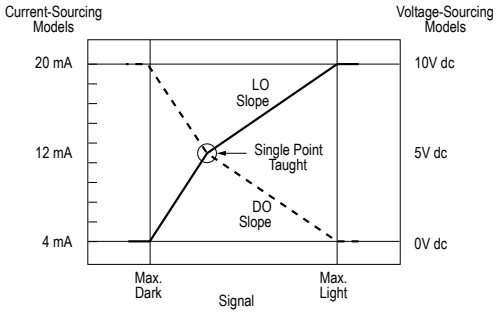
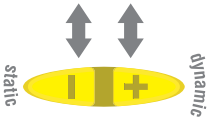
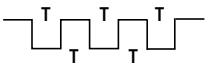
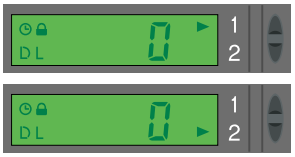


Figure 3. Analog output as a function of target position – window SET

Active Channel Select

- Selects which channel to teach
- Displays channel configuration information.

Push Button	Remote 0.04 sec. ≤ T ≤ 0.8 sec.	Result
Single-click both buttons simultaneously. 	Triple-pulse the remote line.* 	Pointer icon: moves to the other channel indicator. 

* Note: Triple-pulse will change the display, but will not save. To save Channel Select, make an adjustment to that channel as a TEACH, SET, or Sensor Setup.

Two-Point Static TEACH (Threshold)

- Establishes a single switching threshold
- Threshold position is adjustable using "+" and "-" buttons (see *Manual Adjust* on page 9)

Static TEACH is the traditional setup method, used when two conditions can be presented by the user. The sensor locates a single sensing threshold (the switchpoint) midway between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other.

The first condition taught is the ON condition. The Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in Setup mode (see *Sensor Setup* on page 10).

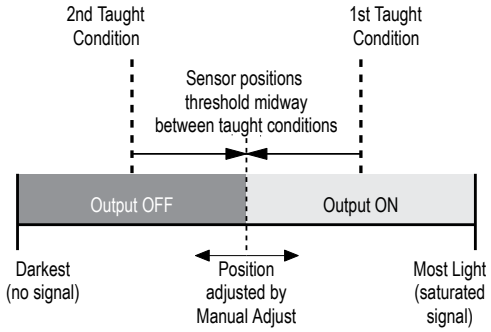


Figure 4. Static TEACH (Light Operate shown)

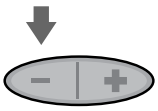
Static TEACH and Manual Adjust. Discrete output: Using Manual Adjust with Static TEACH moves the switching threshold.

Analog output: Using Manual Adjust with Static TEACH moves the entire span up (+) or down (-).

Contrast Values	
500+	Excellent: Very stable operation.
100-500	Good: Minor sensing variables will not affect sensing reliability.
32-99	Low: Minor sensing variables may affect sensing reliability.
0-31	Marginal: Consider an alternate sensing scheme.

Figure 5. Contrast Values

1. Access the Static TEACH Mode.

Method	Action	Result
Push Button	Press and hold the Static (-) button > 2 seconds. 	• Display flashes "1St" • Arrow icon turns red 
Remote Input[2]	No action is required; the sensor is automatically ready for the 1st TEACH condition	

2. TEACH the Output ON condition.

[2] 0.04 seconds ≤ T ≤ 0.8 seconds

Method	Action	Result
Push Button	a. Present the Output ON condition b. Click the Static button	Display flashes “2nd”
Remote Input	a. Present the Output ON condition b. Single-pulse the remote line	

1. TEACH the Output OFF condition.

Method	Action	Result
Push Button	a. Present the Output OFF condition b. Click the Static button	TEACH conditions accepted • Display flashes “PASS,” followed by a number (denoting contrast); see *Figure 5* on page 4. • Sensor returns to RUN mode with new settings • Arrow icon turns green TEACH conditions unacceptable • Display flashes “FAIL” and returns to “1St” • Arrow icon remains red • After 60 seconds, sensor returns to RUN mode (Arrow icon turns green) without changing settings
Remote Input[3]	a. Present the Output OFF condition b. Single-pulse the remote line	

Dynamic TEACH and Adaptive Thresholds

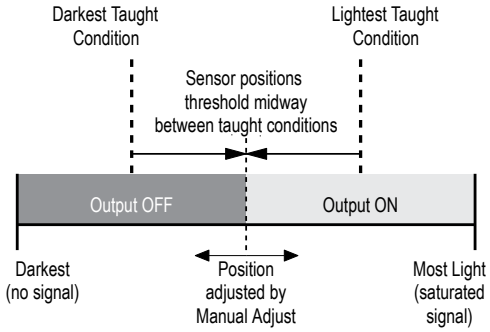


Figure 6. Dynamic TEACH (Light Operate shown)

Contrast Values	
500+	Excellent: Very stable operation.
100-500	Good: Minor sensing variables will not affect sensing reliability.
32-99	Low: Minor sensing variables may affect sensing reliability.
0-31	Marginal: Consider an alternate sensing scheme.

Figure 7. Dynamic Contrast Values

- TEACH on-the-fly
- Sets a single threshold
- Threshold position is adjustable using the “+” and “-” buttons (see *Manual Adjust* on page 9)

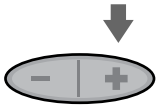
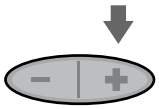
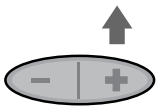
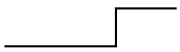
Dynamic TEACH is used to program sensitivity during actual machine run conditions. During Dynamic TEACH, the sensor takes multiple samples of the light and dark conditions and automatically sets the sensitivity at the optimum level. Dynamic TEACH activates the sensor’s adaptive threshold system, which continuously tracks minimum and maximum signal levels, and automatically maintains centering of the switch point between the light and dark conditions. The adaptive threshold system remains in effect during RUN mode to automatically adjust for changes in the light or the dark conditions.

When Dynamic TEACH mode is used to program sensitivity, the output ON state (light or dark operate) will remain as it was last programmed. To change to either light or dark operate, use the SETUP mode (see *Sensor Setup* on page 10).

Dynamic TEACH and Manual Adjust

Sensitivity may be adjusted at any time when the sensor is in RUN mode by clicking the “+” and “-” buttons. However, when a manual adjustment is made, the adaptive threshold system is disabled (cancelled).

[3] 0.04 seconds ≤ T ≤ 0.8 seconds

	Push Button	Remote 0.04 sec. ≤ T ≤ 0.8 sec.	Result
Access Dynamic TEACH Mode	Press and hold Dynamic (+) button. 	Hold remote line low (to ground). 	• Display flashes “dYn” • Arrow icon turns red 
TEACH Sensing Conditions	Present Output ON/OFF conditions while continuing to hold Dynamic button. 	Present Output ON/OFF conditions while continuing to hold remote line low (to ground). 	
Return to RUN Mode	Release Dynamic button. 	Release remote line/switch. 	TEACH conditions accepted • Display flashes “PASS,” followed by a number (denoting contrast); see *Figure 7* on page 5 • Sensor returns to RUN mode with new settings • Arrow icon turns green  TEACH conditions unacceptable • Display flashes “FAIL” • Arrow icon remains red • Sensor returns to RUN mode (Arrow icon turns green) without changing settings 

Single-Point Window Set

- Sets a single ON condition that extends 200 counts above and below the taught condition (including ±100 counts hysteresis)
- All other conditions (lighter or darker) result in OFF output
- Sensing window size (sensitivity) is adjustable using “+” and “-” buttons (see *Manual Adjust* on page 9)

Window Set is most useful when a product may not always appear in the same place, or when other signals may appear. Window Set designates a sensing window, with the Output ON condition inside the window, and the Output OFF conditions outside the window. The sensor accepts a single sensing condition, and adds switching thresholds and hysteresis above and below that condition to create a sensing window. Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in Setup mode.

Window Set and Manual Adjust

Discrete: Using Manual Adjust with Window Set expands or contracts the size of the window.

Analog: Analog manual adjust increases (+) or decreases (-) counts on both ends by the same amount, but it does not rescale. Cycling the power will rescale the window and adjustments.

