Q4X Stainless Steel Laser Sensor

Instruction Manual

Original Instructions
181483 Rev. K
19 September 2019

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181483

Contents

1 Product Description

Class 1 laser CMOS sensor with a discrete (PNP or NPN) output. Patent pending.

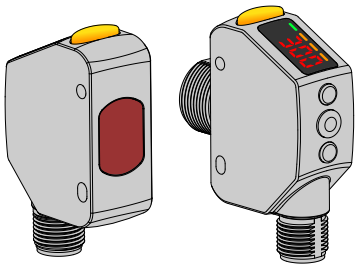


Figure 1. Flush Mount (Left) and Threaded Barrel (Right) Models

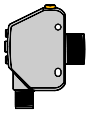
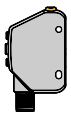
- The ultimate problem solver: reduce sensor inventory with a reliable, durable sensor that solves the most challenging applications
- Solves difficult distance-based applications regardless of target surface reflectivity, including black foam on black plastic, black rubber in front of metal, transparent objects, multicolor packaging, and targets of all colors
- Reliable sensing up to 500 mm (11.81 in) for threaded barrel models or up to 310 mm (12.2 in) for flush mount models, depending on model
- Best in class excess gain
- Angled four-digit display with submillimeter resolution is easily viewed from multiple vantage points
- Display provides clear user feedback for easy setup, and bright output indicator provides high visibility of sensor operation
- Intuitive setup using three tactile buttons conveniently located below the display
- Durable and robust construction resists mechanical impact, over tightening, and extreme vibration
- FDA grade stainless steel and plastics, ECOLAB® certified chemically-resistant materials, and laser marked sensor information withstands aggressive cleaning procedures
- Superior resistance to ambient light interference prevents nuisance output trips under changing lighting conditions
- Temperature-compensated design ensures reliable detection during changing temperature conditions

For illustration purposes, the threaded barrel model Q4X images are used throughout this document.

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 Range	Output	Connection[1]
	**Q4XTBLAF500-Q8**	25 mm to 500 mm (0.98 in to 19.68 in)	Bipolar: 1 NPN; 1 PNP	Integral 5-pin M12/Euro-style male quick disconnect
	Q4XTBLAF300-Q8	25 mm to 300 mm (0.98 in to 11.81 in)	Bipolar: 1 NPN; 1 PNP	
	Q4XTBLAF100-Q8	25 mm to 100 mm (0.98 in to 3.94 in)	Bipolar: 1 NPN; 1 PNP	
	**Q4XFNLAF310-Q8**	35 mm to 310 mm (1.38 in to 12.20 in)	NPN	Integral 4-pin M12/Euro-style male quick disconnect
	Q4XFPLAF310-Q8	35 mm to 310 mm (1.38 in to 12.20 in)	PNP	
	Q4XFNLAF110-Q8	35 mm to 110 mm (1.38 in to 4.33 in)	NPN	Integral 4-pin M12/Euro-style male quick disconnect
	Q4XFPLAF110-Q8	35 mm to 110 mm (1.38 in to 4.33 in)	PNP	

[1] QD models require a mating cordset.

1.2 Overview

The Q4X Sensor is a Class 1 laser CMOS sensor with a bipolar output. The normal sensor state is Run mode. From Run mode, the switch point value and LO/DO selection can be changed and the selected TEACH method can be performed. The secondary sensor state is Setup mode. From Setup mode, the TEACH mode can be selected, all standard operating parameters can be adjusted, and a factory reset can be done.

1.3 Features

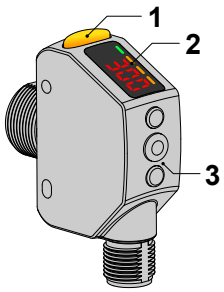


Figure 2. Sensor Features

1. Output Indicator (Amber)
2. Display
3. Buttons

1.3.1 Display and Indicators

The display is a 4-digit, 7-segment LED. The main screen is the Run mode screen.

For 2-pt, BGS, FGS, and DYN TEACH modes, the display shows the current distance to the target in millimeters. For dual TEACH mode, the display shows the percentage matched to the taught reference surface. A display value of 9999 indicates the sensor has not been taught.

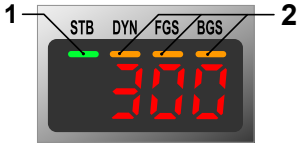


Figure 3. Display in Run Mode

1. Stability Indicator (STB—Green)
2. Active TEACH Indicators
   - DYN—Dynamic (Amber)
   - FGS—Foreground Suppression (Amber)
   - BGS—Background Suppression (Amber)

Output Indicator

- On—Outputs conducting (closed)
- Off—Outputs not conducting (open)

Stability Indicator (STB)

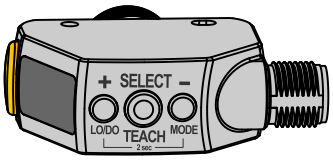
- On—Stable signal within the specified sensing range
- Flashing—Marginal signal, the target is outside the limits of the specified sensing range, or a multiple peak condition exists
- Off—No target detected within the specified sensing range

Active TEACH Indicators (DYN, FGS, and BGS)

- DYN, FGS, and BGS all off—Two-point TEACH mode selected (default)
- DYN on—Dynamic TEACH mode selected
- FGS on—Foreground suppression TEACH mode selected
- BGS on—Background suppression TEACH mode selected
- DYN, FGS, and BGS all on—Dual TEACH mode selected

1.3.2 Buttons

Use the sensor buttons **(SELECT)(TEACH)**, **(+)(DISP)**, and **(-)(MODE)** to program the sensor.



(SELECT)(TEACH)

- Press to select menu items in Setup mode
- Press and hold for longer than 2 seconds to start the currently selected TEACH mode (the default is two-point TEACH)

(-)(MODE)

- Press to navigate the sensor menu in Setup mode
- Press to change setting values; press and hold to decrease numeric values
- Press and hold for longer than 2 seconds to enter Setup mode

(+)(DISP)

- Press to navigate the sensor menu in Setup mode
- Press to change setting values; press and hold to increase numeric values
- Press and hold for longer than 2 seconds to switch between light operate (LO) and dark operate (DO)

Note: When navigating the menu, the menu items loop.

1.4 Laser Description and Safety Information

CAUTION: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. Do not attempt to disassemble this sensor for repair. A defective unit must be returned to the manufacturer.

Class 1 Lasers

Class 1 lasers are lasers that are safe under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.

Laser wavelength: 655 nm **Output:** < 0.20 mW **Pulse Duration:** 7 µs to 2 ms

2 Installation

2.1 Install the Safety Label

The safety label must be installed on Q4X sensors that are used in the United States.

Note: Position the label on the cable in a location that has minimal chemical exposure.

1. Remove the protective cover from the adhesive on the label.
2. Wrap the label around the Q4X cable, as shown.
3. Press the two halves of the label together.

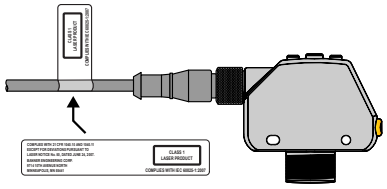


Figure 4. Safety Label Installation

2.2 Sensor Orientation

Optimize detection reliability and minimum object separation performance with correct sensor-to-target orientation. To ensure reliable detection, orient the sensor as shown in relation to the target to be detected.

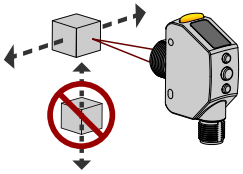


Figure 5. Optimal Orientation of Target to Sensor

See the following figures for examples of correct and incorrect sensor-to-target orientation as certain placements may pose problems for sensing some targets. The Q4X can be used in the less preferred orientation and provide reliable detection performance; refer to the *Performance Curves* for the minimum object separation distance required for each case.

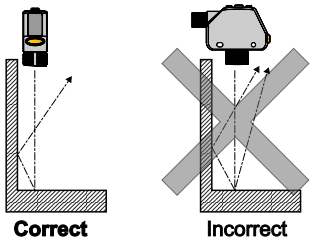


Figure 6. Orientation by a wall

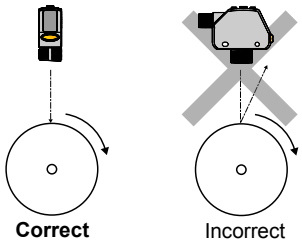


Figure 7. Orientation for a turning object

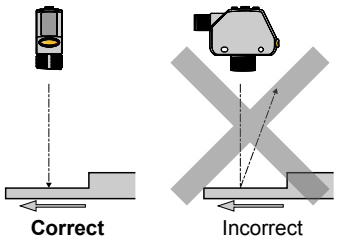


Figure 8. Orientation for a height difference

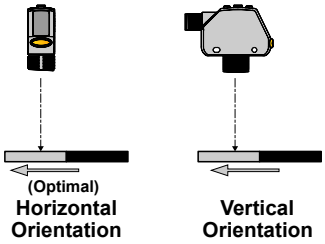


Figure 9. Orientation for a color or luster difference

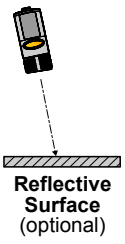


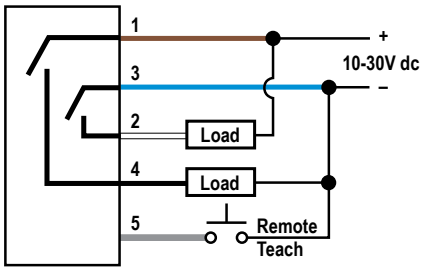
Figure 10. Orientation for highly reflective target[2]

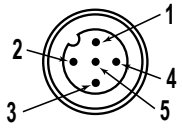
[2] *Applying tilt to sensor may improve performance on reflective targets. The direction and magnitude of the tilt depends on the application, but a 15° tilt is often sufficient.*

2.3 Mount the Device

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

2.4 Wiring Diagram—Threaded Barrel Models





Key

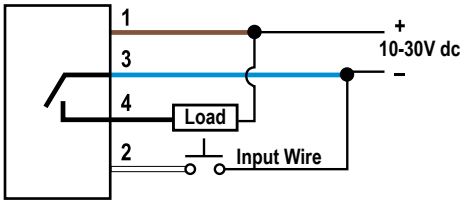
1 = Brown
2 = White
3 = Blue
4 = Black
5 = Gray

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

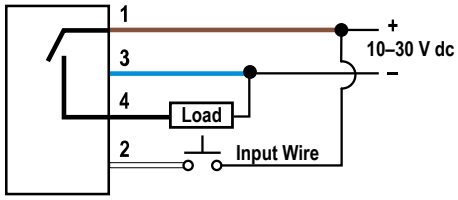
Note: The input wire function is user-selectable. The default for the input wire function is off (disabled).

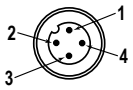
2.5 Wiring Diagram—Flush Mount Models

NPN Models



PNP Models





Key

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

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

Note: The input wire function is user-selectable. The default for the input wire function is off (disabled).

2.6 Cleaning and Maintenance

Handle the sensor with care during installation and operation. Sensor windows soiled by fingerprints, dust, water, oil, etc. may create stray light that may degrade the peak performance of the sensor. Blow the window clear using filtered, compressed air, then clean as necessary using only water and a lint-free cloth.

3 Sensor Programming

Program the sensor using the buttons on the sensor or the remote input (limited programming options).

In addition to programming the sensor, use the remote input to disable the buttons for security, preventing unauthorized or accidental programming changes. See *Locking and Unlocking the Sensor Buttons* (p. 17) for more information.

3.1 Light Operate/Dark Operate

The default output configuration is light operate. To switch between light operate and dark operate, use the following instructions:

1. Press and hold **LO/DO** for longer than 2 seconds. The current selection displays.
2. Press **LO/DO** again. The new selection flashes slowly.
3. Press **SELECT** to change the output configuration and return to Run mode.

Note: If neither **SELECT** nor **LO/DO** are pressed after step 2, the new selection flashes slowly for a few seconds, then flashes quickly and the sensor automatically changes the output configuration and returns to Run mode.

3.2 Setup Mode

Access Setup mode and the sensor menu from Run mode by pressing and holding **MODE** for longer than 2 seconds. Use  and  to navigate through the menu. Press **SELECT** to select a menu option and access the submenus. Use  and  to navigate through the submenus. Press **SELECT** to select a submenu option and return to the top menu, or press and hold **SELECT** for longer than 2 seconds to select a submenu option and return immediately to Run mode.

