DF-G2 High Speed Expert™ Dual Display Fiber Amplifier

Instruction Manual

Original Instructions
177899 Rev. E
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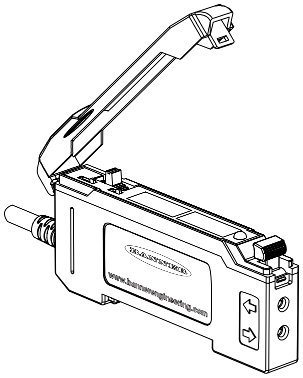
177899

Contents

1 Product Description

Advanced sensor with dual digital displays for use with plastic and glass fiber optic assemblies



- Best in class response speeds of: 10 µs, 15 µs, 50 µs, 250 µs, 500 µs, 1000 µs and 2000 µs allow the operator to optimize for fast response, long distance applications, or noisy environments.
- Outstanding color contrast sensitivity; detects 32 levels of gray scale from black to white
- Choose from IR or one of 4 visible beam colors: red, blue, green and white. Depending on the beam color and fiber, the sensor reliably detects the toughest color mark contrasts
- Easy to read dual digital displays show both signal level and threshold simultaneously
- Lever action fiber clamp provides stable, reliable, and trouble-free fiber clamping
- Simple user interface ensures easy sensor set-up and programming via displays and switches/buttons or remote input teach wire
- *Expert* TEACH and SET methods ensure optimal gain and threshold for all applications, especially for high speed or low contrast applications
- User has full control over all operating parameters: threshold, Light Operate or Dark Operate, output timing functions, gain level, and response speed
- Thermally stable electronics shorten start-up time and maintain signal stability during operation
- ECO (economy) display mode reduces amplifier power consumption by 25%
- Cross talk avoidance algorithm allows two sensors to operate in close proximity for many applications
- Sleek 10 mm wide housing mounts to 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.

1.1 Models

Model	Sensing Beam Color	Reference Sensing Range[1]	Outputs	Connector[2]
DF-G2-NS-2M	Visible Red	1100 mm	Single NPN	2 m (6.5 ft) cable, 4-wire
DF-G2-PS-2M			Single PNP	
DF-G2W-NS-2M	Broad Spectrum White	550 mm	Single NPN	
DF-G2W-PS-2M			Single PNP	
DF-G2G-NS-2M	Visible Green	660 mm	Single NPN	
DF-G2G-PS-2M			Single PNP	
DF-G2B-NS-2M	Visible Blue	770 mm	Single NPN	
DF-G2B-PS-2M			Single PNP	
DF-G2IR-NS-2M	Infrared	2100 mm	Single NPN	
DF-G2IR-PS-2M			Single PNP	

1 Excess gain = 1, Long Range response speed, opposed mode sensing. PIT46U plastic fiber used for visible LED models, IT.83.3ST5M6 glass fiber used for IR model

2 Connector options:
- A model with a QD connector requires a mating cordset (see *Quick-Disconnect Cordsets* on page 29)
- For 9 m cable, change the suffix 2M to 9M in the 2 m model number (example, DF-G2-NS-9M)
- For 150 mm (6 in) PVC pigtail, M8 Pico QD connector, 4-pin change the suffix 2M to Q3 in the 2 m model number (example, DF-G2-NS-Q3)
- For 150 mm (6 in) PVC pigtail, M12 Euro QD connector, 4-pin change the suffix 2M to Q5 in the 2 m model number (example, DF-G2-NS-Q5)
- For integral M8 Pico QD connector, 4-pin change the suffix 2M to Q7 in the 2 m model number (example, DF-G2-NS-Q7)

1.2 Overview

The DF-G2 is an easy-to-use, DIN-rail-mountable fiber optic sensor with best in class response speed and repeatability. It provides high-performance sensing in high speed or low contrast applications where fast response time is required.

The sensor's compact housing has dual digital displays (Red/Green) and a bright output LED for easy programming and status monitoring during operation. The sensor features a single discrete output, either NPN or PNP, by model.

The DF-G2 features improved temperature compensation compared with previous fiber optic sensors. An accessory clamp is available to secure a bank of connected sensors together on a DIN rail (see *Accessories* on page 29).

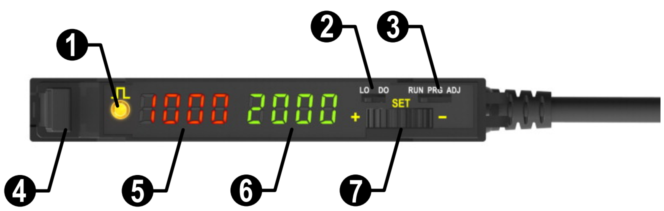


Figure 1. DF-G2 Model Features

1	Output LED
2	LO/DO Switch
3	RUN/PRG/ADJ Mode Switch
4	Lever Action Fiber Clamp
5	Red Signal Level
6	Green Threshold
7	+/SET/- Rocker Button

1.3 Top Panel Interface

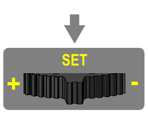
Opening the dust cover provides access to the top panel interface. The top panel interface consists of the RUN/PRG/ADJ mode switch, LO/DO switch, +/SET/- rocker button, dual red/green digital displays, and output LED.

RUN/PRG/ADJ Mode Switch

The RUN/PRG/ADJ mode switch puts the sensor in RUN, PRG (Program), or ADJ (Adjust) mode. RUN mode allows the sensor to operate normally and prevents unintentional programming changes via the +/SET/- button. PRG mode allows the sensor to be programmed through the display driven programming menu (see *Program Mode* on page 7). ADJ mode allows the user to perform Expert TEACH/SET methods and Manual Adjust (see *Adjust Mode* on page 12).

LO/DO Switch

The LO/DO switch is used to select Light Operate or Dark Operate mode. In Light Operate mode, the output is ON when the sensing condition is above the threshold (for Window SET, the output is ON when the sensing condition is inside the window). In Dark Operate mode, the output is ON when the sensing condition is below the threshold (for Window SET, the output is ON when the sensing condition is outside the window).



+/SET/- Rocker Button

The +/SET/- rocker button is a 3-way button. The +/- positions are engaged by rocking the button left/right. The SET position is engaged by clicking down the button while the rocker is in the middle position. All three button positions are used during PRG mode to navigate the display driven programming menu. During ADJ mode, SET is used to perform TEACH/SET methods and +/- are used to manually adjust the threshold(s). The rocker button is disabled during RUN mode, except when using Window SET, see *Window SET* on page 15.

Red/Green Digital Displays

During RUN and ADJ mode, the Red display shows the signal level and the Green display shows the threshold. During PRG mode, both displays are used to navigate the display driven programming menu.

Output LED

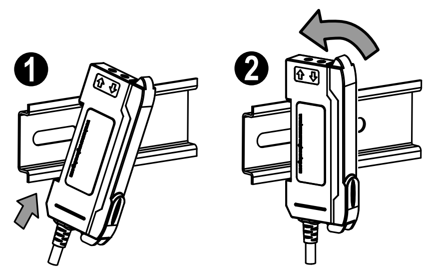
The output LED provides a visible indication when the output is activated.

2 Installation Instructions

2.1 Mounting Instructions

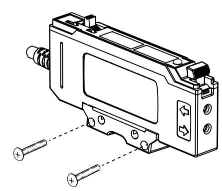
Mount on a DIN Rail

1. Hook the DIN rail clip on the bottom of the DF-G2 over the edge of the DIN rail (1).
2. Push the DF-G2 up on the DIN rail (1).
3. Pivot the DF-G2 onto the DIN rail, pressing until it snaps into place (2).



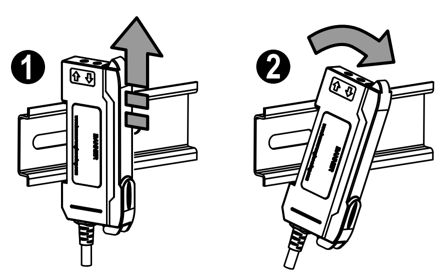
Mount to the Accessory Bracket (SA-DIN-BRACKET)

1. Position the DF-G2 in the SA-DIN-BRACKET.
2. Insert the supplied M3 screws.
3. Tighten the screws.



Remove from a DIN rail

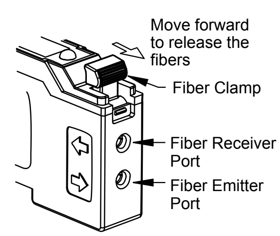
1. Push the DF-G2 up on the DIN rail (1).
2. Pivot the DF-G2 away from the DIN rail and remove it (2).



2.2 Installing the Fibers

Follow these steps to install glass or plastic fibers.

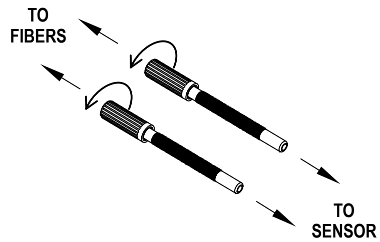
1. Open the dust cover.
2. Move the fiber clamp forward to unlock it.
3. Insert the fiber(s) into the fiber port(s) until they stop.
4. Move the fiber clamp backward to lock the fiber(s).
5. Close the dust cover.



NOTE: For optimum performance of IR models, if applicable, glass fibers must be used.