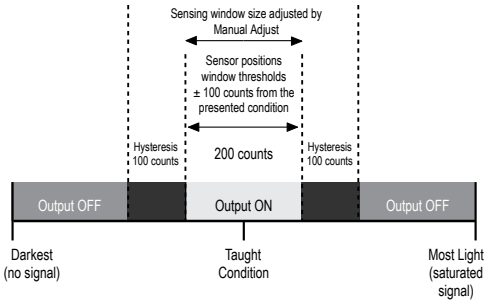
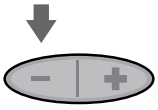
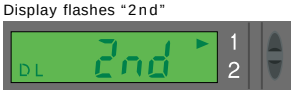


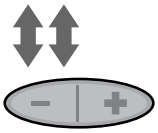
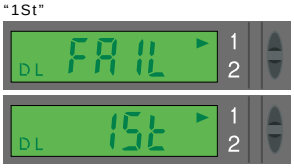
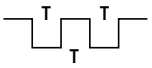
Figure 8. Single-Point Window SET and Hysteresis (Light Operate shown)

1. Access the SET Mode.

Method	Action	Result
Push Button	Press and hold the Static (-) button > 2 seconds 	• Display flashes “1St”  • Arrow icon turns red
Remote Input[4]	a. Present the sensing condition b. Single-pulse the remote line 	• Display flashes “2nd”  • Arrow icon turns red

[4] 0.04 seconds ≤ T ≤ 0.8 seconds

2. SET the sensing condition.

Method	Action	Result
Push Button	a. Present the sensing condition b. Double-click the Static button 	TEACH conditions accepted • Display flashes "Sn6l," then "Pt" twice  • Sensor returns to RUN mode with new settings • Arrow icon turns green TEACH conditions unacceptable • Display flashes "FAIL" and returns to "1St"  • Arrow icon remains red • After 60 seconds, the sensor returns to RUN mode (Arrow icon turns green) without changing settings
Remote Input	Double-pulse the remote line 	

Single-Point Light Set - Discrete Only

- Sets a threshold slightly below the taught condition.
- Any condition darker than the threshold condition causes the output to change state
- Threshold position is adjustable using the "+" and "-" buttons (see *Manual Adjust* on page 9)
- Recommended for applications where only one condition is known, for example a stable light background with varying darker targets

A single sensing condition is presented, and the sensor positions a threshold slightly below the presented condition. When a condition darker than the threshold is sensed, the output either turns ON or OFF, depending on the Light/Dark Operate setting (see *Sensor Setup* on page 10).

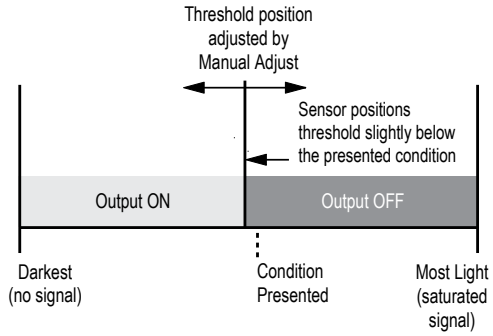


Figure 9. Single-Point Light Set (Light Operate shown)

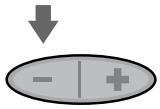
Light SET and Light/Dark Operate Selection

Light Set teaches the Output OFF condition and forces the sensor into Dark Operate (DO) mode. The sensor can be reconfigured to Light Operate (LO) mode after the condition has been taught (see *Sensor Setup* on page 10).

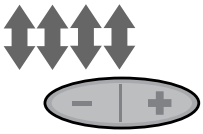
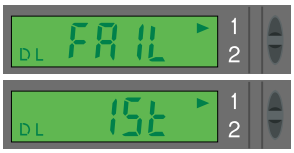
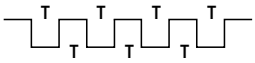
Mode	Threshold Offset (counts below taught signal value)
Super High-Speed	30
High-Speed	22
High-Power	9
Super High-Power	6

Figure 10. Light Set Threshold Offset

1. Access the SET Mode.

Method	Action	Result
Push Button	Press and hold the Static (-) button > 2 seconds 	• Display flashes “1St” • Arrow icon turns red 
Remote Input[5]	Single-pulse the remote line 	• Display flashes “2nd” • Arrow icon turns red 

2. SET the Output OFF condition.

Method	Action	Result
Push Button	a. Present the Output OFF condition b. Four-click the Static button 	Threshold condition accepted • Display flashes “Sn6l,” then "Lt" twice  • Sensor returns to RUN mode with new settings • Arrow icon turns green Threshold conditions unacceptable • Display flashes “FAIL” and returns to “1St”  • Arrow icon remains red • After 60 seconds, the sensor returns to RUN mode (the Arrow icon turns green) without changing settings
Remote Input	a. Present the Output OFF condition b. Four-pulse the remote line 	

Single-Point Dark Set - Discrete Only

- Sets a threshold slightly above the taught condition
- Any condition lighter than the threshold condition causes the output to change state
- Threshold position is adjustable using the “+” and “-” buttons (see *Manual Adjust* on page 9)
- Recommended for applications where only one condition is known, for example a stable dark background with varying lighter targets

A single sensing condition is presented, and the sensor positions a threshold slightly above the taught condition. When a condition lighter than the threshold is sensed, the output either turns ON or OFF, depending on the Light/Dark Operate setting (see *Sensor Setup* on page 10).

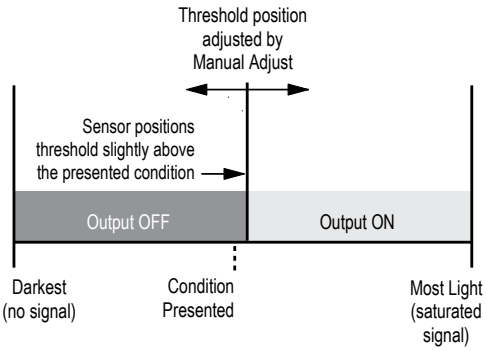


Figure 11. Single-Point Dark Set (Light Operate shown)

Dark Set and Light/Dark Operate Selection

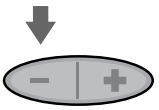
Dark Set teaches the Output OFF condition and forces the sensor into Light Operate (LO) mode. The sensor can be reconfigured to Dark Operate (DO) mode after the condition has been taught (see *Sensor Setup* on page 10).

[5] 0.04 seconds ≤ T ≤ 0.8 seconds

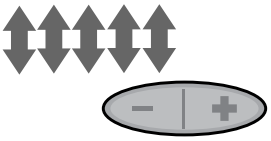
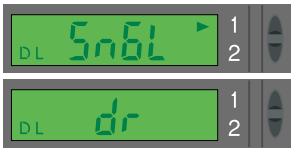
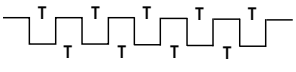
Mode	Threshold Offset (counts above taught signal value)
Super High-Speed	30
High-Speed	22
High-Power	9
Super High-Power	6

Figure 12. Dark Set Threshold Offset

1. Access the Set Mode.

Method	Action	Result
Push Button	Press and hold the Static button > 2 seconds 	• Display flashes “1St” • Arrow icon turns red 
Remote Input[6]	Single-pulse the remote line 	• Display flashes “2nd” • Arrow icon turns red 

2. Set the Output OFF condition.

Method	Action	Result
Push Button	a. Present the Output OFF condition b. Five-click the Static button 	Threshold Condition Accepted • Display flashes “Sn6l,” then "dr" twice  • Sensor returns to RUN mode with new settings • Arrow icon turns green Threshold Condition Unacceptable • Display flashes “FAIL” and returns to “1St”   • Arrow icon remains red • After 60 seconds, the sensor returns to RUN mode (the Arrow icon turns green) without changing settings
Remote Input	a. Present the Output OFF condition b. Five-pulse the remote line 	

Manual Adjust

Manual Adjust is used during Run mode and is accomplished using the push buttons only. Its behavior depends on whether a switching threshold or a sensing window is used.

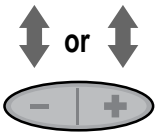
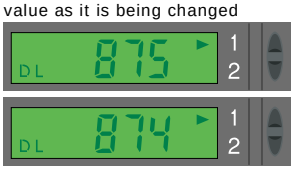
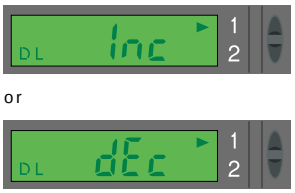
Switching Threshold:

- Fine-tunes sensing sensitivity
- Press “+” to increase; press “-” to decrease

Sensing Window:

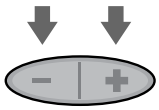
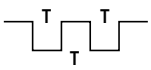
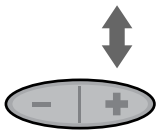
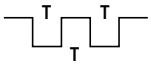
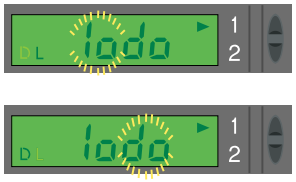
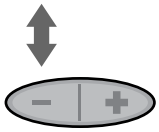
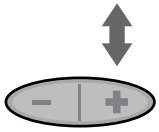
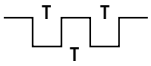
- Adjusts sensing window size (tolerance) for the single-point target condition
- Press “+” to increase; press “-” to decrease

[6] 0.04 seconds ≤ T ≤ 0.8 seconds

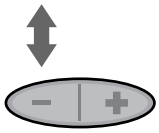
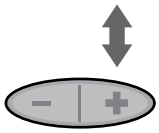
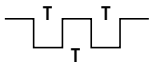
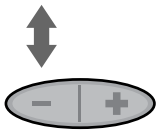
Method	Action	Result
Push Button	Click "+" to increase, or click "-" to decrease. 	Display briefly flashes the threshold setpoint value as it is being changed  OR Display flashes"inc" or "dEc" as the window size is adjusted  or
Remote Input[7]	Not available with remote programming	n/a

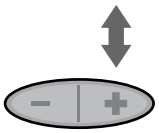
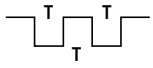
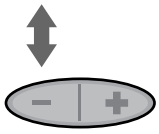
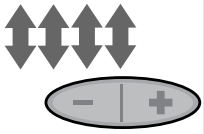
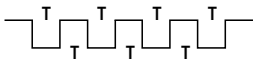
Sensor Setup