To exit Setup mode and return to Run mode, navigate to  and press **SELECT**.

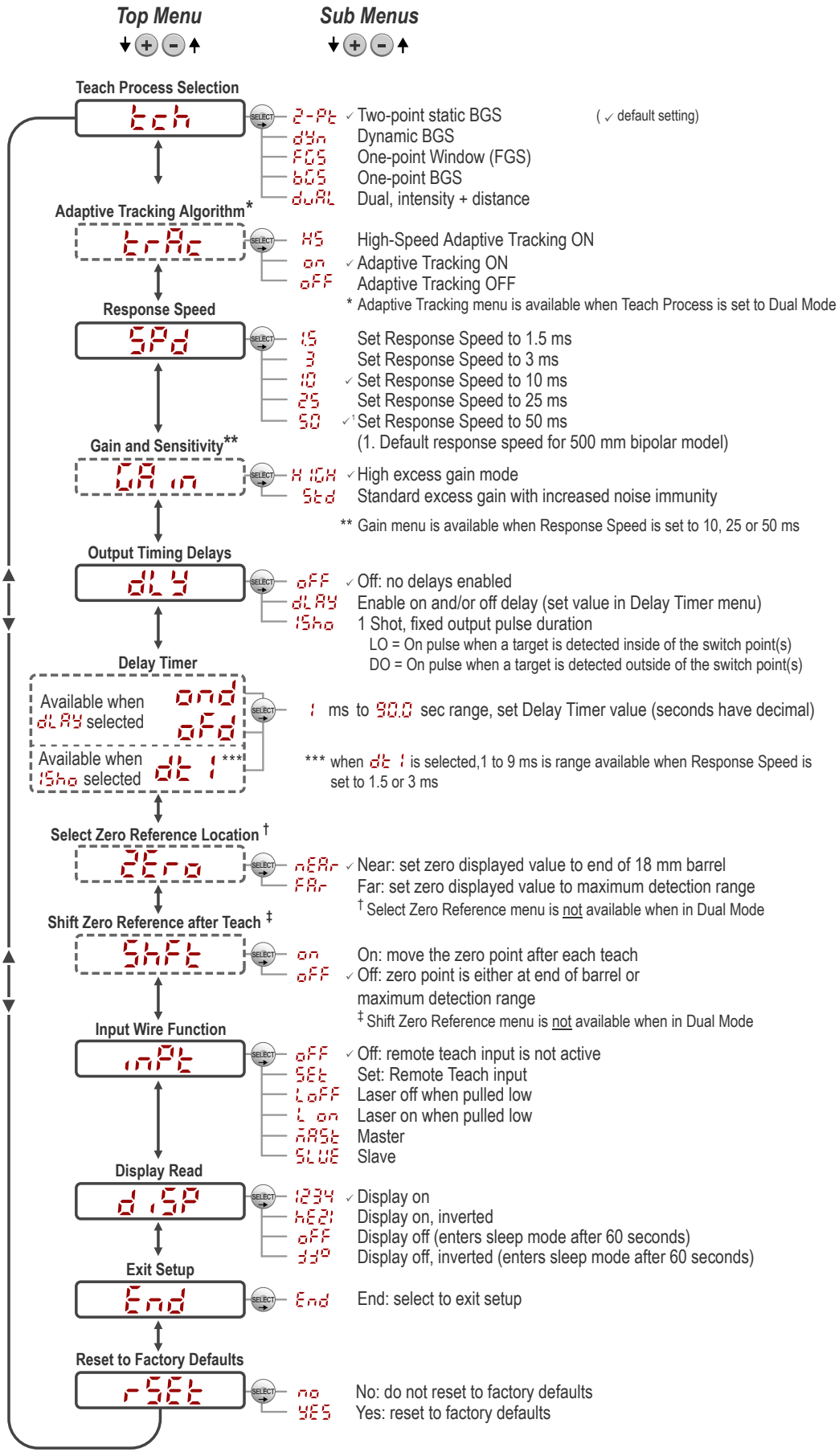


Figure 11. Sensor Menu Map—Channel 1

3.2.1 TEACH Mode tch

Use this menu to select the TEACH mode. The default is two-point TEACH.

- 2-Pt —Two-point static background suppression
- dyn —Dynamic background suppression
- FGS —One-point window (foreground suppression)
- bGS —One-point background suppression
- duAL —Dual (intensity + distance) window

After the TEACH mode is selected, from Run mode, press and hold **TEACH** for longer than 2 seconds to start the TEACH mode and program the sensor. See *TEACH Procedures* (p. 18) for additional information and remote input TEACH instructions.

3.2.2 Adaptive Tracking trc 1 and trc2

In adaptive tracking mode, the laser intensity changes to compensate for a loss in excess gain - normally caused by a dirty lens.

When operating in dual mode, the Adaptive Tracking Algorithm adjusts the switching thresholds (distance and intensity) around a taught reference surface. Adaptive tracking adjusts for small variations in the reference surface to maintain a consistent 100P (100%) on the display and to ensure reliable detection. The Adaptive Tracking menu is only available when Teach Ch1 is set to Dual Mode

Adjustment of the thresholds only occurs when the reference surface is visible to the senor (that is, no target is present). The Adaptive Tracking Algorithm can reduce or eliminate the need to periodically re-teach the sensor as environmental conditions change around the sensor.

Enable or disable the Adaptive Tracking Algorithm from the sensor menu. The appropriate speed depends on the application. This menu is available only if dual (intensity + distance) mode is selected. For Channel 2, the output must be set to light operate or dark operate.

Note: The number that follows **trc** on the display indicates which channel is selected.

- HS —High-Speed Adaptive Tracking On
- on —Adaptive Tracking On
- oFF —Adaptive Tracking Off (default)

OFF disables the Adaptive Tracking Algorithm—Prevents the sensor from adjusting the thresholds around the taught reference surface while the sensor is in dual mode. The sensor will not adapt to or learn any target. Environmental changes may cause the displayed value to deviate from 100P (100%) over time. A periodic re-teach of the reference surface may be required to restore the displayed value to 100P if this is important to the application.

There are some cases in which disabling adaptive tracking is useful. For example, disable adaptive tracking if the target passes very slowly through the sensing beam, if the target might stop while partially blocking the beam, and if the environmental conditions are stable.

ON enables the Adaptive Tracking Algorithm at the standard speed—Recommended for many applications detecting low contrast targets. Standard adaptive tracking adjusts the thresholds around slowly changing background and environmental conditions. It adjusts the sensor for stable detection when the environment changes due to gradual dust accumulation, machine vibration, or ambient temperature changes which influence the signal from the reference surface. Standard adaptive tracking will not easily adapt to or learn slow moving, low contrast targets (for example, clear targets entering and exiting the beam over approximately 2 seconds).

HS enables the Adaptive Tracking Algorithm at high speed—Optional adaptive tracking setting used with dual mode. Use high speed adaptive tracking when the signal from the reference surface changes quickly due to unstable environmental conditions and high contrast and high-speed targets are being detected. High speed adaptive tracking adjusts the sensor for stable detection in challenging environmental conditions such as dust accumulation, machine vibration, ambient temperature changes, or a non-stable reference surface (for example, a running belt or web which influences the signal from the reference surface). For example, if the signal from the reference surface changes by 10% due to environmental effects, high speed adaptive tracking adjusts the displayed value back to 100P (100%) over 2 to 3 seconds.

High speed adaptive tracking addresses certain applications where the reference surface is not stable, but the sensor must detect high speed and high contrast targets reliably. With high speed adaptive tracking there is the potential for the sensor to adapt the thresholds to slow moving or low contrast targets, leading to missed detection events. If the detection events are generating small signal changes of similar magnitude to the background changes, detection problems are likely. Stabilize the reference surface to avoid this problem.

3.2.3 Response Speed SPd

Use this menu to select the response speed. The default is 10 milliseconds. For 500 mm threaded barrel models, the default is 50 milliseconds.

- 1.5 —1.5 milliseconds
- 3 —3 milliseconds
- 10 —10 milliseconds
- 25 —25 milliseconds
- 50 —50 milliseconds

Table 1: Tradeoffs

Response Speed	Response Speed in Sync Mode	Repeatability	Ambient Light Rejection	Excess Gain
1.5 ms	3 ms	500 µs	Disabled	See *Table 9* (p. 27)
3 ms	6 ms	500 µs	Enabled	
10 ms	20 ms	2 ms	Enabled	
25 ms	50 ms	5 ms	Enabled	
50 ms	100 ms	10 ms	Enabled	

3.2.4 Gain and Sensitivity GAIn

Use this menu to set the excess gain mode. This menu is only available when a 10, 25, or 50 millisecond response speed is selected. It is not available for 1.5 or 3 millisecond response speeds.

- HIGH —High excess gain mode
- Std —Standard excess gain mode with increased noise immunity

3.2.5 Output Timing Delays dLY

Use this menu to select the output timing delay to be set. On and off delay timers can be used together. The default is no delay.

- oFF —No delay
- dLAY —Delay—enables the selection of on and off delay timers
- 1Sho —One-shot—enables a one-shot, fixed output pulse duration

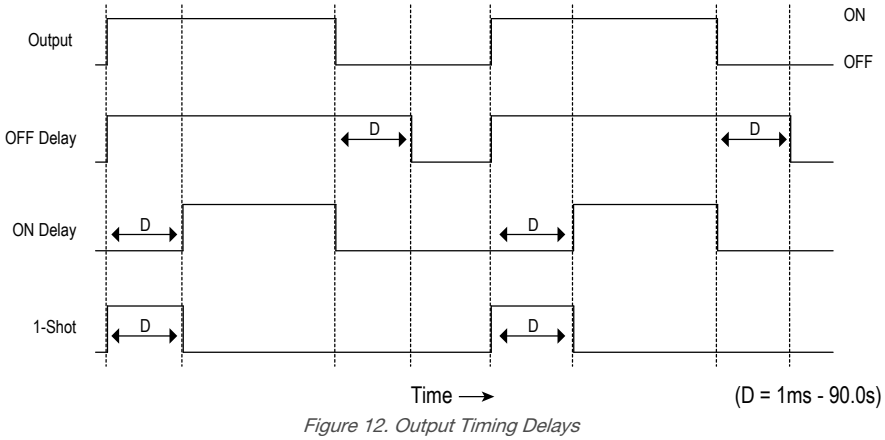


Figure 12. Output Timing Delays

When one of the timing delay options is chosen, the sensor returns to the Setup menu and additional options become available to set the parameter(s):

dLAY

- ond —On delay
- oFd —Off delay

1Sho

- dt 1 —One-shot delay timer

Note: For the one-shot delay timer:
- LO = On pulse when a target is detected inside of the switch point(s)
- DO = On pulse when a target is detected outside of the switch point(s)

3.2.6 Delay Timers ond oFd dt 1

Use these menus to set the delay timers. These menus are available only if an output timing delay is selected.

For ond and oFd, the default is 0.

For dt 1, the default is 10 milliseconds for 10, 25, and 50 millisecond response speeds and 1 millisecond for 1.5 and 3 milliseconds response speeds.

Use ⊕ and ⊖ to scroll through the values. Values greater than 10 increase or decrease by increments of 10. Millisecond values do not include the decimal point; seconds values include the decimal point.

- 1 to 9 ms (when dt 1 is selected, the 1 to 9 ms range is available for 1.5 and 3 ms response times)
- 10 to 90 ms
- 100 to 900 ms
- 1.0 to 90.0 s

3.2.7 Zero Reference Location 2Ero

Use this menu to select the zero reference location. Changing the zero reference location only affects the readout on the display and does not affect the output. The default is nEAr, 0 = the front of the sensor. This menu is not available in dual (intensity + distance) mode.

- nEAr —0 = the front of the sensor; the measurement increases further from the sensor
- FAr —0 = maximum range; the measurement increases closer to the sensor

3.2.8 Shift the Zero Reference Location after a TEACH ShFt

Use this menu to select whether the sensor shifts the zero reference location based on the last TEACH process. The default is oFF, 0 = the front of the sensor or the maximum range. This menu is not available in dual (intensity + distance) mode.