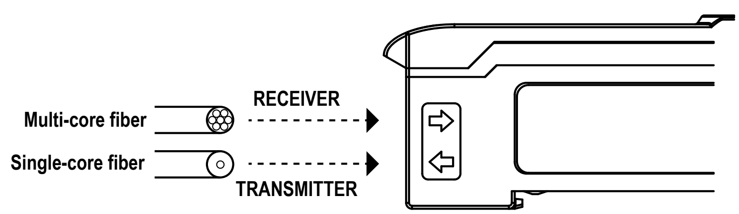
2.3 Fiber Adapters

NOTE: If a thin fiber with less than 2.2 mm outer diameter is used, install the fiber adapter provided with the fiber assembly to ensure a reliable fit in the fiber holder. Align the fibers to the end of the adaptors. Banner includes the adapters with all fiber assemblies.



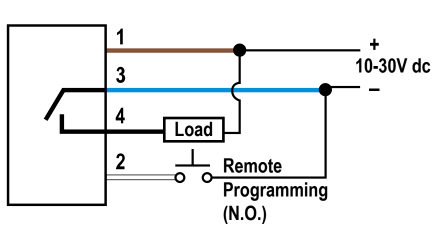
Fiber Outer Diameter (mm)	Adapter Color
Ø 1.0	Black
Ø 1.3	Red
Ø 2.2	No adapter needed

When connecting coaxial-type fiber assemblies to the amplifier, install the single-core (center) fiber to the Transmitter port, and the multi-core (outer) fiber to the Receiver port. This will result in the most reliable detection.

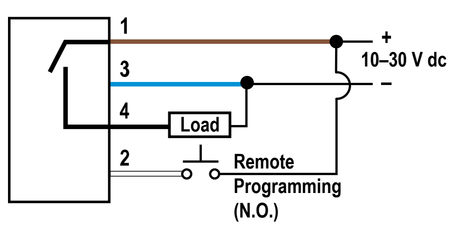


2.4 Wiring Diagrams

NPN Models



PNP Models



Key

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

NOTE: Open lead wires must be connected to a terminal block.

3 Operating Instructions

3.1 Run Mode

Run mode allows the sensor to operate normally and prevents unintentional programming changes. The +/SET/- rocker button is disabled during RUN mode, except when using Window SET.

3.2 Program Mode

Program (PRG) mode allows the following settings to be programmed in the DF-G2 (refer to Program Mode Flowchart and and Remote Input Flowchart for programming). See Factory Default Settings in Specifications.

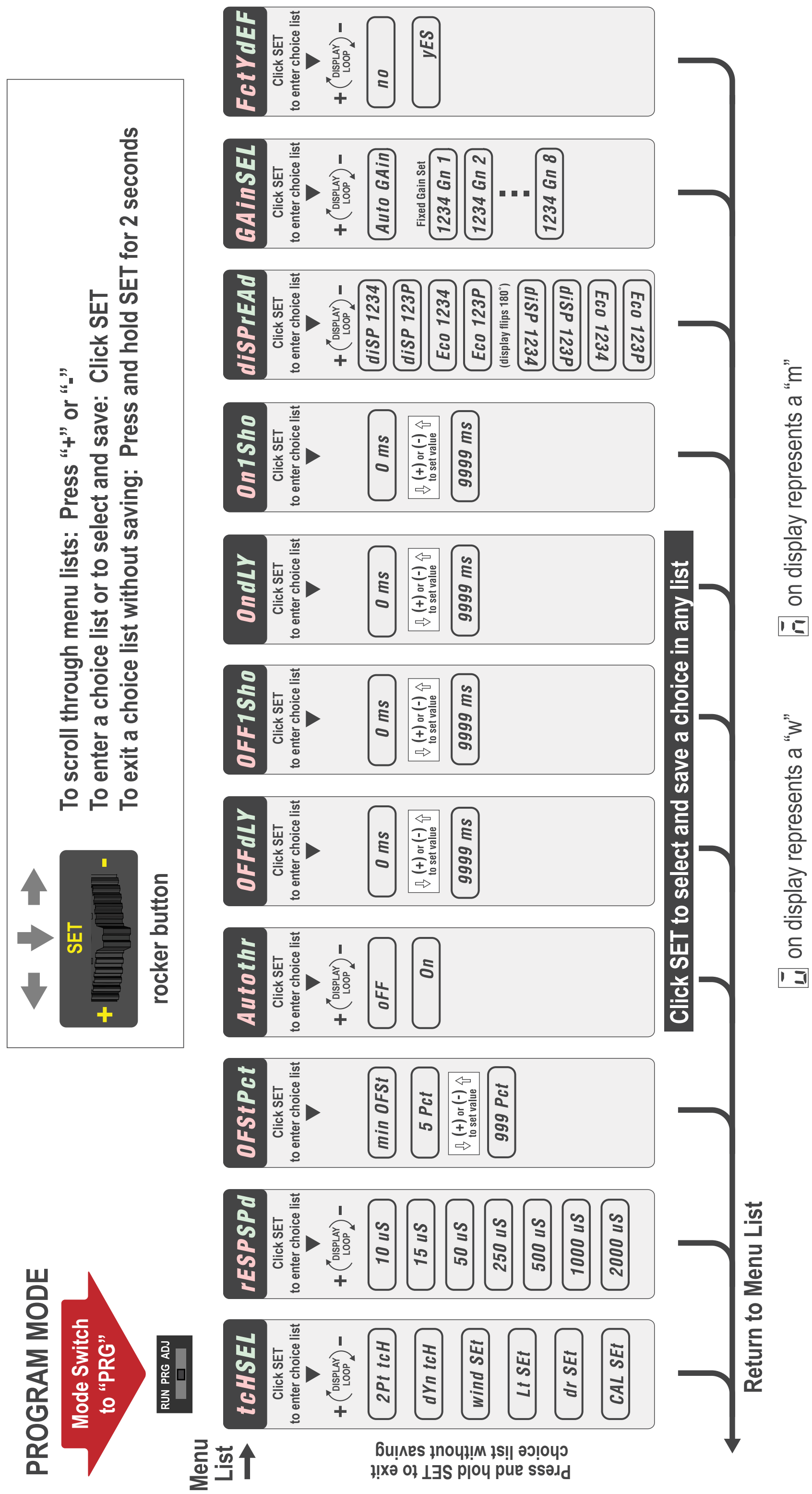


Figure 2.

3.2.1 TEACH Selection

The DF-G2 can be programmed for one of the following TEACH/SET methods:

- Two-Point TEACH
- Dynamic TEACH

- Window SET
- Light SET
- Dark SET
- Calibration SET

NOTE: A TEACH Selection must be selected by programming before TEACH/SET methods can be used.

3.2.2 Response Speed 

The DF-G2 can be programmed for one of the following Response Speeds:

Response Speed	Display Range	Crosstalk Avoidance Algorithm
10 µs (Super High Speed)	0 – 4000	Disabled
15 µs (High Speed)	0 – 4000	Disabled
50 µs (Fast)	0 – 4000	Disabled
250 µs (Standard)	0 – 4000	Enabled
500 µs (Medium Range)	0 – 9999	Enabled
1000 µs (Long Range)	0 – 9999	Enabled
2000 µs (Long Range with immunity to Energy Efficient Lights)	0 – 9999	Enabled

3.2.3 Offset Percent 

The Offset Percent is used during the Window, Light, or Dark SET methods. The threshold(s) are positioned a programmable % offset from the taught condition.

The allowable range depends upon the Response Speed Mode, as shown below:

Response Speed	MIN %	MAX %
10 µs	5	999
15 µs	5	999
50 µs	2	999
250 µs	2	999
500 µs	1	999
1000 µs	1	999
2000 µs	1	999

The offset percent can also be programmed to Minimum Offset. This allows the DF-G2 to set the threshold(s) as close as possible to the presented condition, but still provide for reliable sensing.

NOTE: Offset Percent MUST be programmed to Minimum Offset for Dark SET to accept conditions of no signal (0 counts).

3.2.4 Auto Thresholds 

Auto Thresholds can be programmed to be ON/OFF. The Auto Thresholds algorithm continuously tracks slow changes in the taught condition(s), and optimizes the threshold(s) to provide for reliable sensing. For Two-Point and Dynamic TEACH, the algorithm optimizes the threshold to be centered between the light and dark conditions. For Window, Light, and Dark SET, the algorithm optimizes the threshold(s) to maintain the programmed Offset Percent from the taught condition.

- After programming Auto Thresholds to ON, it is highly recommended to re-perform the TEACH/SET method
- Manual Adjustments are disabled when Auto Thresholds are ON
- Auto Thresholds are automatically disabled in Calibration SET (see *Calibration SET* on page 20)

- Severe contamination/changes in the taught condition can prevent the Auto Thresholds algorithm from optimizing the threshold(s). If this occurs, the DF-G2 enters a Threshold Alert or Threshold Error state. See *Troubleshooting* on page 21 for more explanation.

3.2.5 Delays/Timers

ON/OFF Delays and ON/OFF One-Shot timers can be programmed between 1 - 9999 ms (a value of 0 disables the delay/ timer). *Figure 3* on page 10 defines how the delays/timers affect the output behavior.