- Configures sensor display and operating parameters
- Changes are updated instantly
- Click Dynamic (+) or double-pulse remote line to select an option
- Click Static (-) or single-pulse remote line to advance

	Push Button	Remote 0.04 seconds ≤ T ≤ 0.8 seconds	Result
Access SETUP Mode	Press and hold both buttons concurrently for > 2 seconds. 	Double-pulse the remote line. 	Indicator Arrow Icon 1 ON Red
Select Light/ Dark Operate	Click Dynamic (+) to toggle between selections. 	Double-pulse remote line to toggle between selections. 	Light Operate • Display flashes "lo" • L icon Dark Operate • Display flashes "do" • D icon 
	Click Static (-) to save selection and advance to "OFF-Delay." 	Single-pulse remote line to save selection and advance to "OFF-Delay." 	
Select OFF-Delay Timing Enable	Click Dynamic (+) to toggle between selections. 	Double-pulse remote line to toggle between selections. 	Off (No OFF-Delay) • "t 0" • Clock icon OFF 

[7] 0.04 seconds ≤ T ≤ 0.8 seconds

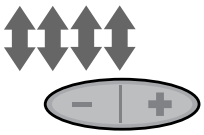
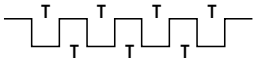
	Push Button	Remote 0.04 seconds ≤ T ≤ 0.8 seconds	Result
	Click Static (-) to save selection and advance to "Display." 	Single-pulse remote line to save selection and advance to "Display." 	2 to 100 ms OFF-Delay  • "t 2," "t 5," "t 10," "t 15," "t 20," "t 30," "t 40," "t 60," "t 80," or "t100" • Clock icon ON
Select Display Parameters	Click Dynamic (+) to toggle between selections. 	Double-pulse remote line to toggle between selections. 	Raw Signal Value Discrete: "1234"  Analog: 4 -20, 0-10, A = mA , V = Volts Percent of excess signal  Discrete: "123P" 
	Click Static (-) to save selection and advance to "Power/Speed." 	Single-pulse remote line to save selection and advance to "Power/Speed." 	

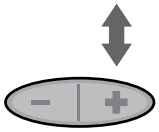
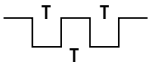
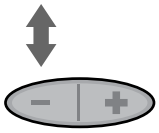
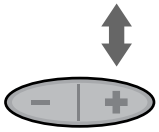
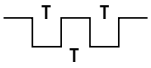
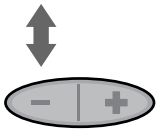
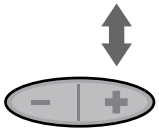
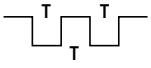
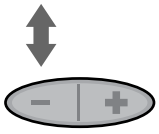
	Push Button		Remote 0.04 seconds ≤ T ≤ 0.8 seconds	Result
Select Speed and Power Combination	Click Dynamic (+) to toggle between selections. 		Double pulse the remote line to toggle between selections. 	Indicator Arrow Icons 1 and 2 ON Red Super-high-speed (50-µs response) "SHS" (Complementary outputs; see note below)  High-speed (200-µs response) "HS"  High-power (1-ms response) "HP"  Super-high-power (2.5-ms response) "SHP" 
	Return to RUN mode. OR	Click Static (-) to save selection and return to RUN mode. 	Single-pulse the remote line to save selection and return to RUN mode. 	
	Proceed to Advanced Setup.	Quad-click Static (-) to proceed to Advanced Setup. 	Quad-pulse the remote line to proceed to Advanced Setup. 	See *Advanced Setup* on page 11.

Super-High-Speed Operation Note: Under most conditions, the sensor's two discrete outputs operate independently. However, the outputs become complementary when operating at Super-High-Speed, due to its extremely fast response time. Only channel 1 is taught/adjusted; channel 2 is complementary to it (output 1 conducts for the taught ON condition, and output 2 conducts for the OFF state). To invert these conditions (output 1 – OFF condition, output 2 – ON), change light/dark operate setting.

Advanced Setup

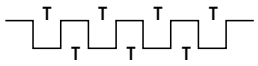
- Advanced adjustments to previously configured sensor display and operating parameters
- Quad-click Static (-) or quad-pulse remote line before exiting "Power and Speed" settings to enter this mode
- Click Dynamic (+) or double-pulse remote line to select an option
- Click Static or single-pulse remote line to advance
- Changes are updated instantly

	Push Button	Remote (0.04 s ≤ T ≤ 0.8 s)	Result
Enter SETUP Mode	From "Power and Speed" mode, quad-click the Static (-) button. 	From "Power and Speed" mode, quad-pulse the remote line. 	• Indicator Arrow Icons 1 and 2 remain red • Display shows "Tracking Enabled" option 

	Push Button	Remote (0.04 s ≤ T ≤ 0.8 s)	Result
Track Enable	Click Dynamic (+) to toggle between selections. 	Double-pulse the remote line to toggle between selections. 	Sets output 2 identical to output 1 Tracking Disabled Display shows "tr n"  Tracking Enabled Display shows "tr Y" 
	Click Static (-) to save selection and advance to "Factory Default." 	Single-pulse the remote line to save selection and advance to "Factory Default." 	
Factory Default Settings	Click Dynamic (+) to toggle between selections. 	Double-pulse the remote line to toggle between selections. 	Returns to factory default factory settings Factory Default Settings Not Selected Display shows "Fd n"  Factory Default Settings Selected Display shows "Fd Y" 
	Click Static (-) to save selection and advance to "Display Orientation." 	Single-pulse the remote line to save selection and advance to "Display Orientation." 	
Display Orientation	Click Dynamic (+) to toggle between selections. 	Double-pulse the remote line to toggle between selections. 	Inverts display to read "upside-down" Normal For example: 1234  Inverted For example: 1234 
	Click Static (-) to return to RUN mode. 	Single-pulse the remote line to return to RUN mode. 	NOTE: Icons do not invert.

Push Button Lockout

- Prevents unwanted adjustments or tampering of the push buttons
- Push buttons can be enabled or disabled only from the remote line and only during normal RUN mode

	Push Button	Remote (0.04 seconds ≤ T ≤ 0.8 seconds)	Result
Enable or Disable Push Buttons	Not available with push-button programming.	From RUN mode, quad-pulse the remote line to toggle between selections. 	Push buttons Disabled • Display flashes "loc" • Padlock icon appears • Sensor remains in RUN mode  Push Buttons Enabled • Display flashes "uloc" • Padlock icon disappears • Sensor remains in RUN mode 

Self-Diagnostic Error Modes

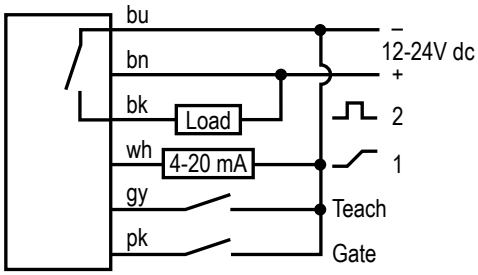
In the unlikely event that the setup parameters are lost or become corrupt, the display will continuously scroll: “USEr PSF Error.” Reteach the sensor to recover. If the problem persists, contact your Banner representative for further information.

Gate Input

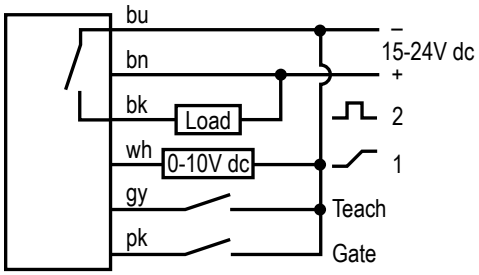
The pink wire is configured as a gate input. When this wire is pulled low (e.g., to the sensor ground; 0-0.5 V dc), it inhibits the outputs from switching, while all other sensor functions continue to be enabled. This feature is useful for controlling when the outputs are allowed to change states. Gate input function response time is 1 millisecond.

Wiring

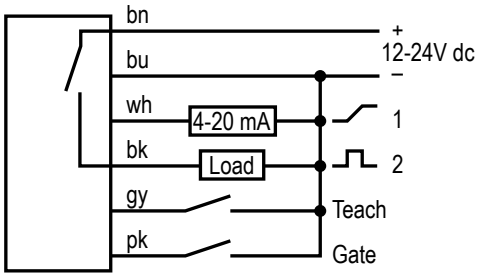
NPN, 4-20 mA Output Models



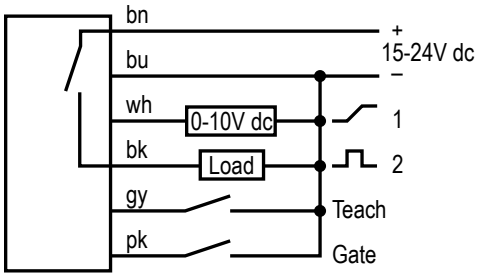
NPN, 0-10V dc Output Models



PNP, 4-20 mA Output Models



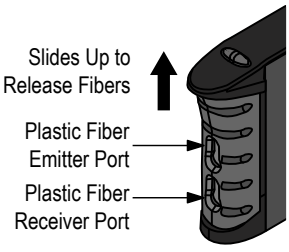
PNP, 0-10V dc Output Models



NOTE: QD hookups are functionally identical.