- on —Shift the zero reference location to one of the taught positions with each TEACH
- oFF —0 = the front of the sensor or the maximum range, depending on the 2Ero setting

This figure illustrates three examples of how changes to the zero and shift settings affect what distance readout is shown on the display when in 2-pt TEACH mode. Changes to the zero setting affect the direction in which the distance increases.

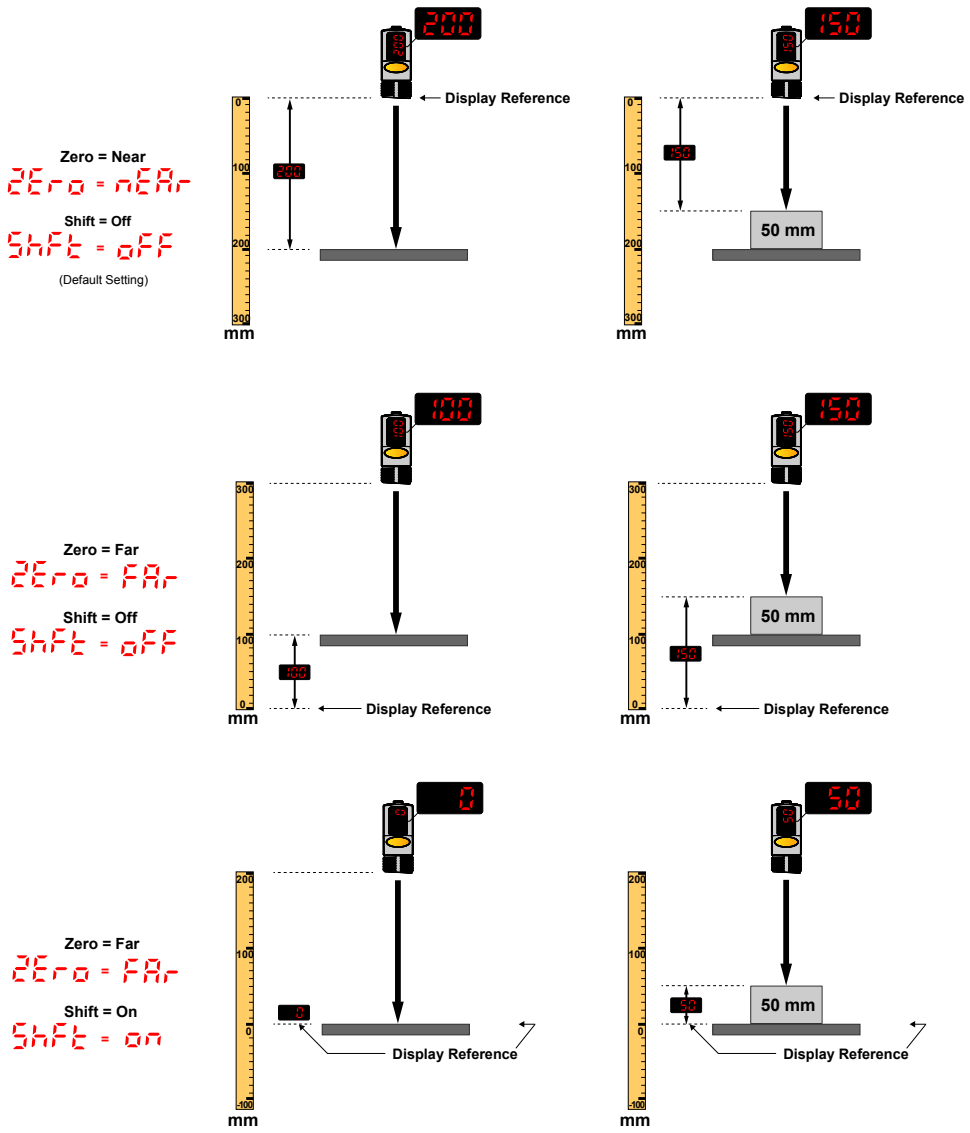


Figure 13. Example Zero and Shift settings

3.2.9 Input Wire Function inPt

Use this menu to select the input wire function. The default is off, ignore all remote input pulses.

- oFF —Ignore all remote input pulses
- SEt —Remote TEACH input
- LoFF —Laser off when pulled low
- L on —Laser on when pulled low
- MASt —Master sync line output for two-sensor cross-talk avoidance
- SLVE —Slave sync line input for two-sensor cross-talk avoidance

To configure sensors for master-slave operation, see *Sync Master/Slave* (p. 26).

3.2.10 Display View diSP

Use this menu to select the display view. The default is right-reading.

- 1234 —Right-reading

- inv — Inverted
- oFF — Right-reading and the display enters sleep mode after 60 seconds
- inv — Inverted and the display enters sleep mode after 60 seconds

When the sensor is in sleep mode, the display wakes with the first button press.

3.2.11 Exit Setup Mode End

Navigate to End and press **SELECT** to exit Setup mode and return to Run mode.

3.2.12 Reset to Factory Defaults rSEt

Use this menu to restore the sensor to the factory default settings.

Select no to return to the sensor menu without restoring the defaults. Select YES to apply the factory defaults and return to Run mode.

Factory Default Settings

Setting	Factory Default
Delay Timers (dLY)	oFF — No delay
Display View (diSP)	1234 — Right-reading, no sleep mode
Gain and Sensitivity (GAin)	HIGH — High excess gain mode
Input Wire Function (inPt)	oFF — Ignore all remote input pulses If the sensor was reset using the remote input, the sensor remains in SEt mode to allow use of the remote input.
LO/DO	LO — Light Operate
Response Speed (SPd)	10 — 10 ms for 100/110 and 300/310 models 50 — 50 ms for 500 models
Shift the Zero Reference Location after a TEACH (SHFt)	oFF — 0 = the front of the sensor
TEACH Mode (tch)	2-Pt — Two-point TEACH
Zero Reference Location (ZEro)	nEAr — Measurement increases further from sensor

3.3 Manual Adjustments

Manually adjust the sensor switch point using the + and − buttons.

1. From Run mode, press either + or − one time. The current switch point value flashes slowly.
2. Press + to move the switch point up or − to move the switch point down. After 1 second of inactivity, the new switch point value flashes rapidly, the new setting is accepted, and the sensor returns to Run mode.

Note: When FGS mode is selected (FGS indicator is on), manual adjustment moves both sides of the symmetrical threshold window simultaneously, expanding and collapsing the window size. Manual adjustment does not move the center point of the window.

Note: When dual mode is selected (DYN, FGS, and BGS indicators are on), after the TEACH process is completed, use the manual adjustment to adjust the sensitivity of the thresholds around the taught reference point. The taught reference point is a combination of the measured distance and returned signal intensity from the reference target. Manual adjustment does not move the taught reference point, but pressing ⊕ increases the sensitivity, and pressing ⊖ decreases the sensitivity. When re-positioning the sensor or changing the reference target, re-teach the sensor.

3.4 Remote Input

Use the remote input to program the sensor remotely. The remote input provides limited programming options and is Active Low. For Active Low, connect the gray input wire to ground (0 V dc), with a remote switch connected between the wire and ground. Pulse the remote input according to the diagram and the instructions provided in this manual.

The length of the individual programming pulses is equal to the value **T: 0.04 seconds ≤ T ≤ 0.8 seconds**.

Exit remote programming modes by setting the remote input Low for longer than 2 seconds.

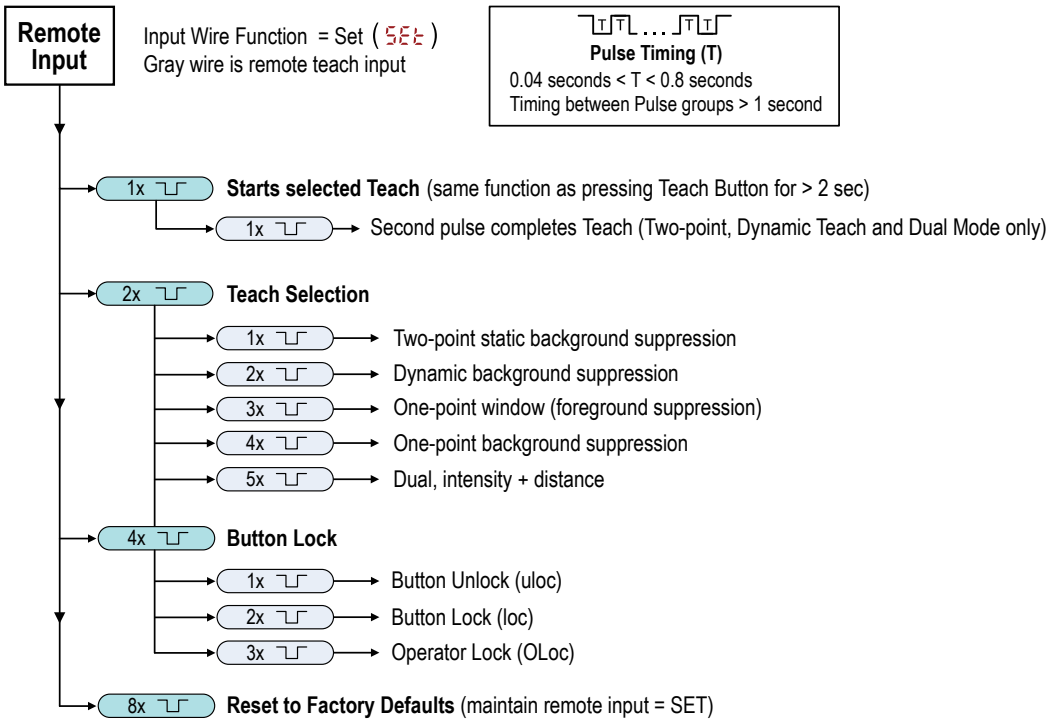
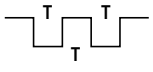


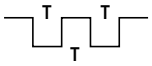
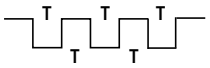
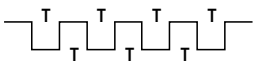
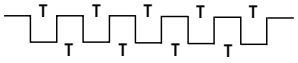
Figure 14. Remote Input Map

3.4.1 Select the TEACH Mode Using the Remote Input

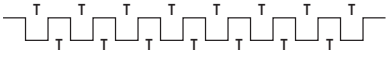
1. Access the TEACH selection.

Action	Result
Double-pulse the remote input. 	tch displays.

2. Select the desired TEACH mode.

Action		Result
Pulses	**TEACH Mode**	The selected TEACH method displays for a few seconds and the sensor returns to Run mode.
1 	Two-point static background suppression	
2 	Dynamic background suppression	
3 	One-point window (foreground suppression)	
4 	One-point background suppression	
5 	Dual (intensity + distance)	

3.4.2 Reset to Factory Defaults Using the Remote Input

Eight-pulse the remote input to apply the factory defaults and return to Run mode. 

Note: The input wire function remains at remote teach input (SEt).

3.5 Locking and Unlocking the Sensor Buttons

Use the lock and unlock feature to prevent unauthorized or accidental programming changes. Three settings are available:

- uLoc —The sensor is unlocked and all settings can be modified (default).
- Loc — The sensor is locked and no changes can be made.
- OLoc —The switch point value can be changed by teaching or manual adjustment, but no sensor settings can be changed through the menu.

When in Loc mode, Loc displays when the **(SELECT)(TEACH)** button is pressed. The switch point displays when **(+)(DISP)** or **(-)(MODE)** are pressed, but Loc displays if the buttons are pressed and held.

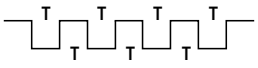
When in OLoc mode, Loc displays when **(+)(DISP)** or **(-)(MODE)** are pressed and held. To access the manual adjust options, briefly press and release **(+)(DISP)** or **(-)(MODE)**. To enter TEACH mode, press the **(SELECT)(TEACH)** button and hold for longer than 2 seconds.

Button Instructions

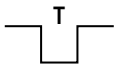
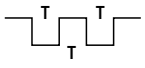
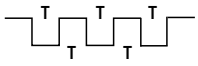
To enter Loc mode, hold (+) and press (-) four times. To enter OLoc mode, hold (+) and press (-) seven times. Holding (+) and pressing (-) four times unlocks the sensor from either lock mode and the sensor displays uLoc .

Remote Input Instructions

1. Access the remote input.

Action	Result
Four-pulse the remote input. 	The sensor is ready to have the button state defined and bEn displays.