Some combinations of delays/timers are not allowed. The DF-G2 programming menu automatically disables invalid combinations of delays/timers. The following table shows the allowable combinations of delays/ timers:

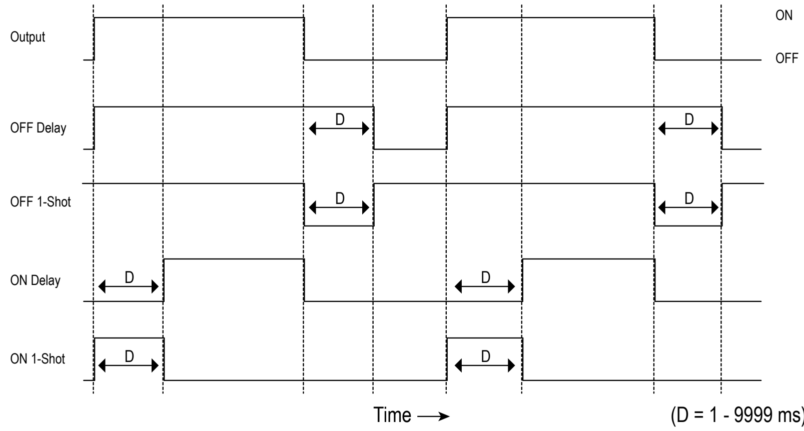


Figure 3. DF-G2 Delays/Timers

	OFF Delay	OFF One-Shot Timer	ON Delay	ON One-Shot Timer
OFF Delay	-	OK	OK	N/A
OFF One-Shot Timer	OK	-	N/A	N/A
ON Delay	OK	N/A	-	OK
ON One-Shot Timer	N/A	N/A	OK	-

3.2.6 Gain Selection

The DF-G2 can operate in Auto Gain mode or the Gain can be fixed to be in Gain 1...8. In Auto Gain, the DF-G2 optimizes the gain during a TEACH/SET method for the presented condition(s). While viewing the fixed gains in the Gain Selection choice list, the DF-G2 will automatically switch to the selected gain and display the measured signal on the Red display. This allows for easy and quick evaluation of the fixed gain mode.

3.2.7 Factory Defaults

The Factory Defaults menu allows the DF-G2 to be easily restored back to original factory default settings (see Factory Default Settings in Specifications).

Display Readout

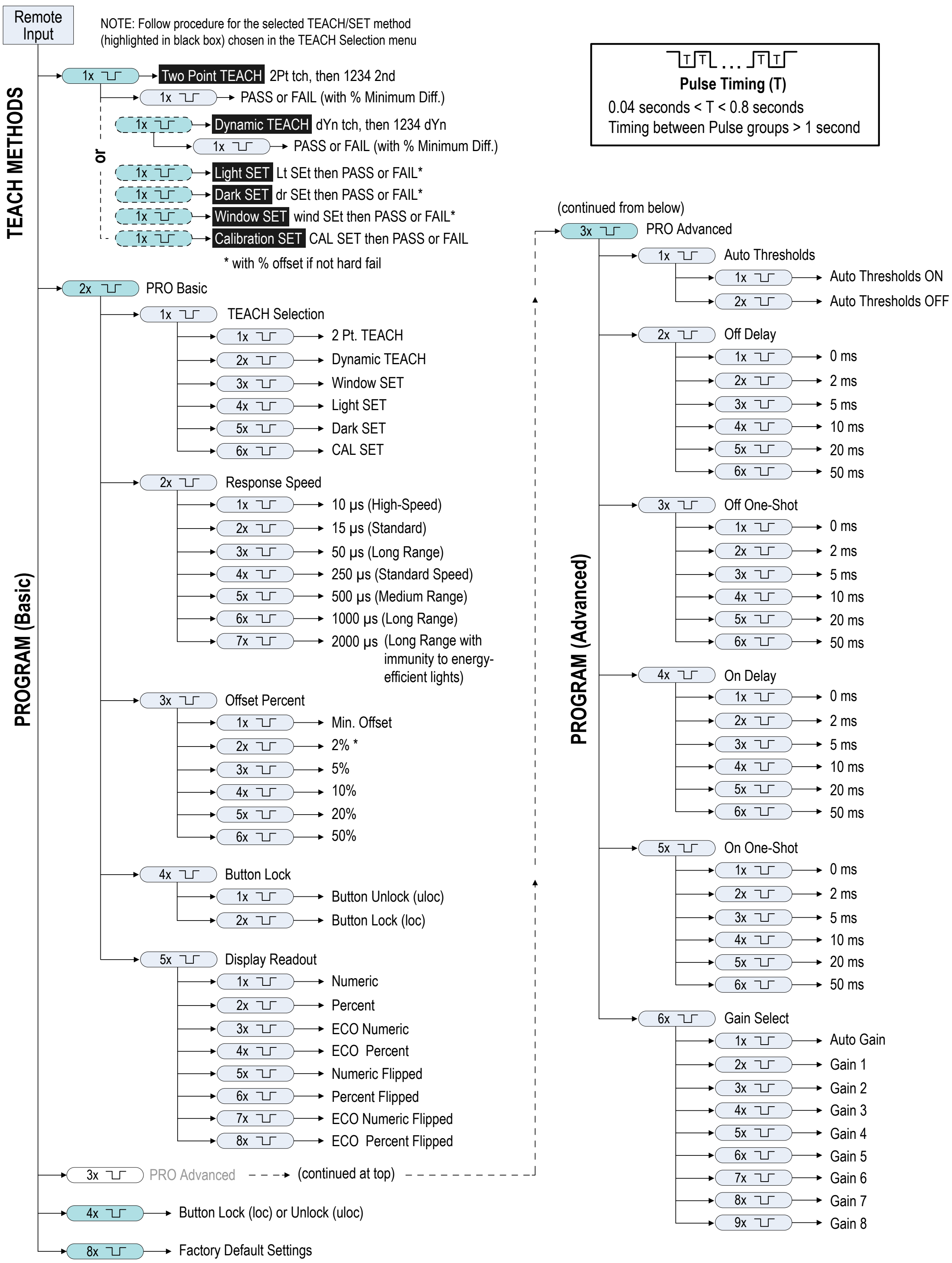
The readout of the digital displays can be programmed for the following options:

- Signal/Threshold readout - Numeric (1234) or % (123P)
- ECO mode - Enabled or Disabled (ECO mode dims the displays to reduce current consumption)
- Display Orientation - Normal (1234) or Flipped (1234)

3.3 Remote Input

The remote input may be used to perform TEACH/SET methods and to program the sensor remotely. Connect the white input wire of the sensor to ground (0 V dc), with a remote switch connected between them. Pulse the remote input according to the diagram shown in *Figure 4* on page 11. Follow the instructions in the TEACH/SET sections in *Adjust Mode* on page 12 to perform a TEACH/SET method.

The sensor exits TEACH and remote programming modes after a 60 second timeout. Users may exit TEACH and remote programming modes by setting the remote input low for more than 2 seconds. In either case, the sensor returns to Run mode without saving any new settings.



* In Super High-Speed and High-Speed Responses, 2% offset is forced to Min. Offset

Figure 4. Remote Input Flowchart

3.4 Adjust Mode 

Sliding the RUN/PRG/ADJ mode switch to the ADJ position allows the user to perform Expert TEACH/SET methods and Manual Adjustment of the threshold(s).

3.4.1 Two-Point TEACH

- Establishes a single switching threshold
- Threshold can be adjusted by using the "+" and "-" rocker button (Manual Adjust)

Two-Point TEACH is used when two conditions can be presented statically to the sensor. The sensor locates a single sensing threshold (the switch point) midway between the two taught conditions, with the Output ON condition on one side, and the Output OFF condition on the other.

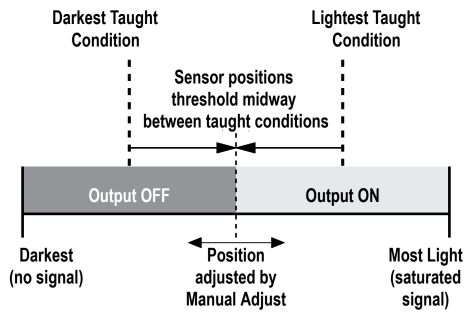


Figure 5. Two-Point TEACH (Light Operate shown)

The Output ON and OFF conditions can be reversed by using the LO/DO (Light Operate/ Dark Operate) switch.

Two-Point TEACH and Manual Adjust
Moves switching threshold value up or down to make adjustments

- Slide Mode switch to ADJ to enter Adjust mode
- Press "+" to increase; press "-" to decrease
  - GREEN display shows the switching threshold value
  - 2 seconds after adjustment, the GREEN display will flash 3 times to confirm
- Slide Mode switch to RUN to complete operation

Remember: Manual adjustments are disabled when Auto Thresholds are ON

Follow these steps to perform a Two-Point TEACH:

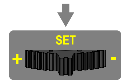
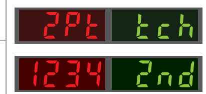
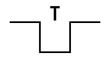
Note: TEACH Selection must be programmed to 2Pt tcH.

1. Enter Adjust mode.

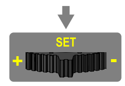
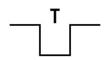
Method	Action	Result
SET Button [3]	Set the Mode switch to ADJ. 	Display: Red - Signal Level; Green - Threshold 
Remote Input [4]	No action is required; sensor is ready for the Two-Point TEACH method	

2. Teach the first condition.

[3] SET Button: 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[4] Remote Input: 0.04 seconds ≤ T ≤ 0.8 seconds

Method	Action	Result
SET Button	a. Present the first condition. b. Click the SET rocker button. 	Display: Flashes "2Pt tch" then holds on "1234 2nd" 
Remote Input	a. Present the first condition. b. Single-pulse the remote input. 	