Installation

Install the product on a 35 mm DIN rail or the included mounting bracket.



Specifications

Required Fiber-Optic Cable
Banner P-Series plastic fibers

Sensing Beam
680 nm visible red or 525 nm visible green, depending on model

Supply Voltage and Current
4-20 mA Analog Models: 12 to 24 V dc (10% maximum ripple) at less than 65 mA, exclusive of load
0-10 V dc Analog Models: 15 to 24 V dc (10% maximum ripple) at less than 70 mA, exclusive of load

Supply Protection Circuitry
Protected against reverse polarity and transient voltage

Output Configuration
Two independently configurable outputs, depending on model: NPN w/analog (4-20 mA or 0-10 V) or PNP w/analog (4-20 mA or 0-10 V)

Output Rating
Discrete Output: 150 mA, maximum load
OFF-state leakage current: < 10 µA at 24 V dc
ON-state saturation voltage: NPN: < 1.5 V at 150 mA load; PNP < 2.5 V at 150 mA load
Analog Output: 4-20 mA or 0-10 V dc
Load: 4-20 mA Models: 100Ω maximum impedance; 0-10 V dc Models: 1 MΩ min. impedance

Operating Conditions
Temperature: –20 to +55 °C (–4 to +131 °F)
Storage: –20 to +80 °C (–4 to +175 °F)
Max. Rel. Humidity: 90% at 50 °C (non-condensing)

Number of Devices, Stacked	Ambient Temperature Rating	Load Specification
3	55 °C (131 °F)	150 mA
7	50 °C (122 °F)	50 mA
10	45 °C (113 °F)	50 mA

Environmental Rating
IEC IP50, NEMA 1

Certifications

Adjustments
Push-button or remote programming of response time, OFF-delay, light/dark operate, and display

Indicators
Four-digit digital display plus LED indicators for active channel, push-button lockout, OFF-delay and light/dark operate selection; 2 yellow output indicators

Construction
Black ABS/polycarbonate alloy (UL94 V-0 rated) housing, clear polycarbonate cover

Connections
PVC-jacketed 2 m or 9 m (6.5 ft or 30 ft) 6-wire integral cable or integral 6-pin Pico-style quick-disconnect

Installation
35 mm DIN rail or included mounting bracket

Output Response Time
Discrete Output: Programmable, 50 microseconds, 200 microseconds, 1 millisecond, 2.5 milliseconds
Analog Output: 1 millisecond

NOTE: < 1 second delay on power-up; outputs do not conduct during this time.

Output Protection Circuitry
Protected against false pulse on power-up and continuous short-circuit

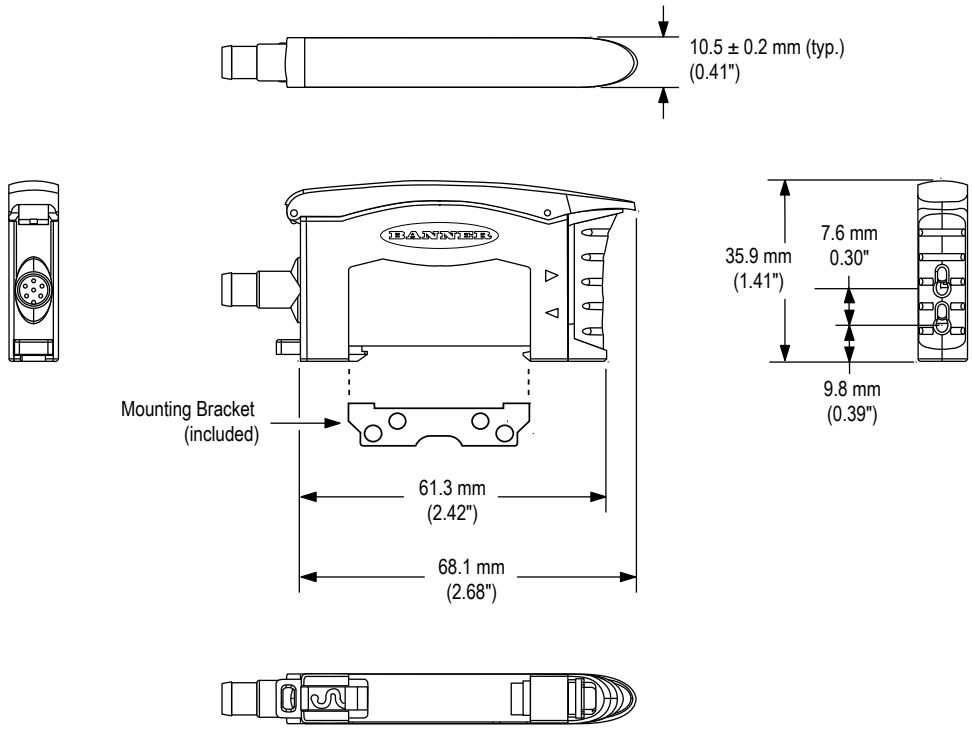
Required Overcurrent Protection

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

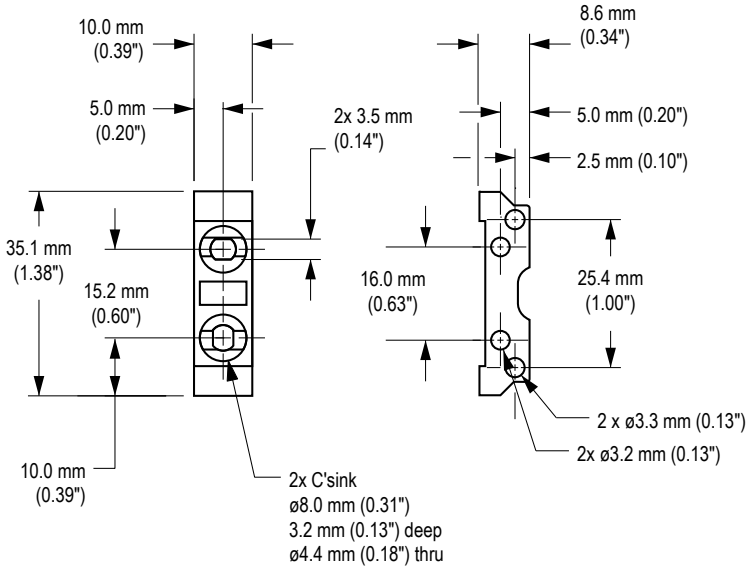
Overcurrent protection is required to be provided by end product application per the supplied table.
Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.
Supply wiring leads < 24 AWG shall not be spliced.
For additional product support, go to *http://www.bannerengineering.com*.

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

Dimensions

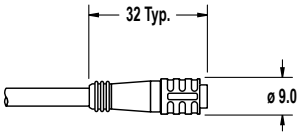
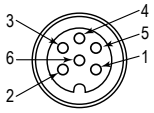
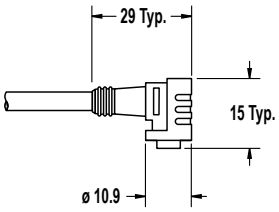


Included Bracket Dimensions



M3 Hardware included:
- Lock Washer (2)
- Flat Washer (2)
- Screws (2)
- Hex Nuts (2)

Accessories

6-Pin Snap-on M8/Pico-Style Cordsets				
Model	Length	Style	Dimensions	Pinout (Female)
PKG6Z-2	2 m (6.5 ft)	Straight		 1 - brown 2 = White 3 = Blue 4 = Black 5 = Gray 6 = Pink
PKG6Z-9	9 m (30 ft)			
PKW6Z-2	2 m (6.5 ft)	Right-angle		
PKW6Z-9	9 m (30 ft)			

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

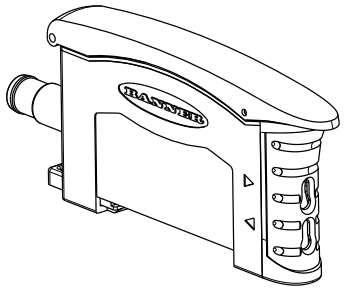
This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. For the most recent version of any documentation, refer to: *www.bannerengineering.com*.

D10 Expert™ Series with Bar Graph Display and Discrete Output

Datasheet

Advanced sensor with dual displays for use with plastic fiber optics



- Easy-to-read 8-segment light bar indicator for teach and signal strength readout, plus indicators for continuous readout of operating status (user configuration)
- Easy-to-set automatic *Expert*-style configuration options include Static and Dynamic TEACH, and Window SET, plus manual adjustment for fine tuning
- Smart gain-control algorithm to maximize performance in low-contrast applications
- Fast 500-microsecond sensing response with improved crosstalk avoidance routine (for two sensors) in Normal mode
- Selectable high-speed (HS) mode option for 200-µs response
- Extreme configuration flexibility via push buttons or a remote input wire
- Easy selection of Light/Dark Operate (LO/DO), 30 ms pulse stretcher (OFF-delay), and response speed, via push buttons or a remote input wire
- Models available with visible red (680 nm) or visible green (525 nm) sensing beam
- Sleek, ultra-slim 10 mm housing, mounts to a standard 35 mm DIN rail
- Models with bussable power provide simplified wiring of up to 16 sensors and feature improved temperature compensation for side-by-side mounting

WARNING: Not To Be Used for Personnel Protection

Never use this device as a sensing device for personnel protection. Doing so could lead to serious injury or death. This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition.