2. Lock or unlock the sensor buttons.

Action	Result
Single-pulse the remote input to unlock the sensor. 	uLoc displays and the sensor returns to Run mode.
Double-pulse the remote input to lock the sensor. 	Loc displays and the sensor returns to Run mode.
Triple-pulse the remote input to apply the operator lock to the sensor 	OLoc displays and the sensor returns to Run mode

3.6 TEACH Procedures

Use the following procedures to teach the sensor.

To cancel a TEACH procedure, press **TEACH** for longer than 2 seconds, or hold the remote input Low for longer than 2 seconds. CnCL momentarily displays when a TEACH procedure is canceled.

3.6.1 Two-Point Static Background Suppression 2-Pt

Two-point TEACH sets a single switch point. The sensor sets the switch point between two taught target distances, relative to the shifted origin location.

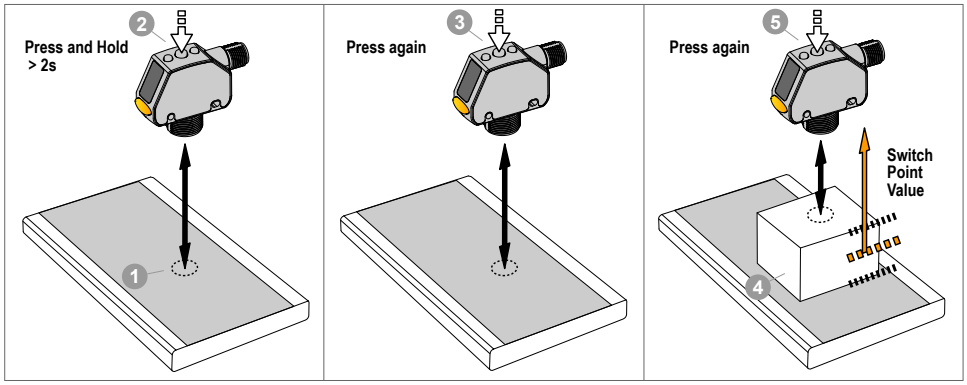


Figure 15. Two-Point Static Background Suppression (Light Operate shown)

Note: The sensor must be set to tch = 2-Pt to use the following instructions.

Note: To program the sensor using remote input, remote input must be enabled (inPt = SEt).

1. Present the target.

Method	Action	Result
Push Button	Present the first target. The sensor-to-target distance must be within the sensor's range.	The target's measurement value displays.
Remote Input		

2. Start the TEACH mode.

Method	Action	Result
Push Button	Press and hold **TEACH** for longer than 2 seconds.	SEt and 1St flash alternately on the display. The DYN, FGS, and BGS indicators flash.

Method	Action	Result
Remote Input	No action required.	N/A

3. Teach the sensor.

Method	Action	Result
Push Button	Press **TEACH** to teach the target.	The sensor is taught the first target.
Remote Input	Single-pulse the remote input. 	SEt , 2nd , and the current distance measurement flash alternately on the display. The DYN, FGS, and BGS indicators flash.

4. Present the target.

Method	Action	Result
Push Button	Present the second target. The sensor-to-target distance must be within the sensor's range.	SEt , 2nd , and the distance measurement flash alternately on the display. The DYN, FGS, and BGS indicators flash.
Remote Input		

5. Teach the sensor.

Method	Action	Result
Push Button	Press **TEACH** to teach the target.	The new switch point flashes rapidly and the sensor returns to Run mode.
Remote Input	Single-pulse the remote input. 	

Table 2: Expected TEACH Behavior for Two-Point Static Background Suppression

See *Figure 21* (p. 30) for the minimum object separation.

Condition	TEACH Result	Display
Two valid distances that are greater than or equal to the horizontal minimum object separation	Sets a switch point between the two taught distances.	The switch point distance flashes on the display.
Two valid distances that are less than the horizontal minimum object separation	Sets a switch point in front of the furthest taught distance by the horizontal minimum object separation.	bOS and the switch point distance flash alternately on the display.
One valid distance with one invalid TEACH point	Sets a switch point between the one taught distance and the maximum range.	obJt and the switch point distance flash alternately on the display.
Two invalid TEACH points	Sets a switch point at the following location: **Model** / **Switch Point** 100 mm threaded barrel models: 99 300 mm threaded barrel models: 290 500 mm threaded barrel models: 477 110 mm flush mount models: 109 310 mm flush mount models: 300	FuLL and the switch point distance flash alternately on the display.

3.6.2 Dynamic Background Suppression dyn

Dynamic TEACH sets a single switch point during machine run conditions. Dynamic TEACH is recommended for applications where a machine or process may not be stopped for teaching. The sensor takes multiple samples and the switch point is set between the minimum and the maximum sampled distances.

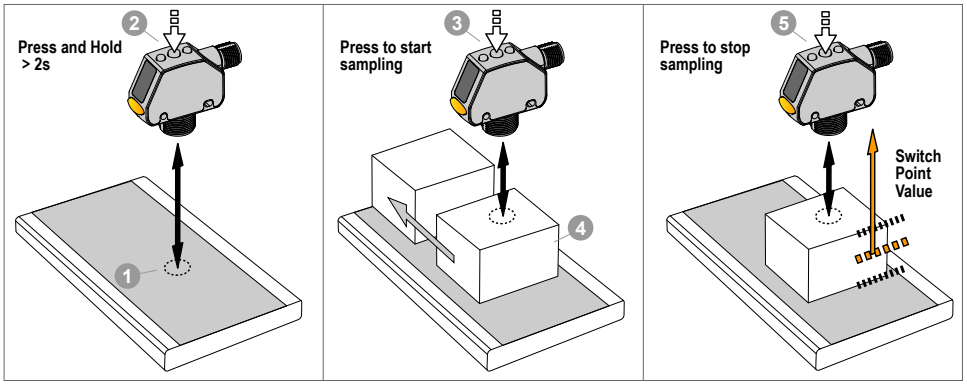


Figure 16. Dynamic Background Suppression

Note: The sensor must be set to tch = dyn to use the following instructions. The DYN indicator is amber to indicate Dynamic TEACH mode.

Note: To program the sensor using remote input, remote input must be enabled (inPt = SEt).

1. Present the target.

Method	Action	Result
Push Button	Present the first target. The sensor-to-target distance must be within the sensor's range.	The target's measurement value displays.
Remote Input		

2. Start the TEACH mode.

Method	Action	Result
Push Button	Press and hold **TEACH** for longer than 2 seconds.	dyn and Strt flash alternately on the display. The DYN indicator flashes.
Remote Input	No action required.	N/A

3. Teach the sensor.

Method	Action	Result
Push Button	Press **TEACH** to teach the target.	The sensor begins sampling target distance information and dyn and StoP flash alternately on the display. The DYN indicator flashes.
Remote Input	Single-pulse the remote input. 	

4. Present the targets.

Method	Action	Result
Push Button	Present additional targets. The sensor-to-target distance must be within the sensor's range.	The sensor continues to sample target distance information and dyn and StoP flash alternately on the display. The DYN indicator flashes.
Remote Input		

5. Teach the sensor.

Method	Action	Result
Push Button	Press **TEACH** to stop teaching the sensor.	The new switch point flashes rapidly and the sensor returns to Run mode.
Remote Input	Single-pulse the remote input. 	

Table 3: Expected TEACH Behavior for Dynamic Background Suppression

See *Figure 21* (p. 30) for the minimum object separation.

Condition	TEACH Result	Display
Two valid distances that are greater than or equal to the horizontal minimum object separation	Sets a switch point between the two taught distances.	The switch point distance flashes on the display.
Two valid distances that are less than the horizontal minimum object separation	Sets a switch point in front of the furthest taught distance by the horizontal minimum object separation.	bOS and the switch point distance flash alternately on the display.
One valid distance with one invalid TEACH point	Sets a switch point between the one taught distance and the maximum range.	obJt and the switch point distance flash alternately on the display.
Two invalid TEACH points	Sets a switch point at the following location: **Model** / **Switch Point** 100 mm threaded barrel models: 75 300 mm threaded barrel models: 200 500 mm threaded barrel models: 375 110 mm flush mount models: 85 310 mm flush mount models: 210	bOS and the switch point distance flash alternately on the display.

3.6.3 One-Point Window (Foreground Suppression) FOS

One-point window sets a window (two switch points) centered around the taught target distance. Loss of signal is treated as a detection in One-Point Window mode. The size of the taught window is the vertical minimum object separation. See *Figure 21* (p. 30).

Manually adjust the window size from Run mode using + and −.

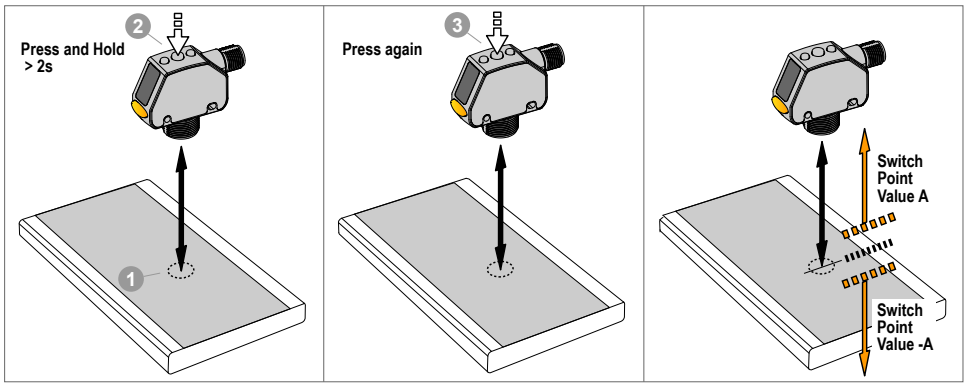


Figure 17. One-Point Window (Foreground Suppression)

In order to reliably detect changes from the taught background, if multiple laser reflections are returning to the sensor, the output status is treated as though the target is outside of the taught window. The display alternates between 2-Lr and the measured distance. Realign the laser to avoid light reflecting off of multiple targets if this extra level of verification is not desired.

Note: The sensor must be set to tch = FGS to use the following instructions. The FGS indicator is amber to indicate One-Point Window (Foreground Suppression) mode.

Note: To program the sensor using remote input, remote input must be enabled (rmt = SEt).

1. Present the target.

Method	Action	Result
Push Button	Present the target. The sensor-to-target distance must be within the sensor's range.	The target's measurement value displays.
Remote Input		

2. Start the TEACH mode.

Method	Action	Result
Push Button	Press and hold **TEACH** for longer than 2 seconds.	**Light Operate** SEt and on flash alternately on the display. The FGS indicator flashes. **Dark Operate** SEt and oFF flash alternately on the display. The FGS indicator flashes.
Remote Input	No action required.	N/A

3. Teach the sensor.

Method	Action	Result
Push Button	Press **TEACH** to teach the target.	The ± window size flashes rapidly and the sensor returns to Run mode.
Remote Input	Single-pulse the remote input. 	

Table 4: Expected TEACH Behavior for One-Point Window (Foreground Suppression)
See *Figure 21* (p. 30) for the minimum object separation.

Condition	TEACH Result	Display
One valid distance	Sets a window (two switch points) centered around the taught distance. The ± window size is the vertical minimum object separation. The two switch points always stay within the specified sensing range.	The ± window size flashes on the display.

<table>
<tr><th>Condition</th><th>TEACH Result</th><th>Display</th></tr>
<tr><td>One invalid TEACH Point</td><td>Sets a window (two switch points) centered around the following location:
<table>
<tr><th>Model</th><th>Window Center Point</th></tr>
<tr><td>100 mm threaded barrel models</td><td>80</td></tr>
<tr><td>300 mm threaded barrel models</td><td>250</td></tr>
<tr><td>500 mm threaded barrel models</td><td>399</td></tr>
<tr><td>110 mm flush mount models</td><td>90</td></tr>
<tr><td>310 mm flush mount models</td><td>260</td></tr>
</table>
The window size is:
<table>
<tr><th>Model</th><th>Window Size</th></tr>
<tr><td>100 mm threaded barrel and 110 mm flush mount models</td><td>±12.5 mm</td></tr>
<tr><td>300 mm threaded barrel and 310 mm flush mount models</td><td>± 25 mm</td></tr>
<tr><td>500 mm threaded barrel models</td><td>± 25 mm</td></tr>
</table></td><td>---- and the window center point distance flash alternately on the display.</td></tr>
</table>

3.6.4 One-Point Background Suppression bGS

One-point background suppression sets a single switch point in front of the taught target distance. Objects beyond the taught switch point are ignored. The switch point is set in front of the taught target distance by the vertical minimum object separation. See *Figure 21* (p. 30).

