

Q5X Laser Triangulation Sensor with Background Suppression

Instruction Manual

Original Instructions
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208794

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1 Product Description

Class 2 laser CMOS sensor with dual outputs and IO-Link. Patent pending.



- Laser triangulation sensor with a range from 95 mm to 2000 mm (9.5 cm to 200 cm)
- Bright output indicators and real-time distance feedback provide easy set up and troubleshooting for reduced installation costs
- Exceptionally high excess gain enables the sensor to reliably detect the darkest objects (< 6% reflective black targets), including black targets against a black background, black targets against a shiny metal background, clear and reflective objects, multicolor packaging, and targets of all colors
- Dual independent output channels and communication over IO-Link
- Optional Remote Sensor Display (RSD) (available separately) enables remote programming and monitoring



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	Channel 1 Default	Channel 2 Default	Connection
Q5XKLAF2000-Q8	95 mm to 2000 mm (9.5 cm to 200 cm)	IO-Link, Push/pull output User selectable to be fixed NPN or PNP	PNP output or user selectable multi-function User selectable to be fixed NPN or PNP	270° rotatable Integral 4-pin M12/Euro-style quick disconnect

1.2 Overview

The Q5X Laser Triangulation Sensor with Background Suppression is a Class 2 laser CMOS sensor with an IO-Link and multifunction input and output.

The normal sensor state is Run mode. From Run mode, users may change the switch point value and channel selection and perform the selected TEACH method.

The secondary sensor state is Setup mode. From Setup mode, users may select the TEACH mode, adjust all standard operating parameters, and perform a factory reset.

1.3 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.

1.3 Class 2 Laser Models



CAUTION: Never stare directly into the sensor lens. Laser light can damage your eyes. Avoid placing any mirror-like object in the beam. Never use a mirror as a retroreflective target.



For Safe Laser Use - Class 2 Lasers

- Do not stare at the laser.
- Do not point the laser at a person’s eye.
- Mount open laser beam paths either above or below eye level, where practical.
- Terminate the beam emitted by the laser product at the end of its useful path.

Reference IEC 60825-1:2007, Section 8.2.

Class 2 Lasers

Class 2 lasers are lasers that emit visible radiation in the wavelength range from 400 nm to 700 nm, where eye protection is normally afforded by aversion responses, including the blink reflex. This reaction may be expected to provide adequate protection under reasonably foreseeable conditions of operation, including the use of optical instruments for intrabeam viewing.

Class 2 Laser Safety Notes

Low-power lasers are, by definition, incapable of causing eye injury within the duration of a blink (aversion response) of 0.25 seconds. They also must emit only visible wavelengths (400 to 700 nm). Therefore, an ocular hazard may exist only if individuals overcome their natural aversion to bright light and stare directly into the laser beam.

Output: < 1.0 mW

Laser wavelength: 640 to 670 nm

Pulse Duration: 20 µs to 2 ms



Figure 1. FDA (CDRH) warning label (Class 2)

1.4 Features



1. Two output indicators (amber)
2. Display
3. Buttons

1.4.1 Display and Indicators

The display is a 4-digit, 7-segment LED. Run mode is the primary view displayed.

For 2-pt, BGS, FGS, and DYN TEACH modes, the display shows the current distance to the target in centimeters. 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 2. 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—Output is on
- Off—Output is off

Stability Indicator (STB)

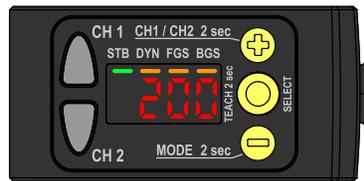
- On—Stable signal within the specified sensing range
- Flashing—Marginal signal, the target is outside the limits of the specified sensing range, or a multiple peak condition exists
- Off—No target detected within the specified sensing range

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

1.4.2 Buttons

Use the sensor buttons **(SELECT)(TEACH)**, **(+)(CH1/CH2)**, 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)

(+)(CH1/CH2)

- 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 Channel 1 and Channel 2

(-)(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



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

2 Installation

2.1 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.

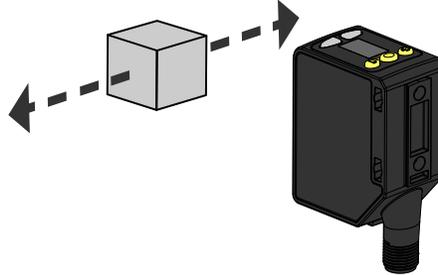


Figure 3. Optimal Orientation of Target to Sensor

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 Q5X can be used in the less preferred orientation and at steep angles of incidence and still provide reliable detection performance due to its high excess gain. For the minimum object separation distance required for each case, refer to [Performance Curves](#) on page 33.