Models

Red Beam Models	Green Beam Models	Description	Cable[1]	Outputs
D10BFP	D10BFPG	Standard sensor	2 m (6.5 ft) Cable	Bipolar NPN/PNP
D10BFPQ	D10BFPGQ		6-pin Pico-style QD	
Models with Bussable Power				
D10B5FP	-	Main unit	2 m (6.5 ft) Cable	Bipolar NPN/PNP
D10B2PFP	-	Sub-unit	2 m (6.5 ft) Cable	Single PNP
D10B2NFP	-		2 m (6.5 ft) Cable	Single NPN

Overview

The D10 *Expert*™ is an easy-to-use, DIN-rail-mountable fiber optic sensor. It provides high-performance sensing in low-contrast applications. Configuration options include Setup mode plus Static and Dynamic TEACH, and Window Set options, in addition to manual fine adjustment, remote programming, and security push button lockout.

[1] To order the 9 m (30 ft) cable model, add the suffix "W/30" to the cabled model number. For example, D10xFP W/30. Models with a quick disconnect require a mating cordset. See Accessories.

The sensor's compact housing has a large, easy-to-see bar graph display plus bright LEDs for easy programming and status monitoring during operation.

Standard models have bipolar outputs, one each NPN and PNP. Main units with bussable power have the same bipolar outputs; sub-units feature a single discrete output, either NPN or PNP.

Models with bussable power are designed for use in machines and other applications where multiple sensors will be grouped tightly. They feature increased temperature compensation compared with standard models and reduce the amount of wiring necessary for such applications. An accessory clamp is available to secure a bank of connected sensors together on a DIN rail (see *Accessories* on page 13).

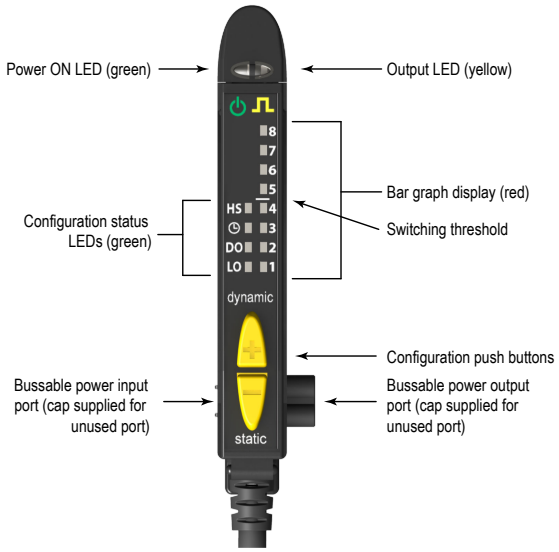


Figure 1. Features

Sensor Configuration

Sensor configuration is accomplished via TEACH, Set, and Setup modes. After the sensing parameters are defined (using either TEACH or Set mode), Setup mode may be used to enable the delay, to change the light/dark operate status, or to select the highspeed response option (HS). Manual Adjust may be used to fine-tune the thresholds. Two push buttons, Dynamic (+) and Static (−), or the remote wire, may be used to access and set the sensing parameters.

Sensor sensitivity may be configured using any of three methods. A single switching threshold may be achieved using either Dynamic (on-the-fly) or Static TEACH; or Window SET may be used to define a sensing window, centered on a single sensing condition.

Remote Configuration

The remote configuration function may be used to configure the sensor remotely or to disable the push buttons for security. Connect the gray wire of the sensor to ground (0V dc), with a remote programming switch connected between them. Pulse the remote line according to the diagrams in the configuration procedures. The duration of the individual pulses is equal to the value T: 0.04 seconds ≤ T ≤ 0.8 seconds

Returning to RUN Mode

Some TEACH, Set, and Setup modes may be exited either after the 60-second timeout, or by exiting the process:

- In Static TEACH or Window Set mode, press and hold the Static (−) button (or hold the remote line) for 2 seconds. The sensor returns to Run mode without saving any new settings.
- In Setup mode, press and hold both the Static (−) and Dynamic (+) buttons (or hold the remote line) for 2 seconds. The sensor returns to Run mode and saves the current setting.

Two-Point Static TEACH (Threshold)

- Establishes a single switching threshold
- Threshold position is adjustable using "+" and "-" buttons (see Manual Adjust)

Static TEACH is the traditional setup method, used when two conditions can be presented by the user. The sensor locates a single sensing threshold (the switchpoint) midway between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other.

The first condition taught is the ON condition. The Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in Setup mode (see *Setup Mode* on page 8).

Static TEACH and Manual Adjust. Using Manual Adjust with Static TEACH moves the switching threshold. The lighted LED on the bar graph will move to exhibit the received signal, relative to the switchpoint.

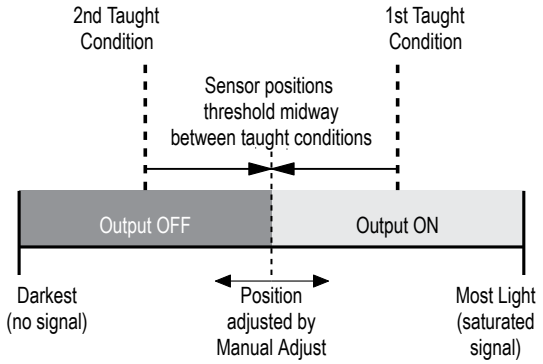


Figure 2. Static TEACH (Light Operate shown)

Bar Graph LED Following TEACH	Relative Signal Difference / Recommendation
6 to 8	Excellent: Very stable operation
4 to 5	Good: Minor sensing variables may affect sensing reliability
2 to 3	Low: Minor sensing variables may affect sensing reliability
1	Unreliable: Consider an alternate sensing scheme

1. Access the TEACH Mode.

Method	Action	Result
Push Button[2]	Press and hold the Static button > 2 seconds.	• Power LED: OFF • Output LED: ON • Status LEDs: LO & DO alternately flash • Bar graph: OFF
Remote Input[3]	No action is required; the sensor is ready for 1st TEACH condition.	

2. TEACH the Output ON condition.

Method	Action	Result
Push Button	a. Present the Output ON condition. b. Click the Static button.	• Power LED: OFF • Output LED: Flash, then OFF • Status LEDs: LO & DO alternately flash • Bar graph: OFF
Remote Input	a. Present the Output ON condition. b. Single-pulse the remote line.	

3. TEACH the Output OFF condition.

Method	Action	Result
Push Button	a. Present the Output OFF condition. b. Click the Static button.	TEACH Accepted • Power LED: ON • Bar graph: One LED flashes to show relative contrast (good signal difference shown; see table above) Sensor returns to Run mode. TEACH Unacceptable • Power LED: OFF • Bar graph: #1, 3, 5, 7 alternately flash to show failure Sensor returns to the "TEACH Output ON condition".
Remote Input	a. Present the Output OFF condition. b. Single-pulse the remote line.	

[2] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[3] 0.04 seconds ≤ T ≤ 0.8 seconds

Dynamic TEACH and Adaptive Thresholds

- Teach on-the-fly
- Establishes a single switching threshold
- Threshold position is adjustable using "+" and "-" buttons (Manual Adjust)

Dynamic TEACH is best used when a machine or process may not be stopped for teaching. It programs the sensor during actual sensing conditions, taking multiple samples of the light and dark conditions and automatically setting the threshold at the optimum level.

Dynamic TEACH activates the sensor's adaptive threshold system, which continuously tracks minimum and maximum signal levels, and automatically maintains centering of the switchpoint between the light and dark conditions. The adaptive threshold system remains in effect during Run mode. The adaptive routine saves to non-volatile memory at least once per hour.

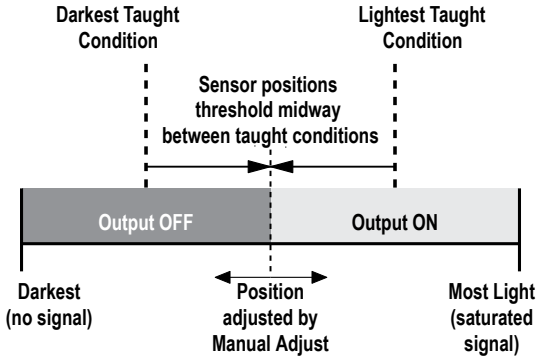


Figure 3. Dynamic TEACH (Light Operate shown)

When Dynamic TEACH mode is used, the output ON state (Light or Dark Operate) remains as it was last programmed. To change the output ON state, use Setup mode.

Dynamic TEACH and Manual Adjust

The switchpoint may be adjusted (fine-tuned) whenever the sensor is in Run mode by clicking the "+" and "-" buttons. However, when a manual adjustment is made, the adaptive threshold system is disabled (cancelled).

Bar Graph LED Following TEACH	Relative Signal Difference / Recommendation
6 to 8	Excellent: Very stable operation
4 to 5	Good: Minor sensing variables may affect sensing reliability
2 to 3	Low: Minor sensing variables may affect sensing reliability
1	Unreliable: Consider an alternate sensing scheme

1. Access the Dynamic TEACH Mode.

Method	Action	Result
Push Button[4]	Press and hold the Dynamic push button > 2 seconds. 	• Power LED: OFF • Output LED: OFF • Bar graph: LO & DO alternately flash
Remote Input[5]	Hold the remote line low (to ground) > 2 seconds. 	