3. Teach the second condition.

Method	Action	Result
SET Button	a. Present the second condition. b. Click the SET rocker button. 	TEACH Accepted Displays alternate "PASS" and % Minimum Difference[5]; Sensor returns to Adjust mode  TEACH Not Accepted Displays alternate "FAIL" and % Minimum Difference[5]; Sensor returns to Adjust mode 
Remote Input	a. Present the second condition. b. Single-pulse the remote input. 	

4. Return to Run mode.

Method	Action	Result
SET Button	Move the Mode switch to RUN 	Display: Red - Signal Level; Green - Threshold 
Remote Input	No action is required; sensor returns to RUN mode automatically	

3.4.2 Dynamic TEACH

- Teaches on-the-fly
- Establishes a single switching threshold
- Threshold can be adjusted using "+" and "-" rocker button (Manual Adjust)

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

[5] See *Troubleshooting* on page 21 for more explanation of the % Minimum Difference displayed after the Two-Point TEACH method.

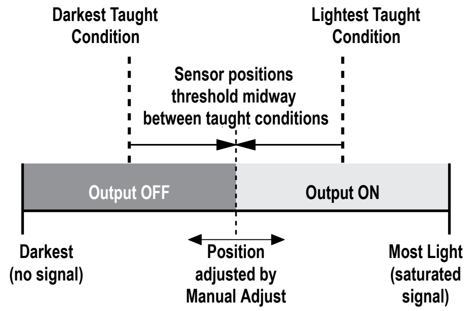


Figure 6. Dynamic TEACH (Light Operate shown)

The output ON and OFF conditions can be reversed using the LO/DO switch.

Dynamic TEACH and Manual Adjust

Moves switching threshold value up or down to make adjustments

- Slide Mode switch to ADJ to enter Adjust mode
- Press "+" to increase; press "-" to decrease
  - GREEN display shows the switching threshold value
  - 2 seconds after adjustment, GREEN display will flash 3 times to confirm
- Slide Mode switch to RUN to complete operation

Remember: Manual adjustments are disabled when Auto Thresholds are ON

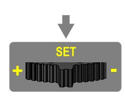
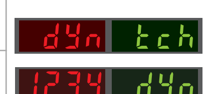
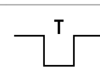
Follow these steps to perform Dynamic TEACH:

NOTE: TEACH Selection must be programmed to dYn tcH.

1. Enter Adjust Mode.

Method	Action	Result
SET Button [6]	Set Mode switch to ADJ 	Display: Red - Signal Level; Green - Threshold 
Remote Input [7]	No action required; sensor is ready for Dynamic TEACH method	

2. Enter Dynamic TEACH.

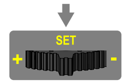
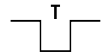
Method	Action	Result
SET Button	Click the SET rocker button 	Display: Flashes "dYn tch" then holds on "1234 dYn" 
Remote Input	Single-pulse remote input 	

3. Present ON and OFF Conditions.

Method	Action	Result
SET Button	Present ON and OFF conditions	Display: Red - Signal Level; Green - Threshold 
Remote Input	Present ON and OFF conditions	

[6] SET Button: 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[7] Remote Input: 0.04 seconds ≤ T ≤ 0.8 seconds

4. Exit Dynamic TEACH.

Method	Action	Result
SET Button	Click the SET rocker button 	TEACH Accepted Displays alternate "PASS" with % Minimum Difference[8], Sensor returns to Adjust mode  TEACH Not Accepted Displays alternate "FAIL" with % Minimum Difference[8], Sensor returns to Adjust mode 
Remote Input	Single-pulse remote input 	

5. Return to RUN Mode.

Method	Action	Result
SET Button	Move Mode switch to RUN 	Display: Red - Signal Level; Green - Threshold 
Remote Input	No action required; sensor returns to RUN mode automatically	

3.4.3 Window SET

- Sets window thresholds that extend a programmable % offset above and below the presented condition
- All other conditions (lighter or darker) cause the output to change state
- Sensing window center can be adjusted using "+" and "-" rocker button (Manual Adjust)
- Recommended for applications where a product may not always appear in the same place, or when other signals may appear
- See Program Mode for programming the Offset Percent setting

A single sensing condition is presented, and the sensor positions window thresholds a programmable % offset above and below the presented condition. In LO mode, Window SET designates a sensing window with the Output ON condition inside the window, and the Output OFF conditions outside the window.

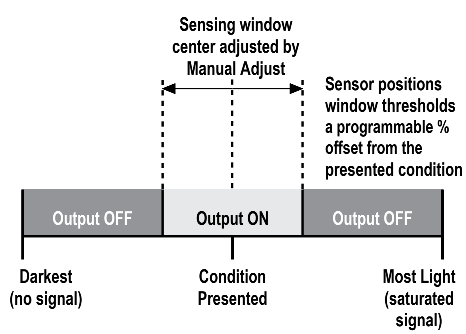


Figure 7. Window SET (Light Operate shown)

Output ON and OFF conditions can be reversed using the LO/DO switch.

[8] See *Troubleshooting* on page 21 for more explanation of the % Minimum Difference displayed after the Dynamic TEACH method.

Window SET and Manual Adjust

Moves sensing window center value up or down to make adjustments

- Slide Mode switch to ADJ to enter Adjust mode
- Press "+" to increase; press "-" to decrease
  - GREEN display shows the sensing window center value
  - 2 seconds after adjustment, the GREEN display will flash 3 times to confirm
- Slide Mode switch to RUN to complete operation

Remember: Manual adjustments are disabled when Auto Thresholds are ON

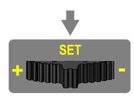
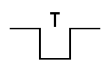
Follow these steps to perform a Window SET:

Note: TEACH Selection must be programmed to wind SEt.

1. Enter Adjust Mode

Method	Action	Result
SET Button [9]	Set Mode switch to ADJ 	Display: Red - Signal Level; Green - Threshold 
Remote Input [10]	No action required; sensor is ready for Window SET method	

2. SET Sensing Condition

Method	Action	Result
SET Button	• Present sensing condition • Click the SET rocker button 	Threshold Condition Accepted Displays read "w I nd SEt" then alternate "PASS" with % Offset[11]; Sensor returns to Adjust mode  Threshold Condition Not Accepted Displays read "w I nd SEt" then alternate "FA I L" with minimum % Offset[11] for sensing condition; Sensor returns to Adjust mode 
Remote Input	• Present sensing condition • Single-pulse the remote input 	

3. Return to RUN Mode

Method	Action	Result
SET Button	Move Mode switch to Run 	Display: Red - Signal Level; Green - Window Center (see *Figure 8* on page 17 for instructions on how to display upper and lower thresholds) 
Remote Input	No action required; sensor returns to Run mode automatically	

9 SET Button: 0.04 seconds ≤ "Click" ≤ 0.8 seconds
10 Remote Input: 0.04 seconds ≤ T ≤ 0.8 seconds
11 See *Troubleshooting* on page 21 for more explanation of the % Offset displayed after the Window SET method

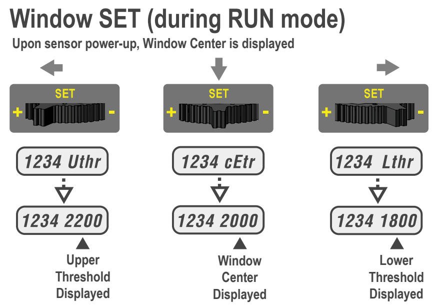


Figure 8. Upper and Lower Thresholds

3.4.4 Light SET

- Sets a threshold a programmable % offset below the presented condition
- Changes output state on any condition darker than the threshold condition
- Threshold can be adjusted using "+" and "-" rocker button (Manual Adjust)
- Recommended for applications where only one condition is known, for example a stable light background with varying darker targets
- See Program Mode for programming the Offset Percent setting

A single sensing condition is presented, and the sensor positions a threshold a programmable % offset below the presented condition. When a condition darker than the threshold is sensed, the output either turns ON or OFF, depending on the LO/DO setting.

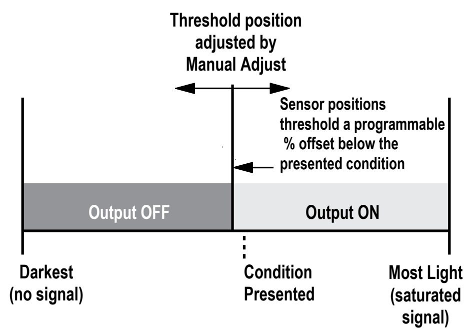


Figure 9. Light SET (Light Operate shown)

Light SET and Manual Adjust

Moves switching threshold value up or down to make adjustments

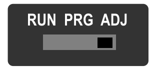
- Slide Mode switch to ADJ to enter Adjust mode
- Press "+" to increase; press "-" to decrease
    - GREEN display shows the switching threshold value
    - 2 seconds after adjustment, the GREEN display will flash 3 times to confirm
- Slide Mode switch to RUN to complete operation

Remember: Manual adjustments are disabled when Auto Thresholds are ON

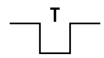
Follow these steps to perform a Light SET:

Note: TEACH Selection must be programmed to Lt SEt.