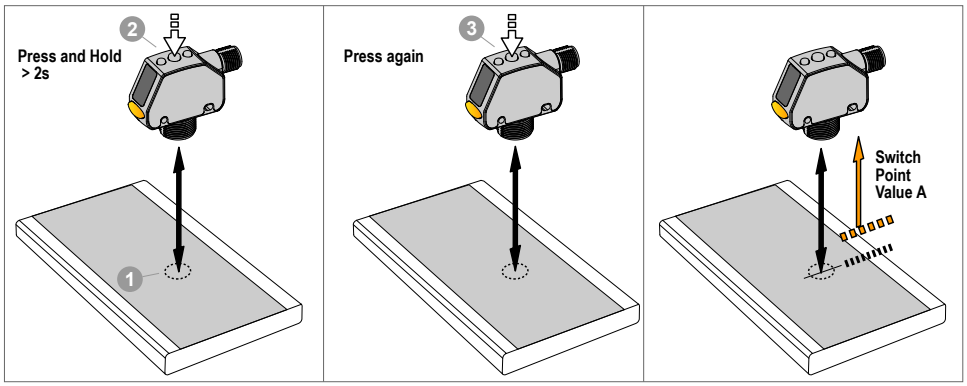


Figure 18. One-Point Background Suppression

Note: The sensor must be set to tch = bGS to use the following instructions. The BGS indicator is amber to indicate Background Suppression mode.

Note: To program the sensor using remote input, remote input must be enabled (rmt = SEt).

1. Present the target.

Method	Action	Result
Push Button	Present the target. The sensor-to-target distance must be within the sensor's range.	The target's measurement value displays.

Method	Action	Result
Remote Input		

2. Start the TEACH mode.

Method	Action	Result
Push Button	Press and hold **TEACH** for longer than 2 seconds.	**Light Operate** SEt and oFF flash alternately on the display. The BGS indicator flashes. **Dark Operate** SEt and on flash alternately on the display. The BGS indicator flashes.
Remote Input	No action required.	N/A

3. Teach the sensor.

Method	Action	Result
Push Button	Press **TEACH** to teach the target.	The new switch point flashes rapidly and the sensor returns to Run mode.
Remote Input	Single-pulse the remote input. 	

Table 5: Expected TEACH Behavior for One-Point Background Suppression

See *Figure 21* (p. 30) for the minimum object separation.

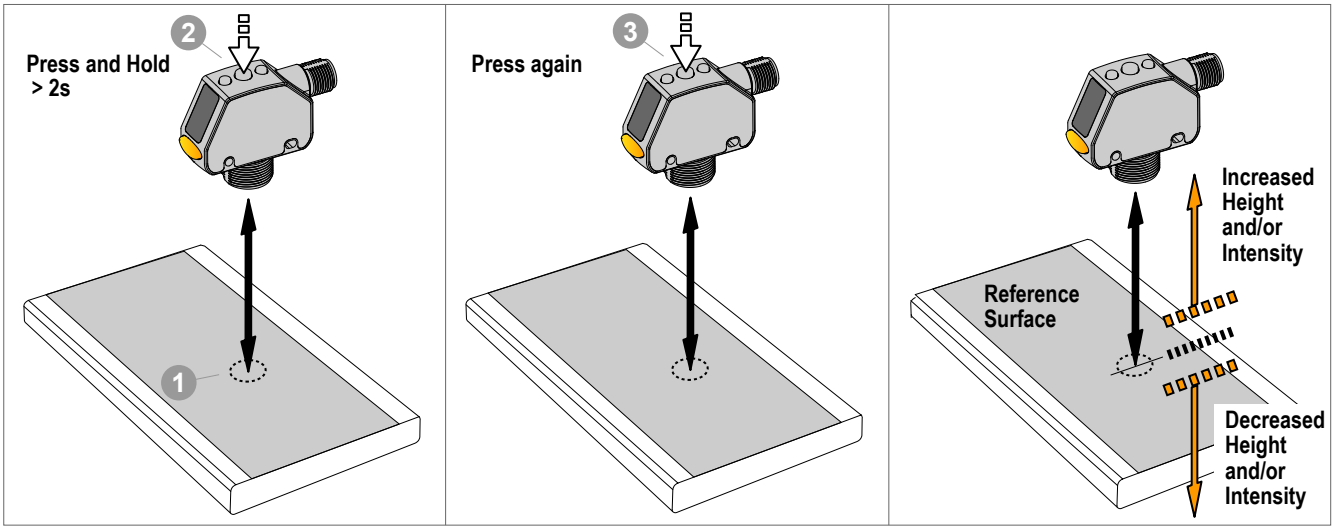
Condition	TEACH Result	Display
One valid TEACH point	Sets a switch point in front of the taught distance by the vertical minimum object separation.	The switch point distance flashes on the display.
One invalid TEACH point	Sets a switch point at the following location: **Model** / **Switch Point** 100 mm threaded barrel models: 75 300 mm threaded barrel models: 200 500 mm threaded barrel models: 375 110 mm flush mount models: 85 310 mm flush mount models: 210	bGS and the switch point distance flash alternately on the display.

3.6.5 Dual (Intensity + Distance) dUAL

Dual (intensity + distance) TEACH records the distance and amount of light received from the reference surface. The output switches when an object passing between the sensor and the reference surface changes the perceived distance or amount of returned light. For more information on dual TEACH mode, see *Dual (Intensity + Distance) Mode* (p. 32).

Note: To use the following instructions, set the sensor to tCH = dUAL. The DYN, FGS, and BGS indicators are amber.

Note: To program the sensor using remote input, remote input must be enabled (inPt = SEt).



1. Present the target.

Method	Action	Result
Push Button **Remote Input**	Present the reference target.	The target's match percentage displays

2. Start the TEACH mode.

Method	Action	Result
Push Button	Press and hold the TEACH button for more than 2 seconds.	Light Operate: SEt and on flash on the display. The DYN, FGS, and BGS indicators flash. Dark Operate: SEt and oFF flash on the display. The DYN, FGS, and BGS indicators flash.
Remote Input	No action required.	N/A

3. Teach the sensor.

Method	Action	Result
Push Button	Press the TEACH button.	The switching threshold flashes rapidly and the sensor returns to Run mode.
Remote Input	Single-pulse the remote input. 	

Table 6: Expected TEACH Behavior for Dual (Intensity + Distance) Mode

Condition	TEACH Result	Display
One valid reference surface is taught within sensing range	Sets a dual (intensity + distance) window centered around the taught reference surface. The ± window size is the previously used switching threshold, or 75% by default.	The switching threshold flashes on the display.
One reference surface is taught outside the sensing range	Sets a dual (intensity + distance) window centered around the taught reference surface that is outside the sensing range. The sensing conditions may not be as reliable.	out flashes on the display.

Condition	TEACH Result	Display
One invalid TEACH Point	No reference surface is taught, the output will change when any object is detected.	FULL flashes on the display.

3.7 Sync Master/Slave

Two Q4X sensors may be used together in a single sensing application. To eliminate crosstalk between the two sensors, configure one sensor to be the master and one to be the slave. In this mode, the sensors alternate taking measurements and the response speed doubles.

Important: The master sensor and the slave sensor must be programmed for the same Response Speed and Gain and Sensitivity settings. The master sensor and slave sensor must share a common power source.

1. Configure the first sensor as the master; navigate: SYNC > MAST .
2. Configure the second sensor as the slave; navigate: SYNC > SLVE .
3. Connect the gray (input) wires of the two sensors together.

4 Specifications

Sensing Beam
Visible red Class 1 laser, 655 nm

Supply Voltage (Vcc)
10 to 30 V dc

Power and Current Consumption, exclusive of load
< 675 mW

Sensing Range—Threaded Barrel Models
500 mm models: 25 mm to 500 mm (0.98 in to 19.69 in)
300 mm models: 25 mm to 300 mm (0.98 in to 11.81 in)
100 mm models: 25 mm to 100 mm (0.98 in to 3.94 in)

Sensing Range—Flush Mount Models
310 mm models: 35 mm to 310 mm (1.38 in to 12.20 in)
110 mm models: 35 mm to 110 mm (1.38 in to 4.33 in)

Output Configuration
Threaded Barrel Models: Bipolar (1 PNP and 1 NPN) output
Flush Mount Models: PNP or NPN output, depending on model

Output Rating
100 mA total maximum (protected against continuous overload and short circuit)
Off-state leakage current: < 5 µA at 30 V dc
PNP On-state saturation voltage: < 1.5 V dc at 100 mA load
NPN On-state saturation voltage: < 1.0 V dc at 100 mA load

Discrete Output Distance Repeatability

Table 7: Discrete Output Repeatability—300/310 mm and 500 mm Models

Distance (mm)		Repeatability
Threaded Barrel Models	Flush Mount Models	
25 to 50 mm	35 to 60 mm	± 0.5 mm
50 to maximum range	60 to 310 mm	± 1% of range

Table 8: Discrete Output Repeatability—100/110 mm Models

Distance (mm)		Repeatability
Threaded Barrel Models	Flush Mount Models	
25 to 100 mm	35 to 110 mm	+/-0.2 mm

Remote Input
Allowable Input Voltage Range: 0 to Vcc
Active Low (internal weak pullup—sinking current): Low State < 2.0 V at 1 mA max.

Supply Protection Circuitry
Protected against reverse polarity and transient overvoltages

Response Speed
User selectable:

- 1.5 —1.5 milliseconds
- 3 —3 milliseconds
- 10 —10 milliseconds
- 25 —25 milliseconds
- 50 —50 milliseconds

Excess Gain—Threaded Barrel Models

Table 9: HIGH Excess Gain (Std Excess Gain[3])

Response Speed (ms)	Excess Gain—90% White Card			
	at 25 mm	at 100 mm	at 300 mm	at 500 mm
1.5	200	100	20	7
3	200	100	20	7
10	1000 (500)	500 (250)	100 (50)	36 (18)
25	2500 (1000)	1250 (500)	250 (100)	90 (36)
50	5000 (2500)	2500 (1250)	500 (250)	180 (90)

Excess Gain—Flush Mount Models

Table 10: HIGH Excess Gain (Std Excess Gain[4])

Response Speed (ms)	Excess Gain—90% White Card		
	at 35 mm	at 110 mm	at 310 mm
1.5	200	100	20
3	200	100	20
10	1000 (500)	500 (250)	100 (50)
25	2500 (1000)	1250 (500)	250 (100)
50	5000 (2500)	2500 (1250)	500 (250)

Beam Spot Size—300/310 mm and 500 mm Models

Table 11: Beam Spot Size—300/310 mm and 500 mm Models

Distance (mm)		Size (Horizontal × Vertical)
Threaded Barrel Models	Flush Mount Models	
25	35	2.6 mm × 1.0 mm
150	160	2.3 mm × 0.9 mm
300	310	2.0 mm × 0.8 mm
500	-	1.9 mm × 1.0 mm

Beam Spot Size—100/110 mm Models

Table 12: Beam Spot Size—100/110 mm Models

Distance (mm)		Size (Horizontal × Vertical)
Threaded Barrel Models	Flush Mount Models	
25	35	2.4 mm × 1.0 mm
50	60	2.2 mm × 0.9 mm
100	110	1.8 mm × 0.7 mm

[3]
- Std excess gain available in 10 ms, 25 ms, and 50 ms response speeds only
- Std excess gain provides increased noise immunity

[4]
- Std excess gain available in 10 ms, 25 ms, and 50 ms response speeds only
- Std excess gain provides increased noise immunity

Delay at Power Up
< 750 ms

Maximum Torque
Side mounting: 1 N·m (9 in·lbs)
Nose mounting: 20 N·m (177 in·lbs)

Ambient Light Immunity
> 5,000 lux at 300 mm
> 2,000 lux at 500 mm

Connector
Threaded Barrel Models: Integral 5-pin M12/Euro-style male quick disconnect
Flush Mount Models: Integral 4-pin M12/Euro-style male quick disconnect

Construction
Housing: 316 L stainless steel
Lens cover: PMMA acrylic
Lightpipe and display window: polysulfone