2. TEACH the sensing condition.

Method	Action	Result
Push Button	Continue to hold push button and present Output ON and OFF conditions. 	• Power LED: OFF • Output LED: OFF • Bar graph: LO & DO alternately flash
Remote Input	Continue to hold remote line low (to ground) and present Output ON and OFF conditions. 	

3. Return to RUN Mode.

Method	Action	Result
Push Button	Release the push button. 	TEACH Accepted • Power LED: ON • Bar graph: One LED flashes to show relative contrast (good signal difference shown; see table above) Sensor returns to Run mode with new settings. TEACH Not Accepted • Power LED: OFF • Bar graph: #1, 3, 5, 7 alternately flash to show failure Sensor returns to Run mode without changing settings
Remote Input	Release the remote line/switch 	

[4] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[5] 0.04 seconds ≤ T ≤ 0.8 seconds

Single-Point Window Set

- Sets a single ON condition that extends 12.5% above and below the taught condition
- All other conditions (lighter or darker) result in OFF output
- Sensing window size (sensitivity) is adjustable using "+" and "-" buttons (see *Manual Adjust* on page 8)

Window Set is most useful when a product may not always appear in the same place, or when other signals may appear. Window Set designates a sensing window, with the Output ON condition inside the window, and the Output OFF conditions outside the window. The sensor accepts a single sensing condition, and adds switching thresholds above and below that condition to create a sensing window. Output ON and OFF conditions can be reversed by changing Light/Dark Operate status in Setup mode.

Window Set and Manual Adjust

Using Manual Adjust with Window Set expands or contracts the size of the window. The lighted LEDs on the light bar separate to a greater or lesser extent to exhibit the relative sensing window size.

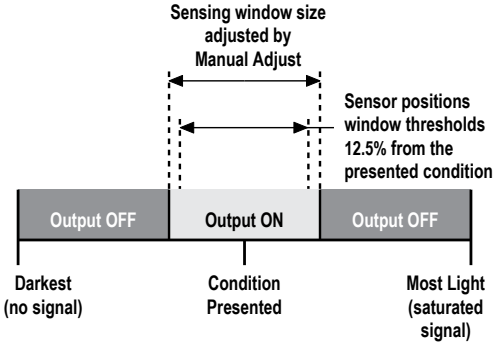
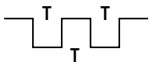


Figure 4. Single-Point Window SET (Light Operate shown)

1. Access the SET Mode.

Method	Action	Result
Push Button[6]	Press and hold the Static button > 2 seconds. 	• Power LED: OFF • Output LED: ON (Push Button) • Output LED: OFF (Remote) • Status LEDs: LO & DO flash alternately
Remote Input[7]	Single-pulse the remote line. 	

2. SET the sensing condition.

Method	Action	Result
Push Button	a. Present the sensing condition. b. Double-click the Static button. 	Window Accepted • Power LED: ON • Bar graph: 2 indicators flash together to show Window accepted Sensor returns to Run mode with the new settings.
Remote Input	a. Present sensing the condition. b. Double-pulse the remote line. 	Window Not Accepted • Power LED: OFF • Bar graph: #1, 3, 5, 7 flash to show failure Sensor returns to the "SET Sensing condition".

[6] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[7] 0.04 seconds ≤ T ≤ 0.8 seconds

Single-Point Light Set

- Sets a threshold 6.25% below the taught condition.
- Any condition darker than the threshold condition causes the output to change state
- Threshold position is adjustable using the "+" and "-" buttons (see *Manual Adjust* on page 8)
- Recommended for applications where only one condition is known, for example a stable light background with varying darker targets

A single sensing condition is presented, and the sensor positions a threshold 6.25% below the presented condition. When a condition darker than the threshold is sensed, the output either turns ON or OFF, depending on the Light/Dark Operate setting (see *Setup Mode* on page 8).

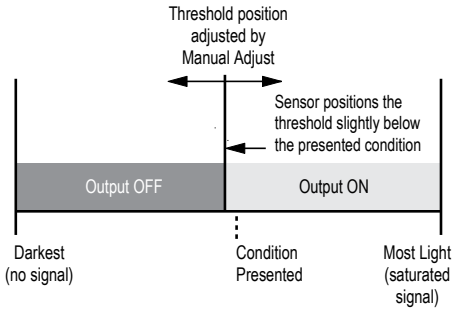


Figure 5. Single-Point Light Set (Light Operate shown)

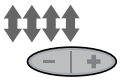
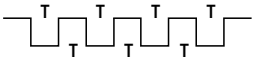
Light SET and Light/Dark Operate Selection

In Light Operate mode, Light Set teaches the Output ON condition. In Dark Operate mode, Light Set teaches the Output OFF condition.

1. Access the SET Mode.

Method	Action	Result
Push Button[8]	Press and hold the Static button > 2 seconds. 	• Power LED: OFF • Output LED: ON (push button) • OFF (remote line) • Static LEDs: LO & DO alternately flash
Remote Input[9]	Single-pulse the remote line. 	

2. SET the sensing condition.

Method	Action	Result
Push Button	a. Present the sensing condition. b. Four-click the Static push button. 	Threshold condition accepted • Power LED: ON • Output LED: ON (push button) • OFF (remote line) • Bar graph: 4 indicators flash together Sensor returns to Run mode with the new settings. Threshold condition not accepted • Power LED: ON • Output LED: ON (push button) • OFF (remote line) • Bar graph: #1, 3, 5, 7 alternately flash to show failure Sensor returns to the "SET Sensing Condition".
Remote Input	a. Present the sensing condition. b. Four-pulse the remote line. 	

[8] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[9] 0.04 seconds ≤ T ≤ 0.8 seconds

Single-Point Dark Set

- Sets a threshold 6.25% above the taught condition
- Any condition lighter than the threshold condition causes the output to change state
- Threshold position is adjustable using the "+" and "-" buttons (see *Manual Adjust* on page 8)
- Recommended for applications where only one condition is known, for example a stable dark background with varying lighter targets

A single sensing condition is presented, and the sensor positions a threshold 6.25% above the taught condition. When a condition lighter than the threshold is sensed, the output either turns ON or OFF, depending on the Light/Dark Operate setting (see *Setup Mode* on page 8).

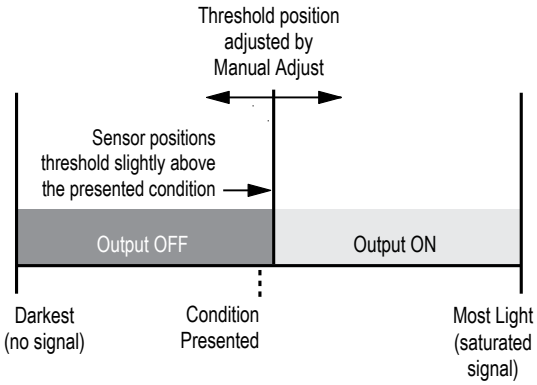


Figure 6. Single-Point Dark Set (Light Operate shown)

Dark Set and Light/Dark Operate Selection

In Light Operate mode, Dark Set teaches the Output OFF condition. In Dark Operate mode, Dark Set teaches the Output ON condition.

1. Access Set Mode

Method	Action	Result
Push Button[10]	Press and hold the Static button > 2 seconds.	• Power LED: OFF • Output LED: ON (push button) • OFF (remote line) • Static LEDs: LO & DO alternately flash
Remote Input[11]	Single-pulse the remote line.	

2. Set the sensing condition.

Method	Action	Result
Push Button	a. Present the sensing condition. b. Five-click the Static button.	Threshold Condition Accepted • Power LED: ON • Output LED: ON (push button) • OFF (remote line) • Bar graph: 4 indicators flash together The sensor returns to Run mode with the new settings. Threshold Condition Not Accepted • Power LED: ON • Output LED: ON (push button) • OFF (remote line) • Bar graph: #1, 3, 5, 7 flash to show failure The sensor returns to the "SET Sensing Condition".
Remote Input	a. Present the sensing condition. b. Five-pulse the remote line.	

[10] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[11] 0.04 seconds ≤ T ≤ 0.8 seconds

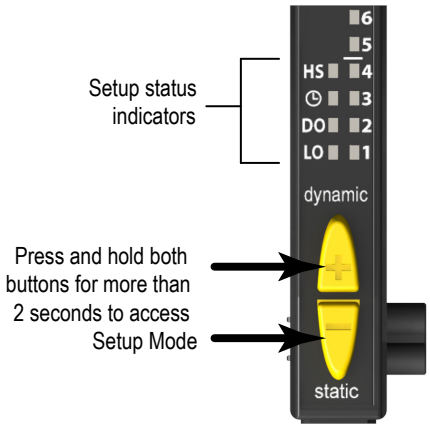
Setup Mode

Use Setup mode to change sensor output response for:

- Light or Dark operate
- 30-millisecond pulse stretcher (OFF-delay), if required
- 200 µs high-speed response

If Setup mode configuration is interrupted and remains inactive for 60 seconds, the sensor returns to Run mode with the most recent settings (i.e., exits and saves current selection).