1. Enter Adjust Mode

Method	Action	Result
SET Button [12]	Set Mode switch to ADJ 	Display: Red - Signal Level; Green - Threshold 
Remote Input [13]	No action is required; sensor is ready for Light SET method	

2. SET Sensing Condition

Method	Action	Result
SET Button	• Present sensing condition • Click the SET rocker button 	Threshold Condition Accepted Displays read "Lt SEt" then alternate "PASS" with % Offset[14]; Sensor returns to Adjust mode  Threshold Condition Not Accepted Displays read "Lt SEt" then alternate "FAIL" with minimum % Offset[14] for sensing condition; Sensor returns to Adjust mode 
Remote Input	• Present sensing condition • Single-pulse the remote input 	

3. Return to RUN Mode

Method	Action	Result
SET Button	Move Mode switch to RUN 	Display: Red - Signal Level; Green - Threshold 
Remote Input	No action required; sensor returns to RUN mode automatically	

3.4.5 Dark SET

- Sets a threshold a programmable % offset above the presented condition
- Any condition lighter than the threshold condition causes the output to change state
- Threshold can be adjusted using "+" and "-" rocker button (Manual Adjust)
- Recommended for applications where only one condition is known, for example a stable dark background with varying lighter targets
- See Program Mode for programming the Offset Percent setting

NOTE: Offset Percent MUST be programmed to Minimum Offset to accept conditions of no signal (0 counts).

A single sensing condition is presented, and the sensor positions a threshold a programmable % offset above the presented condition. When a condition lighter than the threshold is sensed, the output either turns ON or OFF, depending on the LO/DO setting.

12 SET Button: 0.04 seconds ≤ "Click" ≤ 0.8 seconds
13 Remote Input: 0.04 seconds ≤ T ≤ 0.8 seconds
14 See *Troubleshooting* on page 21 for more explanation of the % Offset displayed after the Light SET method

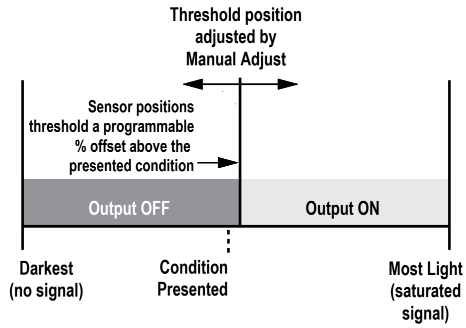


Figure 10. Dark SET (Light Operate shown)

Dark SET and Manual Adjust

Moves switching threshold value up or down to make adjustments

- Slide Mode switch to ADJ to enter Adjust mode
- Press "+" to increase; press "-" to decrease
  - GREEN display shows the switching threshold value
  - 2 seconds after adjustment, the GREEN display will flash 3 times to confirm
- Slide Mode switch to RUN to complete operation

> Remember: Manual adjustments are disabled when Auto Thresholds are ON

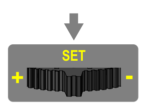
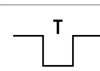
Follow these steps to perform a Dark SET:

> Note: TEACH Selection must be programmed to dr SEt.

1. Enter Adjust Mode.

Method	Action	Result
SET Button [15]	Set Mode switch to ADJ 	Display: Red - Signal Level; Green - Threshold 
Remote Input [16]	No action required; sensor is ready for Dark SET method	

2. SET Sensing Condition.

Method	Action	Result
SET Button	• Present sensing condition • Click the SET rocker button 	Threshold Condition Accepted Displays read "dr SEt" then alternate "PASS" with % Offset[17]; Sensor returns to Adjust mode  Threshold Condition Not Accepted Displays read "dr SEt" then alternate "FAIL" with minimum % Offset[17] for sensing condition; Sensor returns to Adjust mode 
Remote Input	• Present sensing condition • Single-pulse the remote input 	

[15] SET Button: 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[16] Remote Input: 0.04 seconds ≤ T ≤ 0.8 seconds
[17] See *Troubleshooting* on page 21 for more explanation of the % Offset displayed after the Dark SET method

3. Return to RUN Mode.

Method	Action	Result
SET Button	Move Mode switch to RUN 	Display: Red - Signal Level; Green - Threshold 
Remote Input	No action required; sensor returns to RUN mode automatically	

3.4.6 Calibration SET

- Sets a threshold exactly at the presented condition
- Threshold can be adjusted using "+" and "-" rocker button (Manual Adjust)

A single sensing condition is presented, and the sensor positions a threshold exactly at the presented condition. When a condition lighter than the threshold is sensed, the output either turns ON or OFF, depending on the LO/DO setting.

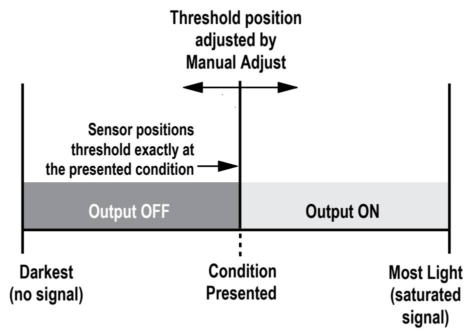


Figure 11. Calibration SET (Light Operate shown)

Calibration SET and Manual Adjust
Moves switching threshold value up or down to make adjustments

- Slide Mode switch to ADJ to enter Adjust mode
- Press "+" to increase; press "-" to decrease
    - GREEN display shows the switching threshold value
    - 2 seconds after adjustment, the GREEN display will flash 3 times to confirm
- Slide Mode switch to RUN to complete operation

Remember: Auto Thresholding is automatically disabled in Calibration SET

Follow these steps to perform a Calibration SET:

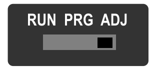
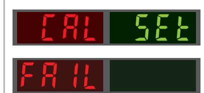
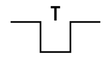
Note: TEACH Selection must be programmed to CAL SEt.

1. Enter Adjust Mode

Method	Action	Result
SET Button [18]	• Set Mode switch to ADJ 	Display: Red - Signal Level; Green - Threshold 
Remote Input [19]	No action required; sensor is ready for Calibration SET method	

2. SET Sensing Condition

[18] SET Button: 0.04 seconds ≤ "Click" ≤ 0.8 seconds
[19] Remote Input: 0.04 seconds ≤ T ≤ 0.8 seconds

Method	Action	Result
SET Button	• Present sensing condition • Click the SET rocker button 	Threshold Condition Accepted Displays read "cAL SEt" then flashes "PASS"; Sensor returns to Adjust mode  Threshold Condition Unacceptable Displays read "cAL SEt" then flashes "FAIL"; Sensor returns to Adjust mode 
Remote Input	• Present sensing condition • Single-pulse the remote input 	

3. Return to RUN Mode

Method	Action	Result
SET Button	Move Mode switch to RUN 	Display: Red - Signal Level; Green - Threshold 
Remote Input	No action required; sensor returns to RUN mode automatically	

3.4.7 Troubleshooting

Manual Adjustments Disabled

Manual adjustments are disabled when Auto Thresholds are ON. If a manual adjustment is attempted while Auto Thresholds are ON, the Green display will flash  .

Percent Minimum Difference after TEACH

The Two-Point and Dynamic TEACH methods will flash a % minimum difference on the displays after a PASS or FAIL.

Value	PASS/FAIL	Description
0 to 99%	FAIL	The difference of the taught conditions does not meet the required minimum
100 to 300%	PASS	The difference of the taught conditions just meets/exceeds the required minimum, minor sensing variables may affect sensing reliability
300 to 600%	PASS	The difference of the taught conditions sufficiently exceeds the required minimum, minor sensing variables will not affect sensing reliability
600% +	PASS	The difference of the taught conditions greatly exceeds the required minimum, very stable operation

Percent Offset after SET

The Window, Dark, and Light SET methods will flash a % offset on the displays after a PASS or FAIL.

SET Result	% Offset Meaning
PASS (with % Offset)	Displays the % offset used for the SET method
FAIL (with % Offset)	Displays the minimum required % offset necessary to PASS the SET method
FAIL (without % Offset)	Presented condition cannot be used for the SET method

Threshold Alert or Threshold Error

Severe contamination/changes in the taught condition can prevent the Auto Thresholds algorithm from optimizing the threshold(s).

State	Display	Description	Corrective Action
Threshold Alert	Alternates thr ALrt and 1234 1234	The threshold(s) cannot be optimized, but the sensor's output will still continue to function	Cleaning/correcting the sensing environment and/or a re-teach of the sensor is highly recommended
Threshold Error	thr Err	The threshold(s) cannot be optimized, and the sensor's output will stop functioning	Cleaning/correcting the sensing environment and/or a re-teach of the sensor is required

4 Specifications

Sensing Beam
DF-G2: Visible red, 635 nm
DF-G2W: Broad spectrum white, 450 nm to 650 nm
DF-G2B: Visible blue, 470 nm
DF-G2G: Visible green, 525 nm
DF-G2IR: Infrared, 850 nm

Supply Voltage
10 to 30 V dc Class 2 (10% maximum ripple)

Power and Current Consumption (exclusive of load)
Standard display mode: 960 mW, Current consumption < 40 mA at 24 V dc
ECO display mode: 720 mW, Current consumption < 30 mA at 24 V dc

Supply Protection Circuitry
Protected against reverse polarity and transient overvoltages

Delay at Power-Up
500 milliseconds maximum; outputs do not conduct during this time

Output Configuration
1 current sinking (NPN) or 1 current sourcing (PNP) output, depending on model

Output Rating
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

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

Output Response Time
Super High Speed: 10 µs
High Speed: 15 µs
Fast: 50 µs
Standard: 250 µs
Medium Range: 500 µs
Long Range: 1000 µs
Long Range with immunity to Energy Efficient Lights: 2000 µs