Temperature Effect
0.05 mm/°C at <125 mm (threaded barrel models)/< 135 mm (flush mount models)
0.35 mm/°C at 300 mm (threaded barrel models)/< 310 mm (flush mount models)
1 mm/°C at 500 mm (threaded barrel models)

Chemical Compatibility
Compatible with commonly used acidic or caustic cleaning and disinfecting chemicals used in equipment cleaning and sanitation. ECOLAB® certified.
Compatible with typical cutting fluids and lubricating fluids used in machining centers

Application Note
For optimum performance, allow 10 minutes for the sensor to warm up

Environmental Rating
IEC IP67 per IEC60529
IEC IP68 per IEC60529
IP69K per DIN 40050-9 per DIN40050-9

Vibration
MIL-STD-202G, Method 201A (Vibration: 10 Hz to 60 Hz, 0.06 inch (1.52 mm) double amplitude, 2 hours each along X, Y and Z axes), with device operating

Shock
MIL-STD-202G, Method 213B, Condition I (100G 6x along X, Y and Z axes, 18 shocks), with device operating

Operating Conditions
–10 °C to +50 °C (+14 °F to +122 °F)
35% to 95% relative humidity

Storage Temperature
–25 °C to +75 °C (–13 °F to +167 °F)

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

Industrial Control Equipment 3TJJ

Class 2 power
UL Environmental Rating: Type 1

chemical compatibility certified

4.1 Dimensions

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

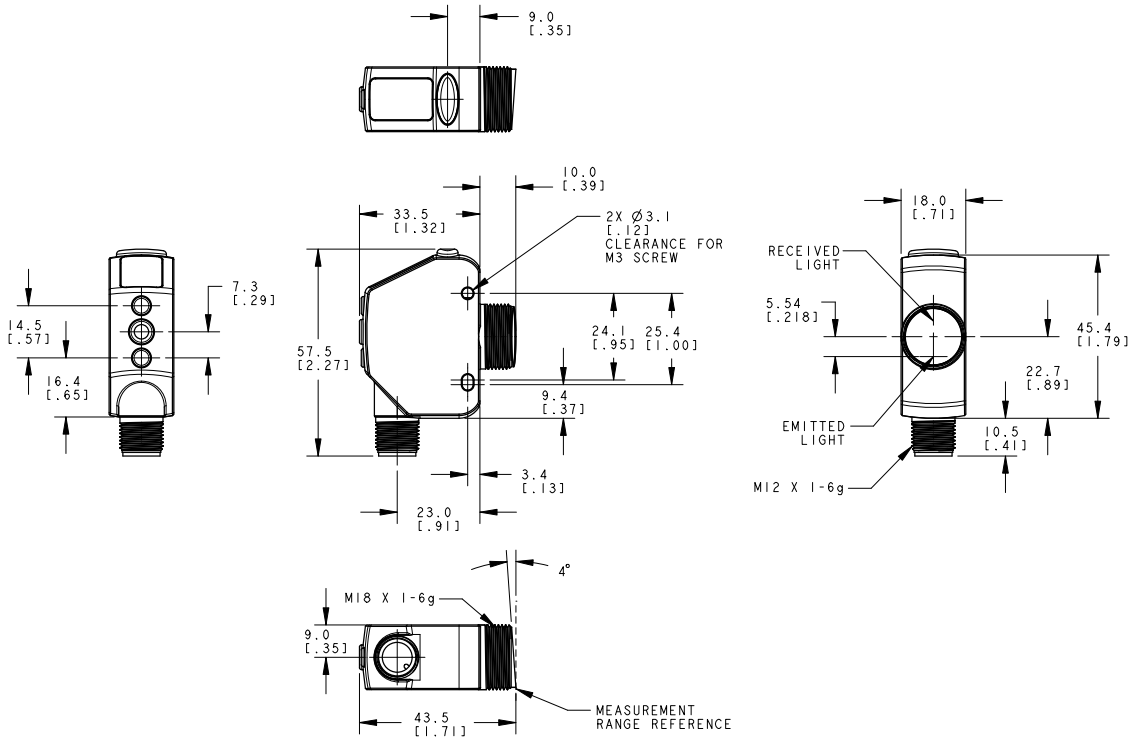


Figure 19. Threaded Barrel Models

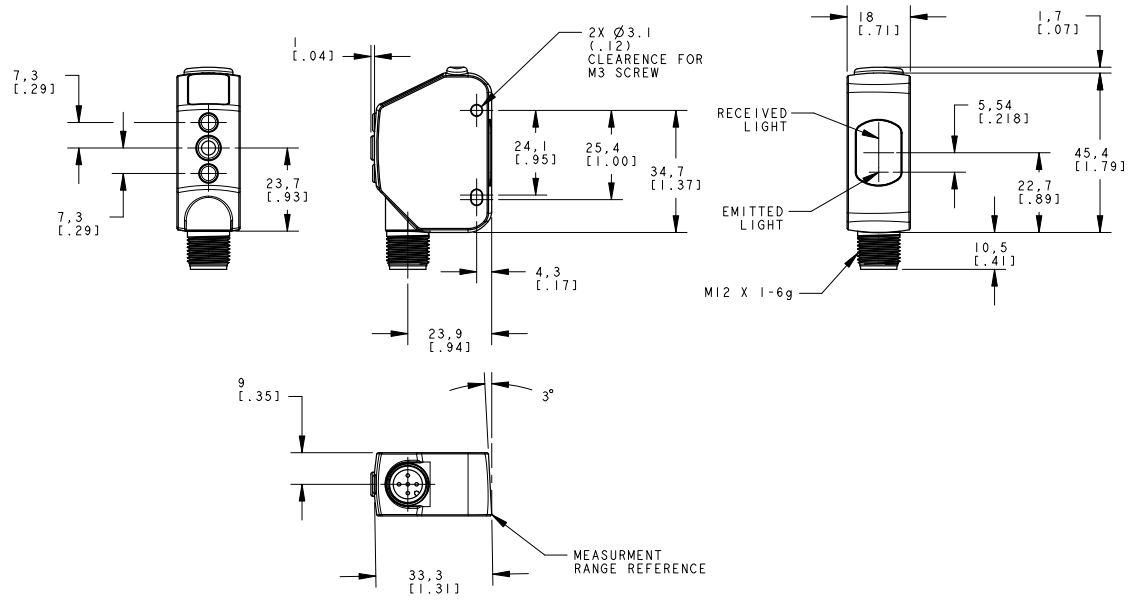


Figure 20. Flush Mount Models

4.2 Performance Curves—Threaded Barrel Models

Minimum Separation Distance Between Target and Background for: Uniform and Non-Uniform Targets

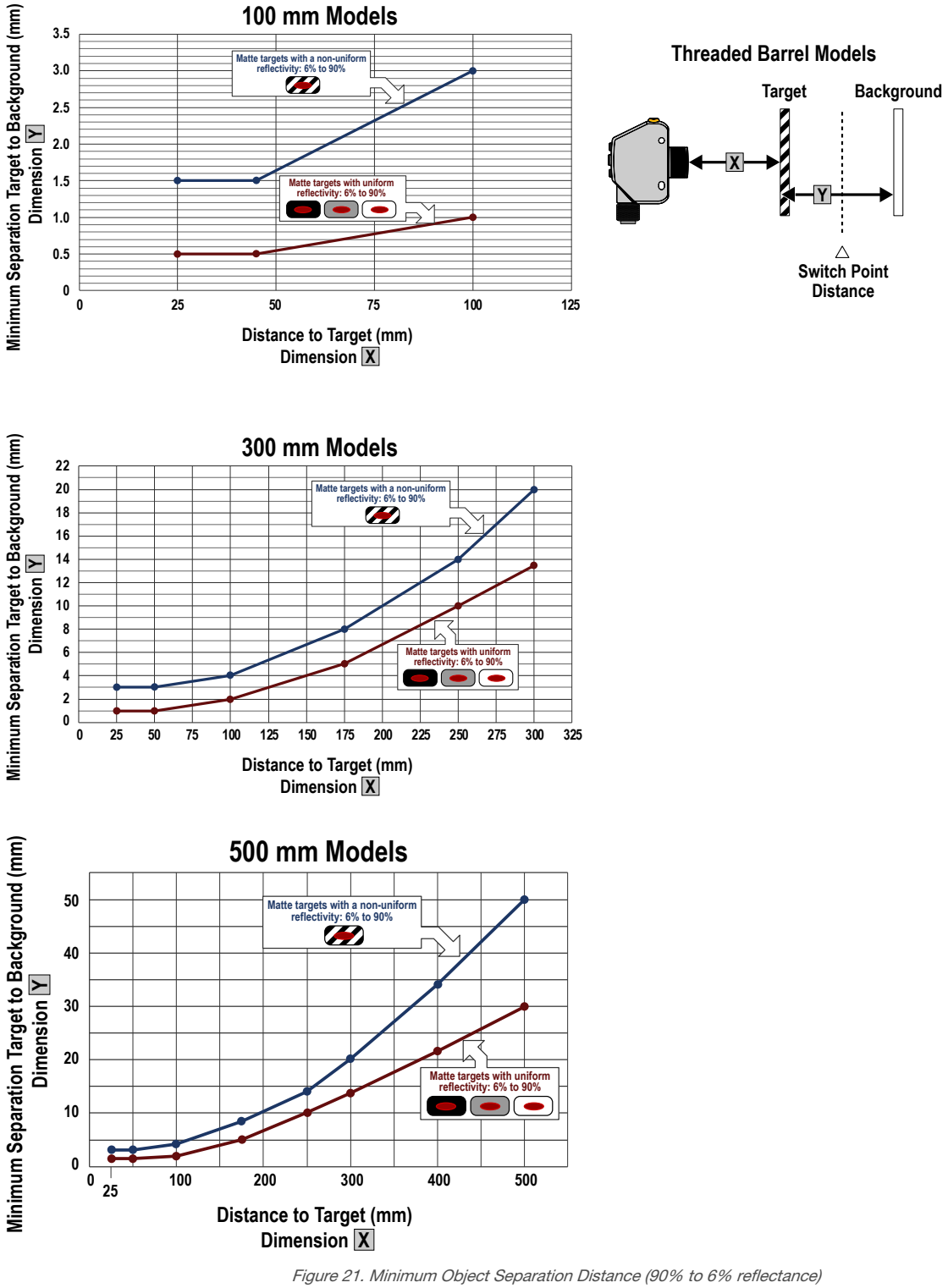


Figure 21. Minimum Object Separation Distance (90% to 6% reflectance)

4.3 Performance Curves—Flush Mount Models

Minimum Separation Distance Between Target and Background for: Uniform and Non-Uniform Targets

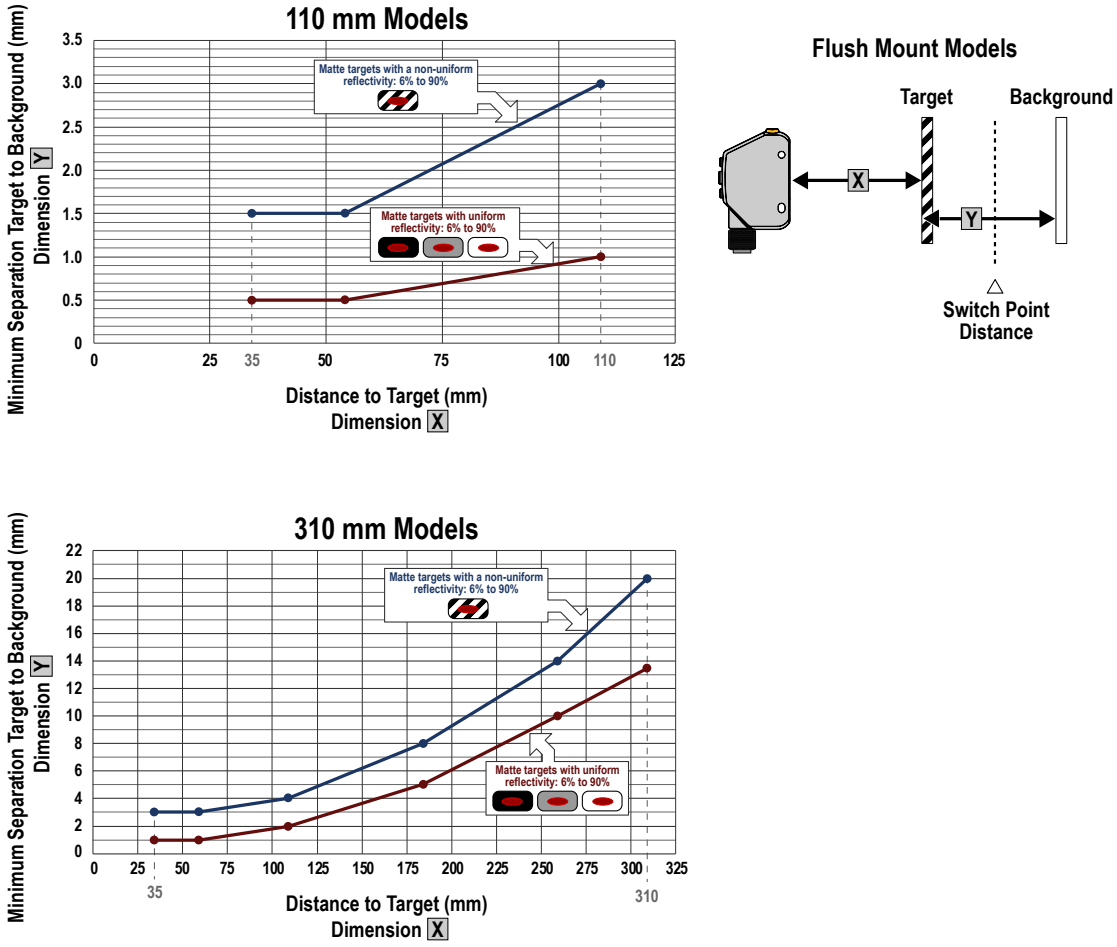


Figure 22. Minimum Object Separation Distance (90% to 6% reflectance)