Setup mode operates in the background, while the outputs are active; changes are updated instantly.



1. Access the Setup Mode.

Method	Action	Result
Push Button[12]	Press and hold both push buttons > 2 seconds.	• Power LED: OFF • Output LED: remains active • Icon continue to display current setup • Static LEDs: OFF
Remote Input[13]	Double-pulse the remote line. T T T	

2. Select the setting combination.

Method	Action	Result
Push Button	Click either push button until the LEDs show desired settings. or	The sensor toggles through eight setting combinations, in the following order: LO - Normal Speed - No Delay (default) DO - Normal Speed - No Delay LO - High Speed - No Delay DO - High Speed - No Delay LO - Normal Speed - Delay DO - Normal Speed - Delay LO - High Speed - Delay DO - High Speed - Delay
Remote Input	Pulse the remote line until the LEDs show desired settings. NOTE: Double-pulsing the remote line will cause the setting to back up one step.	

3. Return to Run Mode.

Method	Action	Result
Push Button	Press and hold both push buttons > 2 seconds.	Power LED: ON The sensor returns to RUN mode with the new settings.
Remote Input	Hold remote the line low > 2 seconds. 2 seconds	

Manual Adjust

Manual Adjust is used during Run mode and is accomplished using the push buttons only. Its behavior depends on whether a switching threshold or a sensing window is used.

Switching Threshold:

- Fine-tunes sensing sensitivity
- Press “+” to increase; press “-” to decrease

Sensing Window:

[12] 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[13] 0.04 seconds ≤ T ≤ 0.8 seconds

- Adjusts sensing window size (tolerance) for the single-point target condition
- Press “+” to increase; press “-” to decrease

The lighted bar graph LEDs move to reflect the increase or decrease.

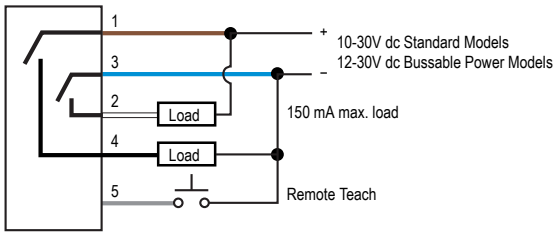
Enabling or Disabling the Push Button

In addition to its programming function, the remote line may be used to disable the push buttons for security. Disabling the push buttons prevents undesired tampering with the sensor configuration settings.

1. Connect the sensor’s gray wire.
2. Four-pulse the remote line to enable or disable the push button.
   The sensor toggles between enable and disable settings and returns to RUN mode.

Wiring Diagrams

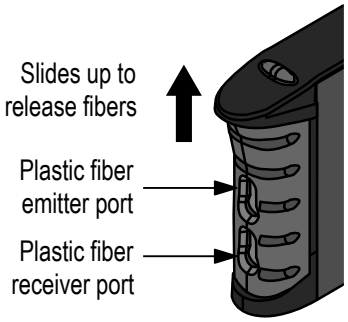
Standard Models and Main Unit



1 - Brown
2 - White
3 - Blue
4 - Black
5 - Gray
6 - Pink (not used)

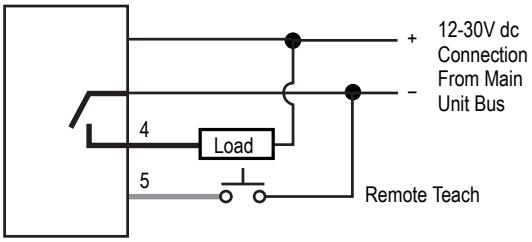
The QD hookup is functionally identical. The pink wire is not used.

Installing Fibers

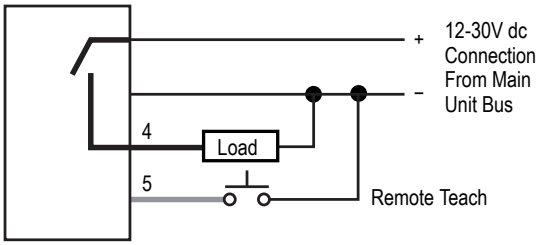


Sub-Units

NPN



PNP



Specifications

Sensing Beam
Standard sensors: 660 nm visible red or 525 nm visible green, depending on model
Models with bussable power: 660 nm visible red

Supply Voltage
Standard sensors: 10 to 30 V dc (10% maximum ripple) at less than 45 mA exclusive of load
Models with bussable power: 12 to 30 V dc (10% maximum ripple) at less than 45 mA exclusive of load

Supply Protection Circuitry
Protected against reverse polarity, over voltage, and transient voltage

Delay at Power Up
Standard Sensors: 200 milliseconds maximum; outputs do not conduct during this time
Models with Bussable Power: 850 milliseconds maximum; outputs do not conduct during this time

Output Rating (Standard Sensors)
Standard Sensors: 150 mA maximum load at 25° C (derate 1 mA per °C increase)
OFF-state leakage current: < 5 µA at 30 V dc
ON-state saturation voltage: NPN: < 200 mV at 10 mA; 1 V at 150 mA load; PNP: < 1 V at 10 mA; 1.5 V at 150 mA load

Output Rating (Models with Bussable Power)
Models with Bussable Power: 100 mA maximum load (derate 1 mA per °C above 30 °C)
OFF-state leakage current: < 5 µA at 30 V dc
ON-state saturation voltage: NPN: < 1.5 V; PNP: < 2 V
Supply 15 V or more: up to 16 units with 100 mA outputs
Less than 15 V supply (9 m cable): up to 4 units with 100 mA outputs; up to 8 units with 50 mA outputs

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*.

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

Output Protection
Protected against output short-circuit, continuous overload, transient over-voltages, and false pulse on power-up

Output Response Time
500 microseconds (normal mode) or 200 microseconds (high-speed mode)

Repeatability
100 microseconds (normal mode) or 66 microseconds (high-speed mode)

Adjustments
2 push buttons and remote wire
- Expert-style configuration (Static and Dynamic TEACH, and Window Set)
- Manually adjust (+/–) sensitivity (from push buttons only)
- LO/DO, OFF-delay, and response speed configurable (from push buttons or remote wire)
- Push button lockout (from remote wire only)

Factory Default Settings: Light Operate, Normal Speed, No Delay
Push-button or remote programming of response time, OFF-delay, light/dark operate, and display

Indicators
8-segment red bar graph: Light-to-dark signal difference relative to taught condition (Window Set); Sensing contrast (Static or Dynamic TEACH)
Green Status Indicators: LO, DO, High Speed (HS), and OFF-Delay
Green LED: Power ON
Yellow LED: Output conducting

Construction
Black ABS/polycarbonate alloy (UL94 V-0 rated) housing, clear polycarbonate cover

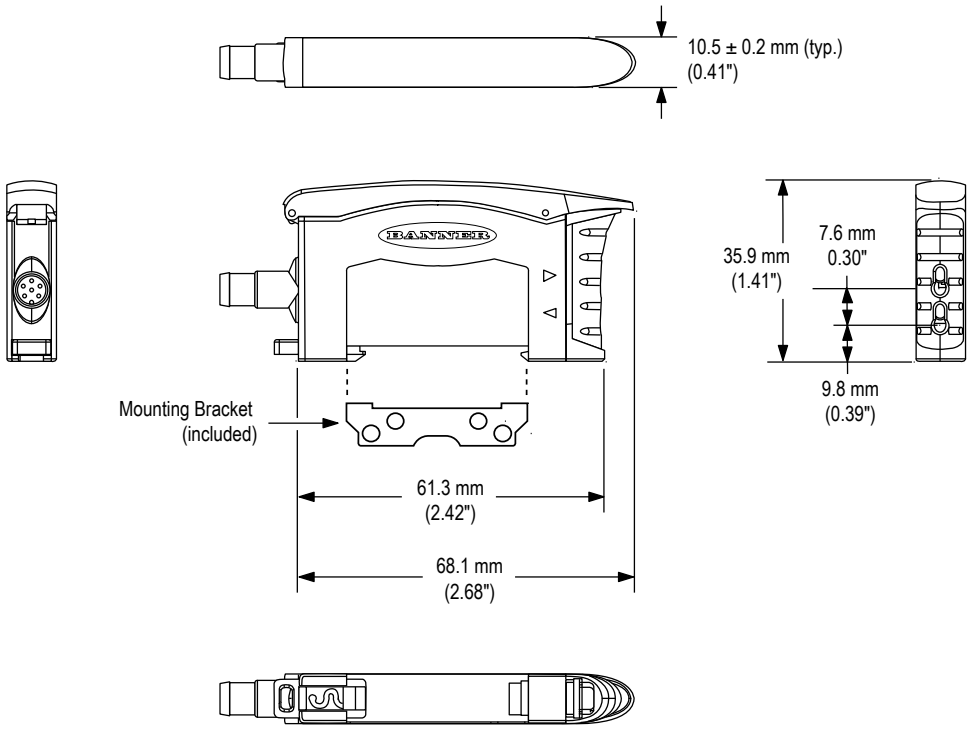
Environmental Rating
IEC IP50, NEMA 1

Connections
Standard Sensors: PVC-jacketed 2 m or 9 m (6.5 ft or 30 ft) 6-wire integral cable or integral 6-pin Pico-style quick-disconnect
Models with Bussable Power: Main units: PVC-jacketed 2 m or 9 m (6.5 ft or 30 ft) 5-wire integral cable; Sub-units: PVC-jacketed 2 m or 9 m (6.5 ft or 30 ft) 2-wire integral cable