Repeatability
Super High Speed: 5 µs
High Speed: 5 µs
Fast: 12 µs
Standard: 50 µs
Medium Range: 80 µs
Long Range: 165 µs
Long Range with immunity to Energy Efficient Lights: 165 µs

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

Adjustments
3-way RUN/PRG/ADJ Mode Switch
2-way LO/DO Switch
3-way +/SET/- Rocker Button
- Expert-style teaching (Two-Point and Dynamic TEACH, Light/Dark/Window/Calibration SET)
- Manually adjust sensitivity (from "+" and "-" rocker button only)
- Response Speed, TEACH Selection, Offset Percent, Auto Thresholds, Delays/Timers, Display Readout, Gain Selection, Factory Defaults (from top panel or remote input)
- Top panel interface lockout (from remote input only)

Factory Default Settings:

Setting	Factory Default
Threshold	2011
TEACH Selection	Two-Point TEACH
Response Speed	Standard: 250 µs
Offset Percent	10%
Auto Thresholds	OFF
OFF Delay	0 (Disabled)
OFF One-Shot	0 (Disabled)
ON Delay	0 (Disabled)
ON One-Shot	0 (Disabled)
Display Readout	Numeric, ECO disabled, Normal Orientation
Gain Selection	Auto Gain

Indicators
Red 4-digit Display: Signal Level
Green 4-digit Display: Threshold
(In Program Mode, Red and Green displays are used for programming menus)
Yellow LED: Output conducting

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.) 4-wire integral cable; or integral 4-pin M8/Pico-style quick disconnect; or 150 mm (6 in.) cable with a 4-pin M12/Euro-style quick disconnect; or 150 mm (6 in.) cable with a 4-pin M8/Pico-style quick disconnect.

Environmental Rating
IEC IP50, NEMA 1

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)
Humidity: 90% at +60 °C maximum relative humidity (non-condensing)

Certifications
CE
c UL us LISTED Industrial Control Equipment 3TJJ

4.1 Excess Gain Curves

The excess gain curves shown are for the standard red LED emitter models. Multiplication factors for the other colored LEDs (with respect to the red LED values) are:

- White 0.5
- Green 0.6
- Blue 0.7
- IR850—see IR850 excess gain curves

The data in the charts that is labeled for the Long Range application apply to both the 1000 µs and 2000 µs response speeds.

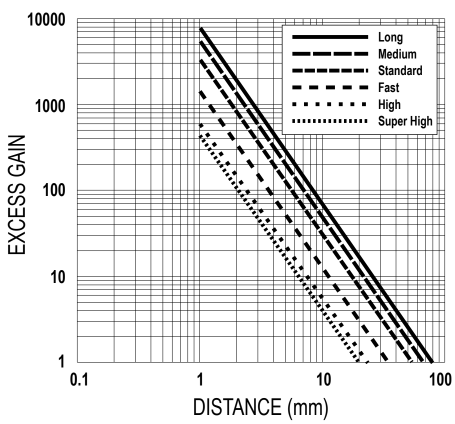


Figure 12. PIT16U-Opposed Mode

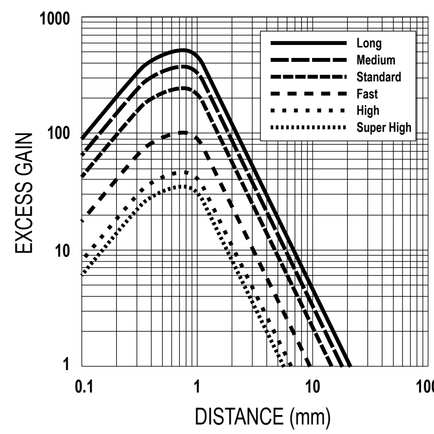


Figure 13. PBT16U-Diffuse Mode

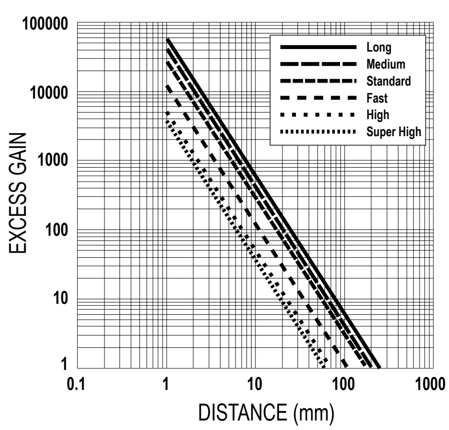


Figure 14. PIT26U-Opposed Mode

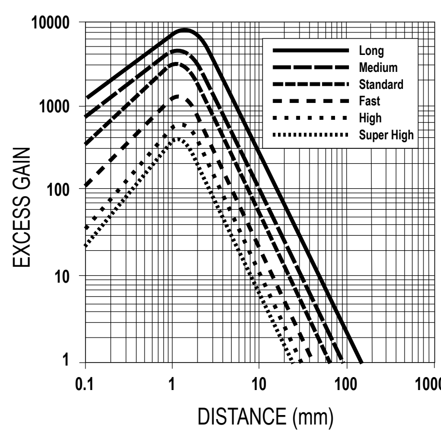


Figure 15. PBT26U-Diffuse Mode

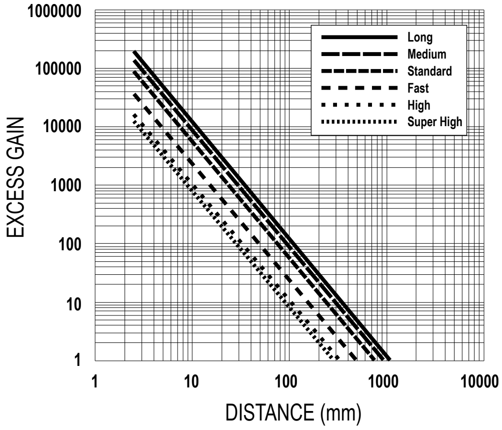


Figure 16. PIT46U-Opposed Mode

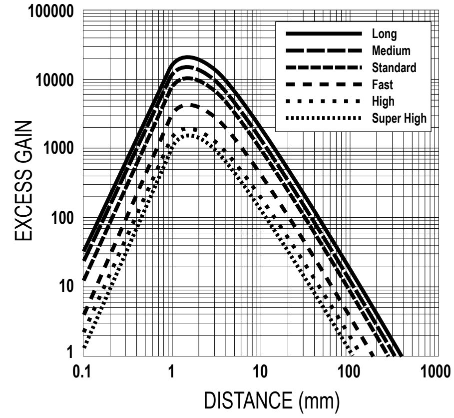


Figure 17. PBT46U-Diffuse Mode

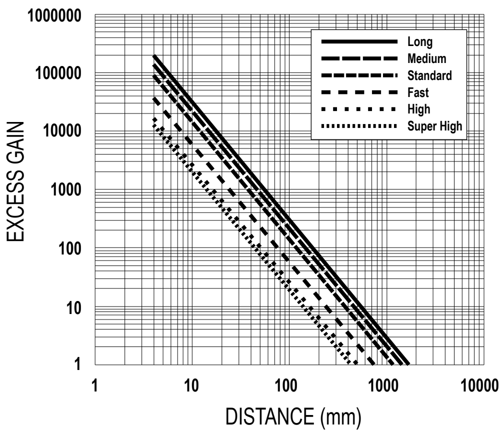


Figure 18. PIT66U-Opposed Mode

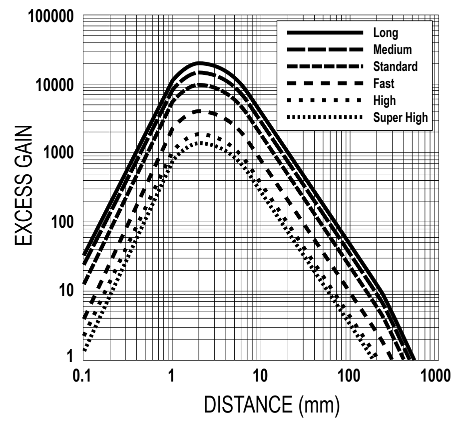


Figure 19. PBT66U-Diffuse Mode

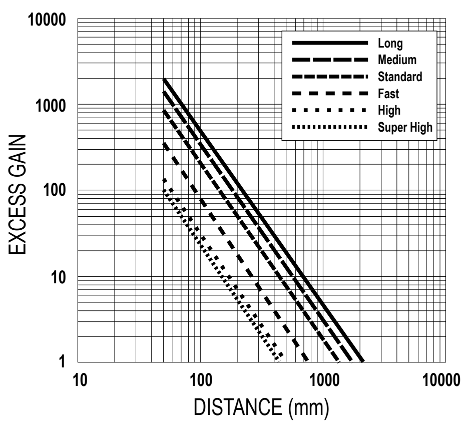


Figure 20. IR850-Opposed Mode

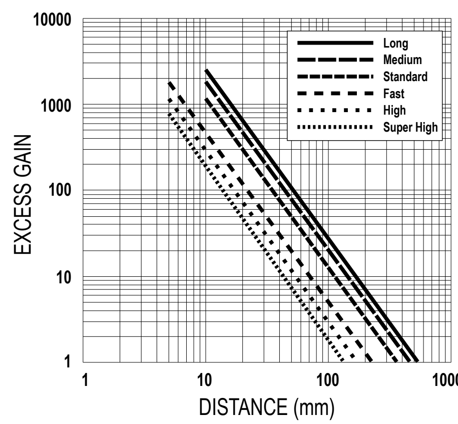


Figure 21. IR850-Diffuse Mode

NOTE: IT.83.3ST5M6 glass fiber used for opposed mode

NOTE: BTC1.13.4ST5M6 glass fiber used for diffuse mode

4.2 Beam Patterns

The beam patterns shown are for the standard red LED emitter models. Multiplication factors for the other colored LEDs (with respect to the red LED values) are:

- White 0.5
- Green 0.6
- Blue 0.7
- IR850—see the IR850 beam patterns

The data in the charts that is labeled for the Long Range application apply to both the 1000 µs and 2000 µs response speeds.