5 Additional Information

5.1 Dual (Intensity + Distance) Mode

In background suppression (DYN, 1-pt, 2-pt) and foreground suppression (FGS) TEACH modes, the Q4X sensor compares changes in the measured distance between the sensor and target to control the output state. Dual TEACH mode, dual intensity + distance window, expands the applications the Q4X can solve by combining distance-based detection with light intensity thresholds. In dual TEACH mode, the user teaches the Q4X a fixed reference surface, and the sensor compares intensity and distance readings against the reference surface it was taught. After teaching the reference target, the displayed value is calibrated to 100P, or a 100% match. When an object enters the sensor's field of view, the degree of consistency with the reference surface becomes lower and causes a change in sensor output.

In dual mode, you can detect when the target is present at the right distance and when it returns the right amount of light. This is useful in error-proofing applications where you need to know not only that the part is present (distance), but also that it is the correct part (intensity).

In dual mode, the Q4X requires a reference surface (far left). Once taught, the distance and intensity of the reference surface are recorded and used as a baseline. A user-adjustable switching threshold is set, and changes in distance and/or intensity outside the switching threshold creates a sensor output change. The example in *Figure 23* (p. 32) uses a 90% (90P) match condition with a 10% change in intensity and/or distance from the reference surface required to change the output state. The default-switching threshold is a 75% match to the reference condition (75P); this sets the threshold 25% from the distance and intensity of the reference surface. A transparent object can be detected either by a change in intensity, distance, or by a double peak reflection (far right). When a double peak reflection is detected, the display alternates between  and the percent match.

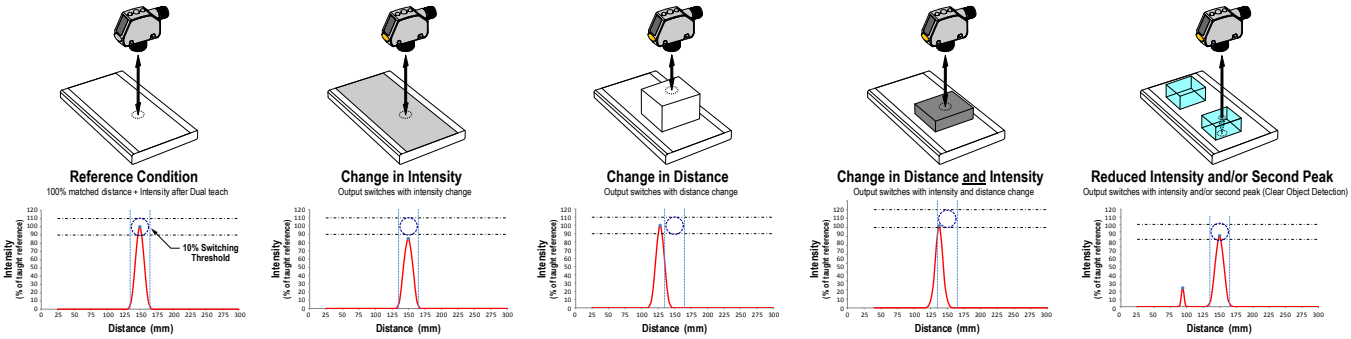


Figure 23. Dual Mode Example

The Q4X sensor can be taught non-ideal reference surfaces, such as surfaces outside of the sensor's range, very dark surfaces, or even empty space. These situations may enable applications requiring a long range detection but are subject to typical diffuse mode detection challenges.

5.2 Dual Mode Reference Surface Considerations

Optimize reliable detection by applying these principals when selecting your reference surface, positioning your sensor relative to the reference surface, and presenting your target. The robust detection capabilities of the Q4X allows successful detection even under non-ideal conditions in many cases. Typical reference surfaces are metal machine frames, conveyor side rails, or mounted plastic targets. Contact Banner Engineering if you require assistance setting up a stable reference surface in your application.

1. Select a reference surface with these characteristics where possible:
   - Matte or diffuse surface finish
   - Fixed surface with no vibration
   - Dry surface with no build-up of oil, water, or dust
2. Position the reference surface between 50 mm and the maximum sensing range for threaded barrel models or between 60 mm and the maximum sensing range for flush mount models.
3. Position the target to be detected as close to the sensor as possible, and as far away from the reference surface as possible.
4. Angle the sensing beam relative to the target and relative to the reference surface 10 degrees or more.

5.3 Dual Mode Considerations for Clear and Transparent Object Detection

The Q4X is able to detect the very small changes caused by transparent and clear objects. A transparent object can be detected either by a change in intensity, distance, or by a double-peak reflection.

The Q4X sensor can be taught non-ideal reference surfaces, such as surfaces outside of the sensor range or very dark surfaces. Teaching non-ideal reference surfaces may enable applications other than transparent or clear object detection, but best results for transparent or clear object detection require a stable reference surface.

The display shows the match percentage to the taught reference point. The user adjustable switch point defines the sensitivity and the output switches when the match percentage to the reference point crosses the switch point. Your specific application may require fine tuning of the switch point, but these values are the recommended starting values:

Switch point (%)	Typical Applications
75 (default)	Default, recommended for PET bottles and Trays
88	Recommended for thin films
50	Recommended for tinted brown, tinted green, or water-filled containers

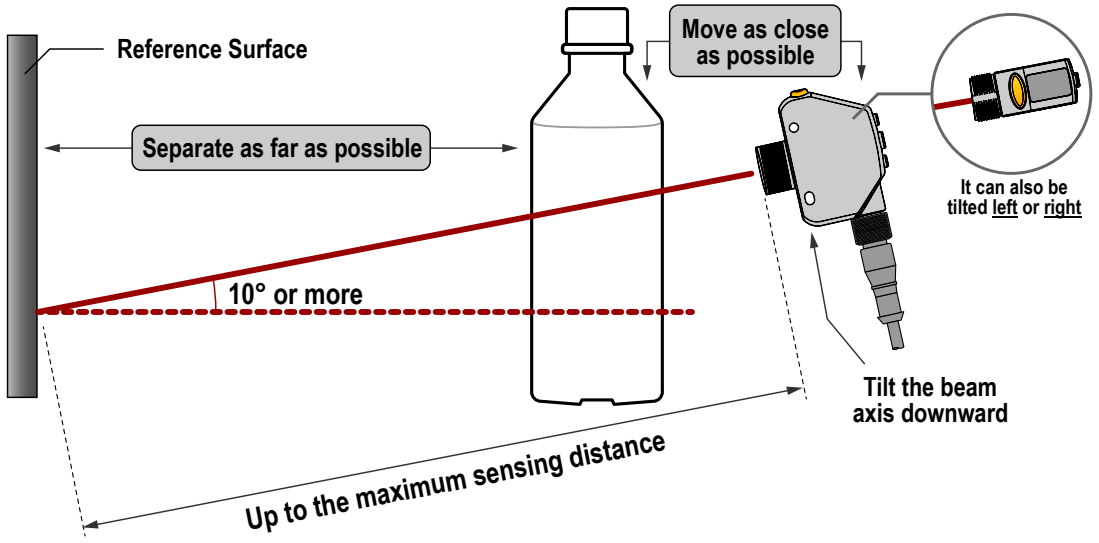


Figure 24. Example mounting considerations

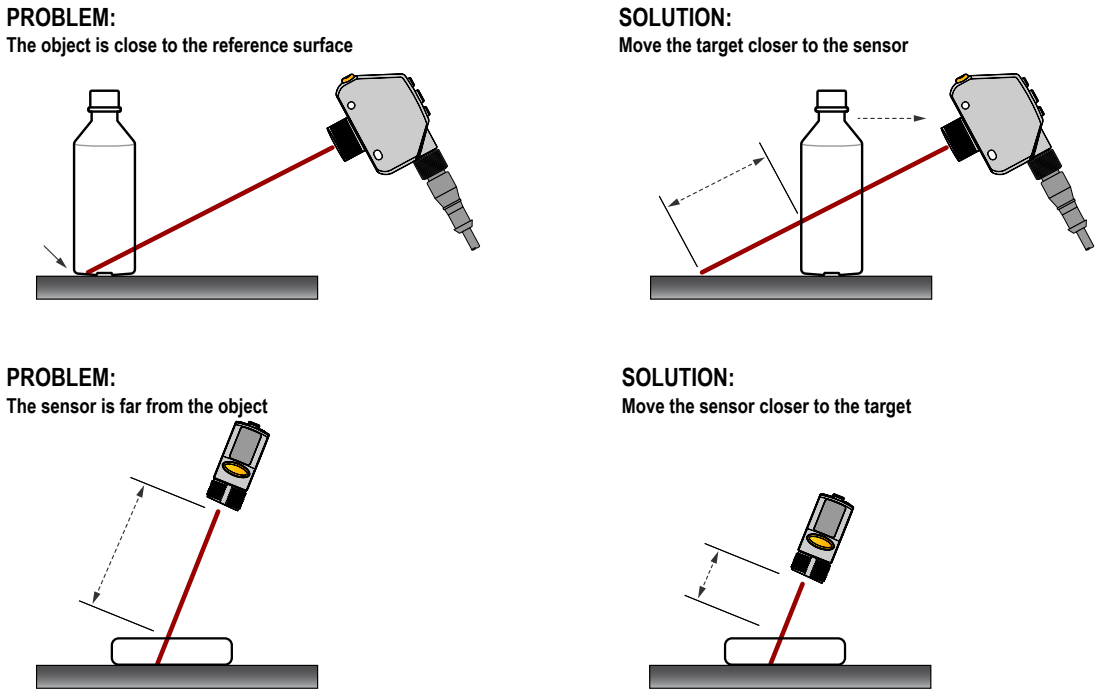


Figure 25. Common problems and solutions for detecting clear objects

5.4 Adaptive Tracking

When operating in dual mode, or when the sensor is a clear object detection (COD) model, the Adaptive Tracking Algorithm adjusts the switching thresholds (distance and intensity) around a taught reference surface. Adaptive tracking adjusts for small variations in the reference surface to maintain a consistent 100P (100%) on the display and to ensure reliable detection. Adjustment of the thresholds only occurs when the reference surface is visible to the senor (that is, no target is present). The Adaptive Tracking Algorithm can reduce or eliminate the need to periodically re-teach the sensor as environmental conditions change around the sensor.

Enable or disable the Adaptive Tracking Algorithm from the sensor menu. Note that the tr Ac menu is available when the TEACH process is set to dual mode. **On** enables adaptive tacking at the standard speed and is the default selection. **OFF** disables adaptive tracking. **HS** is high speed adaptive tracking. The appropriate speed depends on the application.

5.4.1 ON

ON enables the Adaptive Tracking Algorithm at the standard speed.