Operating Conditions
Temperature: –10 °C to +55 °C (+14 °F to +131 °F)
Storage Temperature: –20 °C to +85 °C (–4 °F to +185 °F)
90% at +55 °C maximum relative humidity (non-condensing)

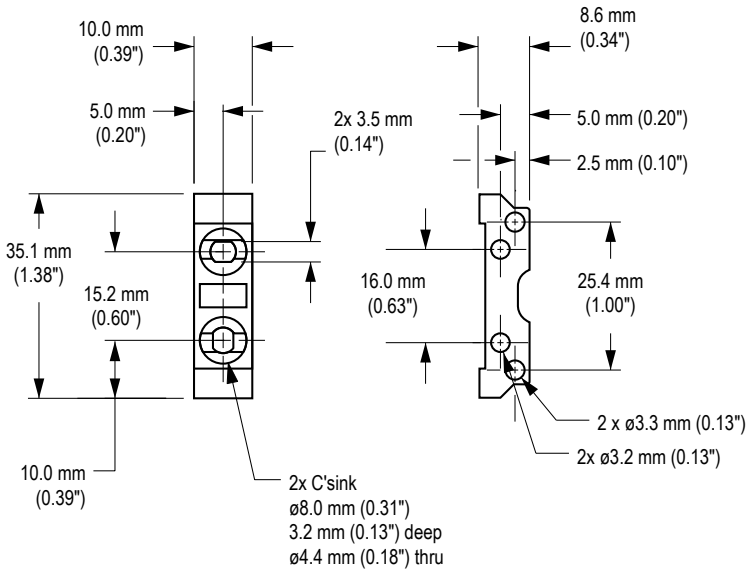
Certifications

Dimensions



All measurements are listed in millimeters [inches], unless noted otherwise.

Included Bracket Dimensions

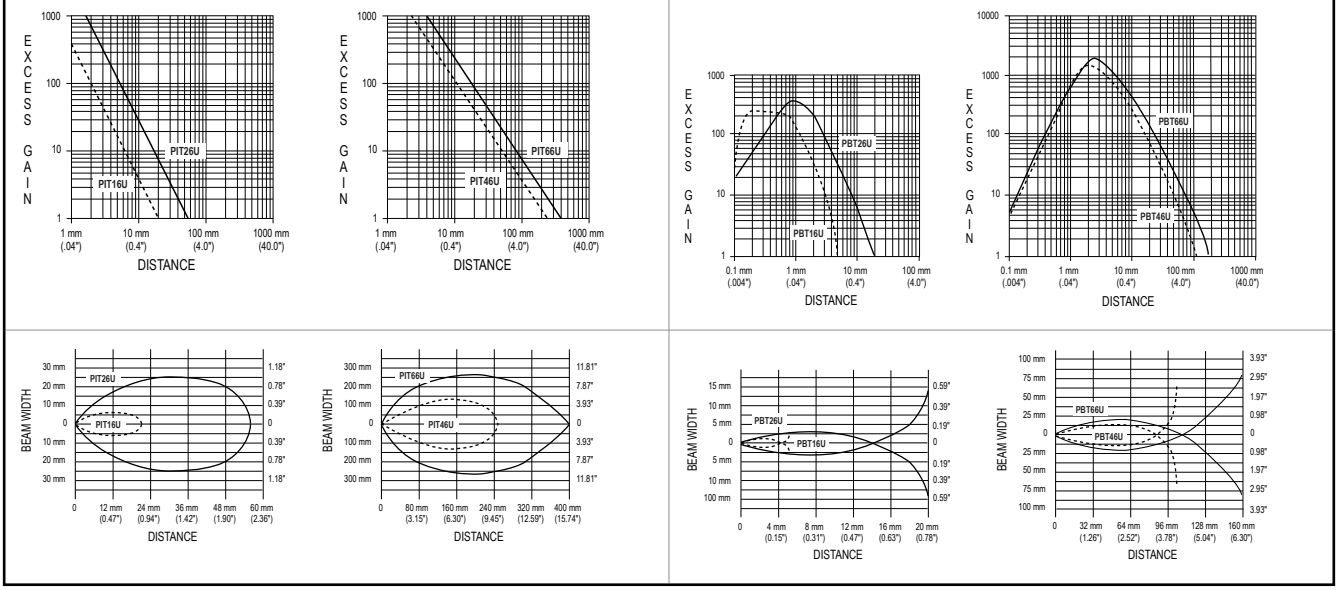


M3 Hardware included:
- Lock Washer (2)
- Flat Washer (2)
- Screws (2)
- Hex Nuts (2)

Performance Curves

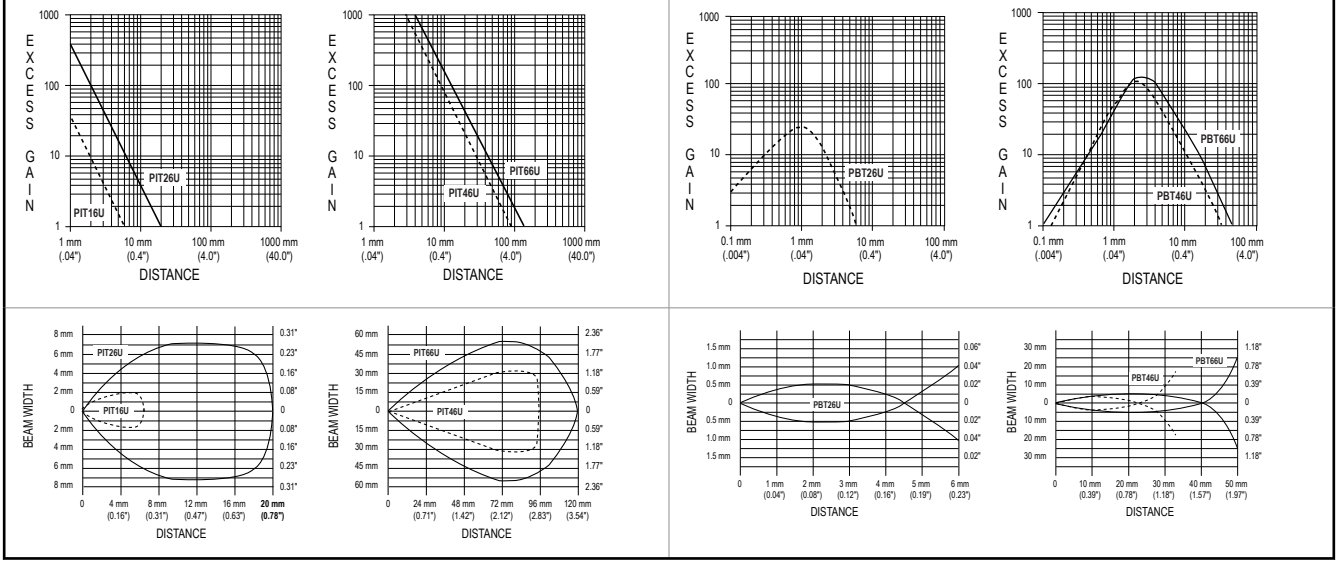
Red Beam Models

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



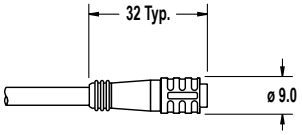
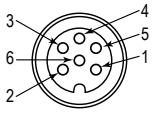
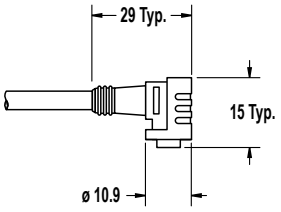
Green Beam Models

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



Accessories

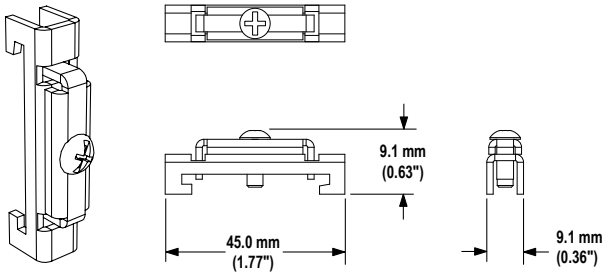
Quick Disconnect Cordsets

6-Pin Snap-on M8/Pico-Style Cordsets				
Model	Length	Style	Dimensions	Pinout (Female)
PKG6Z-2	2 m (6.5 ft)	Straight		 1 - brown 2 = White 3 = Blue 4 = Black 5 = Gray 6 = Pink
PKG6Z-9	9 m (30 ft)			
PKW6Z-2	2 m (6.5 ft)	Right-angle		
PKW6Z-9	9 m (30 ft)			

DIN Rail Accessories

SA-DIN-CLAMP

- Pair of metal DIN rail end stops; slide onto DIN rail at either side of the sensor stack
- Combination (#2 Phillips, #8 standard slotted) set screw



SA-D10B-CAP

Package of 5 each replacement terminal caps and plugs to cover beginning and end of stack of connected sensors.

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: *www.bannerengineering.com*.