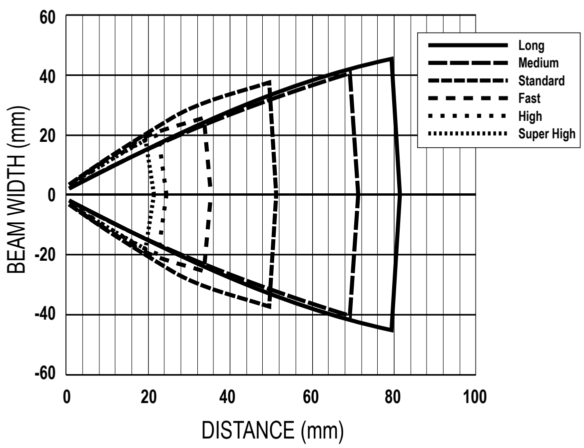


Figure 22. PIT16U-Opposed Mode

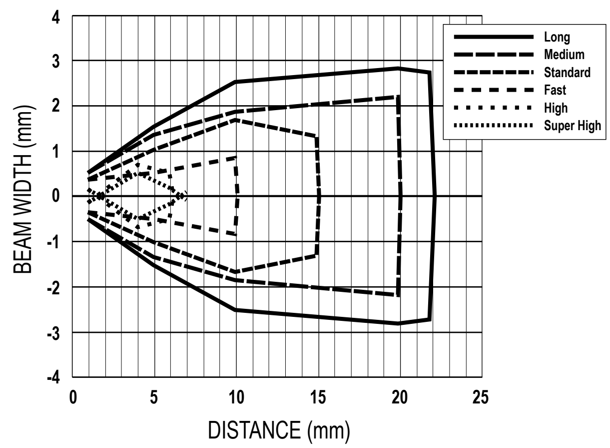


Figure 23. PBT16U-Diffuse Mode

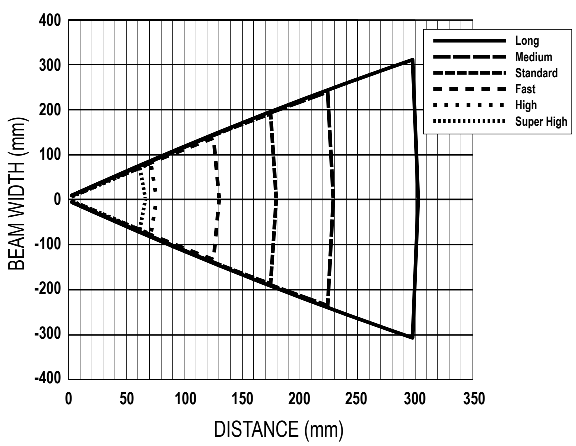


Figure 24. PIT26U-Opposed Mode

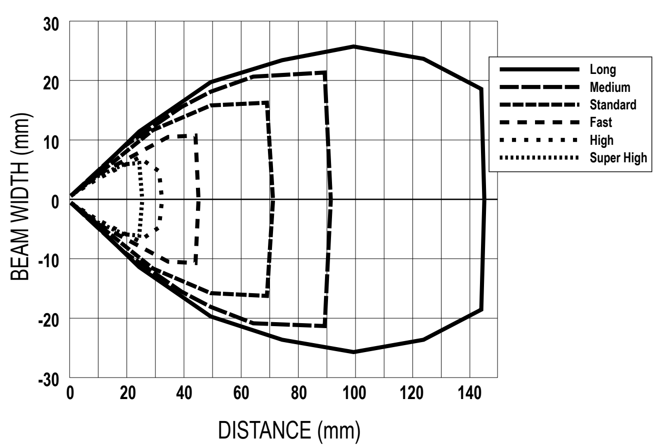


Figure 25. PBT26U-Diffuse Mode

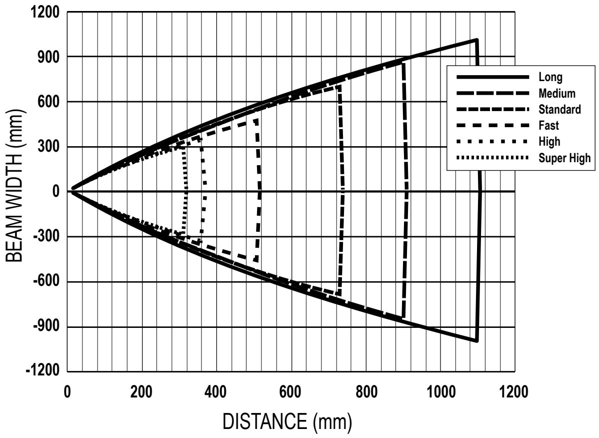


Figure 26. PIT46U-Opposed Mode

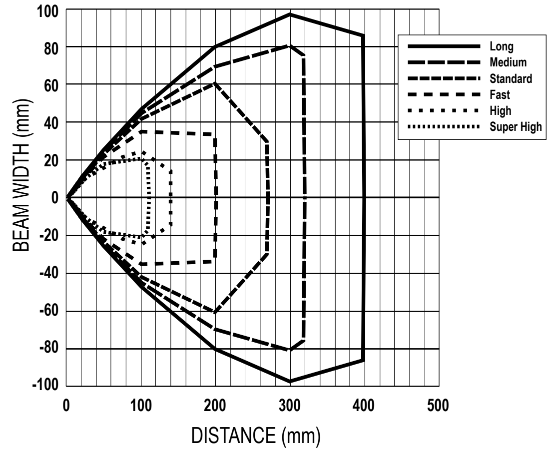


Figure 27. PBT46U-Diffuse Mode

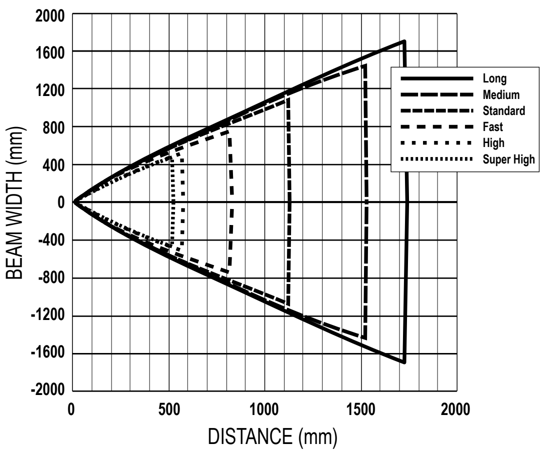


Figure 28. PIT66U-Opposed Mode

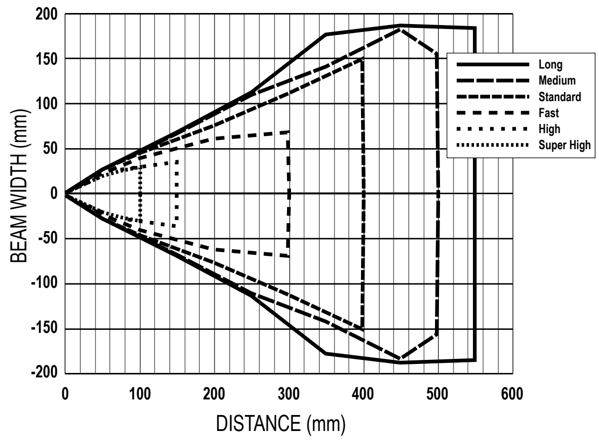


Figure 29. PBT66U-Diffuse Mode

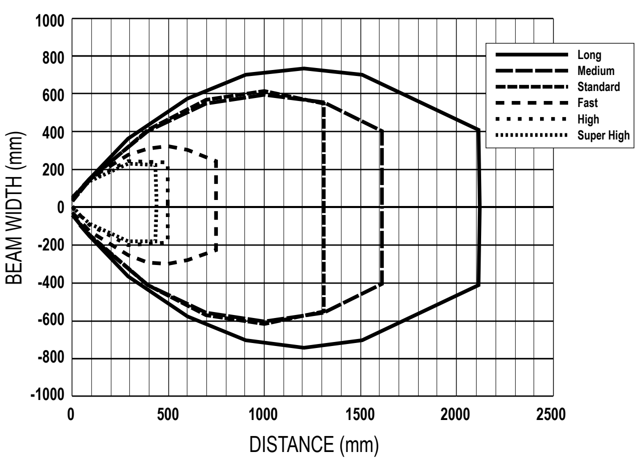


Figure 30. IR850-Opposed Mode

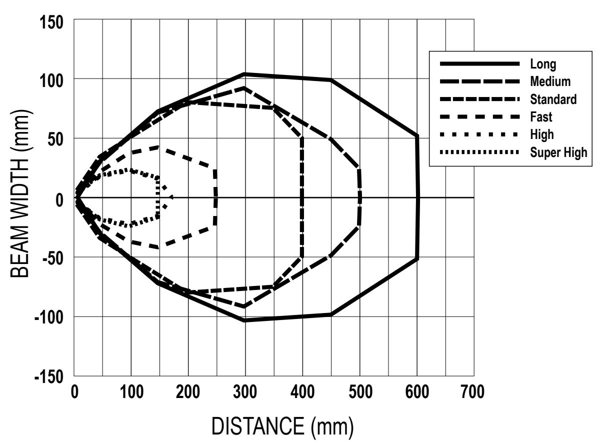
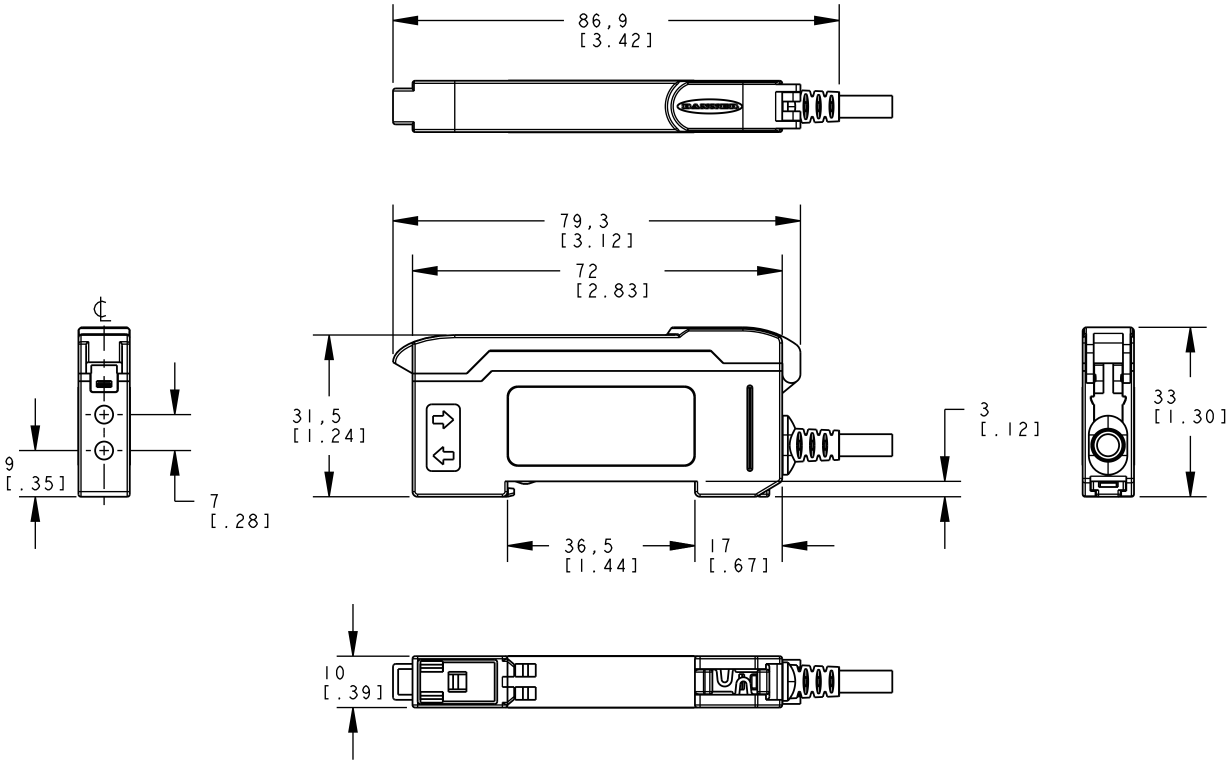


Figure 31. IR850-Diffuse Mode

NOTE: IT.83.3ST5M6 glass fiber used for opposed mode

NOTE: BTC1.13.4ST5M6 glass fiber used for diffuse mode

4.3 Dimensions

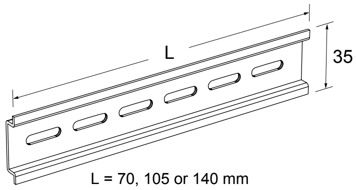


5 Accessories

DIN-35-..

35 mm DIN Rail

Model	Length
DIN-35-70	70
DIN-35-105	105
DIN-35-140	140

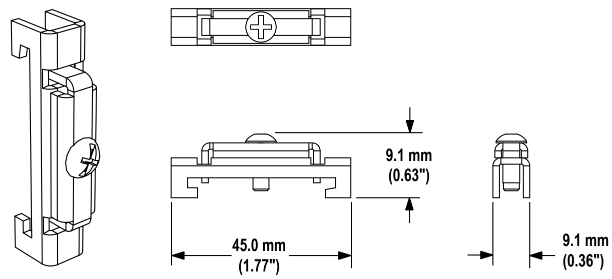


Hole center spacing: 35.1

Hole size: 25.4 x 5.3

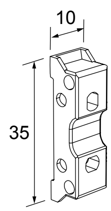
SA-DIN-CLAMP

- 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-DIN-BRACKET

- Plastic bracket with mounting screws

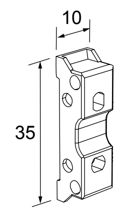


Hole center spacing: A = 16, B = 25.4, C = 15.2

Hole size: A = ø 3.2, B = ø 3.3, C = ø 4.4

SA-DIN-BRACKET-10

- Package of 10 plastic brackets with mounting screws

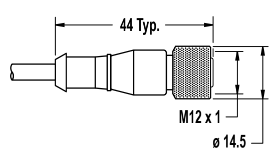
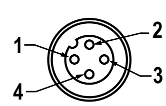
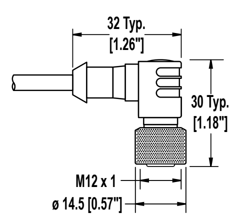


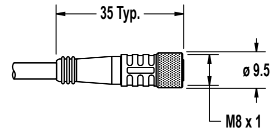
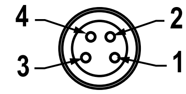
Hole center spacing: A = 16, B = 25.4, C = 15.2

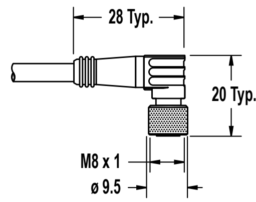
Hole size: A = ø 3.2, B = ø 3.3, C = ø 4.4