ON is the default setting while the sensor is in dual mode. It is recommended for the majority of applications detecting low contrast targets. Standard adaptive tracking adjusts the thresholds around slowly changing background and environmental conditions. It adjusts the sensor for stable detection when the environment changes due to gradual dust accumulation, machine vibration, or ambient temperature changes which influence the signal from the reference surface. Standard adaptive tracking will not easily adapt to or learn slow moving, low contrast targets (for example, clear targets entering and exiting the beam over approximately 2 seconds).

For example, if the signal from the reference surface changes by 10% due to environmental effects, the standard Adaptive Tracking Algorithm adjusts the displayed value back to 100P (100%) over 8 to 9 seconds.

5.4.2 OFF

OFF disables the Adaptive Tracking Algorithm.

OFF prevents the sensor from adjusting the thresholds around the taught reference surface while the sensor is in dual mode. The sensor will not adapt to or learn any target. Environmental changes may cause the displayed value to deviate from 100P (100%) over time. A periodic re-teach of the reference surface may be required to restore the displayed value to 100P if this is important to the application.

There are some cases in which disabling adaptive tracking is useful. For example, disable adaptive tracking if the target passes very slowly through the sensing beam, if the target might stop while partially blocking the beam, and if the environmental conditions are stable.

5.4.3 HS

HS enables the Adaptive Tracking Algorithm at high speed.

HS is an optional adaptive tracking setting used with dual mode. Use high speed adaptive tracking when the signal from the reference surface changes quickly due to unstable environmental conditions **and** high contrast and high speed targets are being detected. High speed adaptive tracking adjusts the sensor for stable detection in challenging environmental conditions such as dust accumulation, machine vibration, ambient temperature changes, or a non-stable reference surface (for example, a running belt or web which influences the signal from the reference surface).

For example, if the signal from the reference surface changes by 10% due to environmental effects, high speed adaptive tracking adjusts the displayed value back to 100P (100%) over 2 to 3 seconds.

High speed adaptive tracking addresses certain applications where the reference surface is not stable, but the sensor must detect high speed and high contrast targets reliably. With high speed adaptive tracking there is the potential for the sensor to adapt the thresholds to slow moving or low contrast targets, leading to missed detection events. If the detection events are generating small signal changes of similar magnitude to the background changes, detection problems are likely. Stabilize the reference surface to avoid this problem.

5.5 Abbreviations

The following table describes the abbreviations used on the sensor display and in this manual.

Abbreviation	Description
----	No valid signal in range
999P	The sensor has not been taught
1Sho	One-shot
1St	First
2-Lr	Multiple light reflections
2nd	Second
2-Pt	Two-point TEACH (static background suppression)
bGS	One-point background suppression
btn	Button
CnCL	Cancel
d.SP	Display read
dLY	Output timing delay
dLAY	Delay
dt 1	Delay timer for one-shot
dyn	Dynamic background suppression
End	End—exit the sensor menu
FAr	Far zero reference location—the maximum range is 0 and the measurement increase as the target moves closer to the sensor
FGS	One-point window (foreground suppression)

Abbreviation	Description
FuLL	Full range
GAin	Excess gain
HIGH	High excess gain mode
inPt	Input wire function
Loc	Lock/locked
LoFF	Laser off
nASt	Master
nEAr	Near zero reference location—the end of the barrel is 0 and the measurement increase as the target moves further away from the sensor
obJt	Object
oFFd	Off delay timer
ond	On delay timer
rSEt	Reset to factory defaults
SEt	Input wire = remote teach function
ShFt	Shift the Zero Reference Location after a TEACH
SLVE	Slave
SPd	Response speed
Std	Standard excess gain mode
Strt	Start
StoP	Stop
tch	TEACH process selection
uLoc	Unlock/unlocked
uuuu	Saturated signal (too much light)
2Ero	Zero—select the zero reference location

6 Troubleshooting

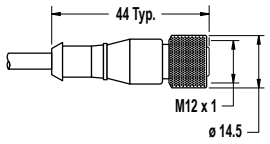
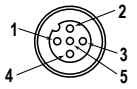
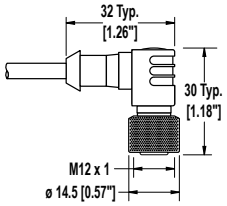
Table 13: Error Codes

Error Code	Description	Resolution
- - - -	No valid signal in range	Reposition the sensor or the target
oooo	The signal is saturated (too much light)	Reposition the sensor or the target to increase the detection distance, or increase the angle of incidence between the sensor and the target
Err E	EEPROM fault	Contact Banner Engineering to resolve
Err L	Laser fault	Contact Banner Engineering to resolve
Err C	Output short-circuited	Check the wiring for an electrical short circuit and to ensure that the wiring is correct
Err S	System fault	Contact Banner Engineering to resolve

7 Accessories

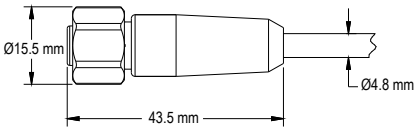
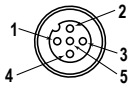
7.1 Cordsets—Threaded Barrel Models

All measurements are listed in millimeters, unless noted otherwise.

5-Pin Threaded M12/Euro-Style Cordsets—Single Ended				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
MQDC1-501.5	0.50 m (1.5 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
MQDC1-506	1.83 m (6 ft)			
MQDC1-515	4.57 m (15 ft)			
MQDC1-530	9.14 m (30 ft)			
MQDC1-506RA	1.83 m (6 ft)	Right-Angle		
MQDC1-515RA	4.57 m (15 ft)			
MQDC1-530RA	9.14 m (30 ft)			

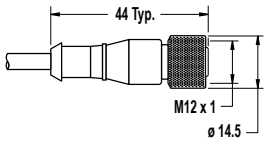
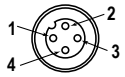
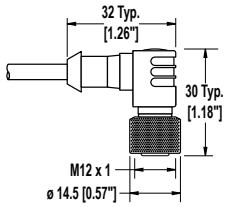
5-Pin Threaded M12/Euro-Style Cordsets—Washdown Stainless Steel

Cable: PVC jacket and over-mold, EPDM o-ring, 316L coupling nut
Environmental Rating: IP69K per DIN 40050-9

5-Pin Threaded M12/Euro-Style Washdown Stainless Steel Cordsets—Double Ended				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
MQDC-WDSS-0506	1.83 m (6 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
MQDC-WDSS-0515	4.57 m (15 ft)			
MQDC-WDSS-0530	9.14 m (30 ft)			

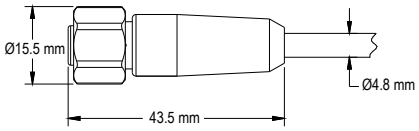
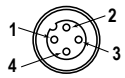
7.2 Cordsets—Flush Mount Models

All measurements are listed in millimeters, unless noted otherwise.

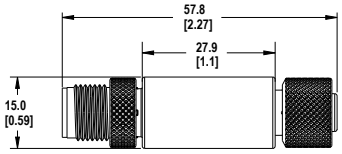
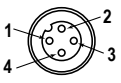
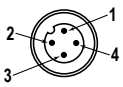
4-Pin Threaded M12/Euro-Style Cordsets—Single Ended				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
MQDC-406	1.83 m (6 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black
MQDC-415	4.57 m (15 ft)			
MQDC-430	9.14 m (30 ft)			
MQDC-450	15.2 m (50 ft)			
MQDC-406RA	1.83 m (6 ft)	Right-Angle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

4-Pin Threaded M12/Euro-Style Cordsets—Washdown Stainless Steel

Cable: PVC cable, stainless steel coupling nut, EPDM o-ring
Environmental Rating: IP69K per DIN 40050-9

4-Pin Threaded M12/Euro-Style Cordsets—Washdown, Stainless Steel, Single Ended				
Model	**Length**	**Style**	**Dimensions**	**Pinout (Female)**
MQDC-WDSS-0406	1.83 m (6 ft)	Straight		 1 = Brown 2 = White 3 = Blue 4 = Black
MQDC-WDSS-0415	4.57 m (15 ft)			
MQDC-WDSS-0430	9.14 m (30 ft)			

7.3 Sensor Status Indicators

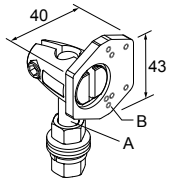
S15L Series In-Line Sensor Status Indicator						
Model	**Input Type**	**LED Color**	**Dimensions**	**Female**	**Male**	**Wiring**
S15LGYPQ	PNP	Power ON = Green Input Active = Yellow				1 = Brown, 10 V dc to 30 V dc 2 = White 3 = Blue, dc common 4 = Black, Sensor Input
S15LGYNQ	NPN					

7.4 Brackets

All measurements are listed in millimeters, unless noted otherwise.

SMBQ4X..

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

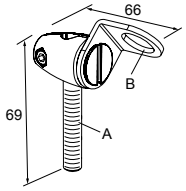


B = 7 × M3 × 0.5

Model	Bolt Thread (A)
SMBQ4XFA	3/8 - 16 × 2¼ in
SMBQ4XFAM10	M10 - 1.5 × 50
SMBQ4XFAM12	n/a; no bolt included. Mounts directly to 12 mm (½ in) rods

SMB18FA..

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

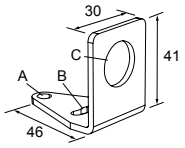


Hole size: B=ø 18.1

Model	Bolt Thread (A)
SMB18FA	3/8 - 16 × 2 in
SMB18FAM10	M10 - 1.5 × 50
SMB18FAM12	n/a; no bolt included. Mounts directly to 12 mm (½ in) rods

SMB18A

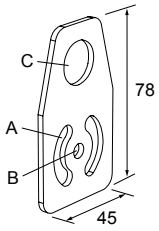
- Right-angle mounting bracket with a curved slot for versatile orientation
- 12-ga. stainless steel
- 18 mm sensor mounting hole
- Clearance for M4 (#8) hardware



Hole center spacing: A to B = 24.2
Hole size: A = ø 4.6, B = 17.0 × 4.6, C = ø 18.5

SMBAMS18P

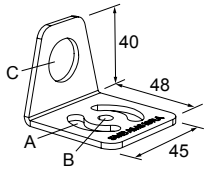
- Flat SMBAMS series bracket with 18 mm hole
- Articulation slots for 90+° rotation
- 12-ga. (2.6 mm) cold-rolled steel



Hole center spacing: A = 26.0, A to B = 13.0
Hole size: A = 26.8 × 7.0, B = ø 6.5, C = ø 19.0

SMBAMS18RA

- Right-angle SMBAMS series bracket with 18 mm hole
- Articulation slots for 90+° rotation
- 12-ga. (2.6 mm) cold-rolled steel



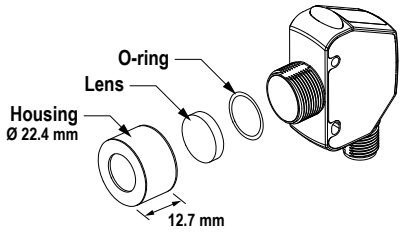
Hole center spacing: A = 26.0, A to B = 13.0
Hole size: A = 26.8 × 7.0, B = ø 6.5, C = ø 19.0

7.5 Aperture Kits—Threaded Barrel Models

APG18S

Kit with glass lens to protect plastic sensor lens from chemical environments and weld splatter damage.

Used with S18, M18, T18, TM18, and Q4X



Additional Information

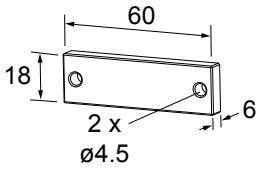
- Borosilicate glass window protects the PMMA window from weld splatter and chemicals
- Adds 4.8 mm to the length of the threaded barrel
- Reduces excess gain by 30%; increase the response time to restore excess gain

7.6 Reference Targets

All measurements are listed in millimeters, unless noted otherwise.

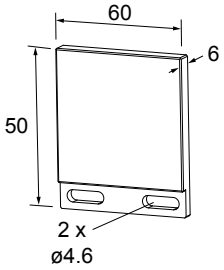
BRT-Q4X-60X18

- Reference target for clear object detection or dual mode applications
- FDA grade acetal material



BRT-Q4X-60X50

- Reference target for clear object detection or dual mode applications
- FDA grade acetal material



8 Product Support

8.1 Contact Us

Banner Engineering Corp. headquarters is located at:

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

For worldwide locations and local representatives, visit *www.bannerengineering.com*.

8.2 Banner Engineering Corp. Limited Warranty

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