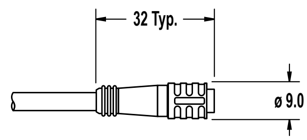
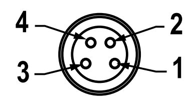
5.1 Quick-Disconnect Cordsets

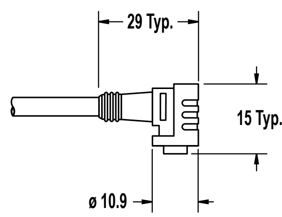
All measurements are listed in millimeters, unless noted otherwise.

4-Pin Threaded M12/Euro-Style Cordsets				
Model	Length	Style	Dimensions	Pinout (Female)
MQDC-406	1.83 m (6 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black
MQDC-415	4.57 m (15 ft)			
MQDC-430	9.14 m (30 ft)			
MQDC-450	15.2 m (50 ft)			
MQDC-406RA	1.83 m (6 ft)	Right-Angle		
MQDC-415RA	4.57 m (15 ft)			
MQDC-430RA	9.14 m (30 ft)			
MQDC-450RA	15.2 m (50 ft)			

<table>
<tr><th colspan="5">4-Pin Threaded M8 / Pico-Style Cordsets</th></tr>
<tr><th>Model</th><th>Length</th><th>Style</th><th>Dimensions</th><th>Pinout (Female)</th></tr>
<tr><td>PKG4M-2</td><td>2 m (6.56 ft)</td><td rowspan="3">Straight</td><td rowspan="3">
</td><td rowspan="6">

1 = Brown
2 = White
3 = Blue
4 = Black</td></tr>
<tr><td>PKG4M-5</td><td>5 m (16.4 ft)</td></tr>
<tr><td>PKG4M-9</td><td>9 m (29.5 ft)</td></tr>
<tr><td>PKW4M-2</td><td>2 m (6.56 ft)</td><td rowspan="3">Right Angle</td><td rowspan="3">
</td></tr>
<tr><td>PKW4M-5</td><td>5 m (16.4 ft)</td></tr>
<tr><td>PKW4M-9</td><td>9 m (29.5 ft)</td></tr>
</table>

<table>
<tr><th colspan="5">4-Pin Snap-on M8 / Pico-Style Cordsets</th></tr>
<tr><th>Model</th><th>Length</th><th>Style</th><th>Dimensions</th><th>Pinout (Female)</th></tr>
<tr><td>PKG4-2</td><td>2 m (6.6 ft)</td><td rowspan="3">Straight</td><td rowspan="3">
</td><td rowspan="5">

1 = Brown
2 = White
3 = Blue
4 = Black</td></tr>
<tr><td>PKG4-5</td><td>5 m (16.4 ft)</td></tr>
<tr><td>PKG4-10</td><td>10 m (32.8 ft)</td></tr>
<tr><td>PKW4Z-2</td><td>2 m (6.6 ft)</td><td rowspan="2">Right-Angle</td><td rowspan="2">
</td></tr>
<tr><td>PKW4Z-5</td><td>5 m (16.4 ft)</td></tr>
</table>

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