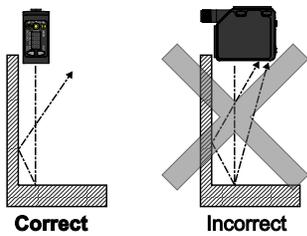


Figure 4. Orientation by a wall

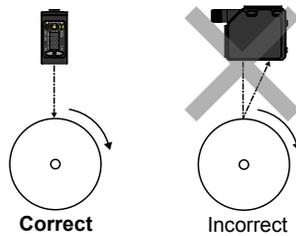


Figure 5. Orientation for a moving object

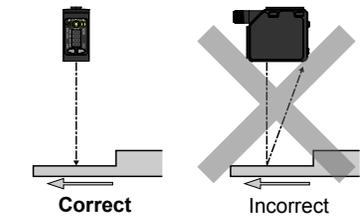


Figure 6. Orientation for a height difference

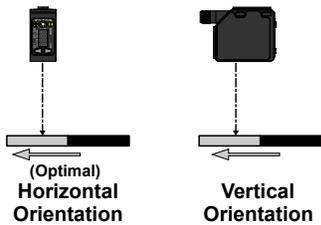


Figure 7. Orientation for a color or luster difference

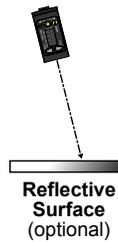


Figure 8. Orientation for highly reflective target¹

2.2 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.

¹ 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 Wiring Diagram

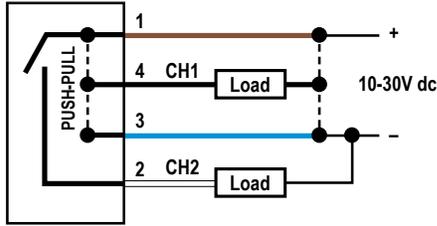


Figure 9. Channel 2 as PNP Discrete or PFM Output

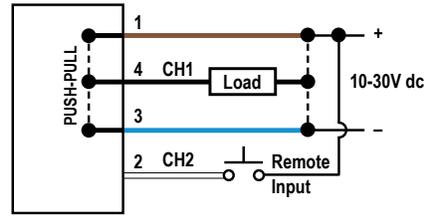
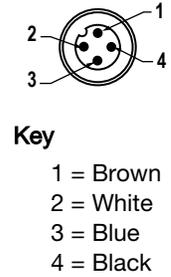


Figure 10. Channel 2 as Remote Input



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



Note: The Channel 2 wire function and polarity is user-selectable. The default for the wire is PNP output.

NPN Discrete Outputs

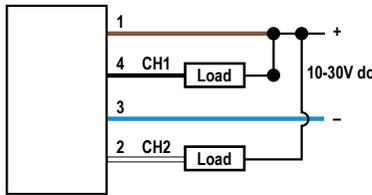


Figure 11. Channel 1 = NPN Output, Channel 2 = NPN Output

PNP Discrete Outputs

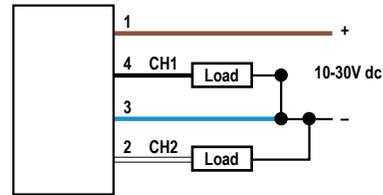


Figure 12. Channel 1 = PNP Output, Channel 2 = PNP Output

NPN Output and Remote Input

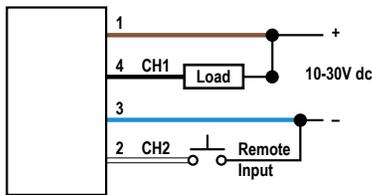


Figure 13. Channel 1 = NPN Output, Channel 2 = NPN Remote Input

PNP Output and Remote Input

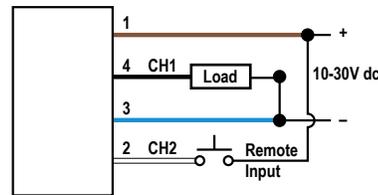


Figure 14. Channel 1 = PNP Output, Channel 2 = PNP Remote Input

2.4 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](#) on page 20 for more information.

3.1 Channel 1 and Channel 2 (CH1/CH2)

Press CH1/CH2 button to switch between Channel 1 and Channel 2. Within each channel there are options specific to that channel. For settings that are common to both channels, the menus are only available in Channel 1. The default is Channel 1.

To switch between Channel 1 and Channel 2:

1. Press and hold **CH1/CH2** for longer than 2 seconds. The current selection displays.
2. Press **CH1/CH2** again. The new selection flashes slowly.
3. Press **SELECT** to change the Channel and return to Run mode.



Note: If neither **SELECT** nor **CH1/CH2** are pressed after step 2, the new selection flashes slowly for a few seconds, then flashes quickly and the sensor automatically changes the Channel 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 **End** and press **SELECT**.



Note: The number that follows a menu option, for example **ech 1**, indicates the channel that is selected. For menu items without a number (excluding submenu items), these menu options are only available from Channel 1 and the settings apply to both channels.

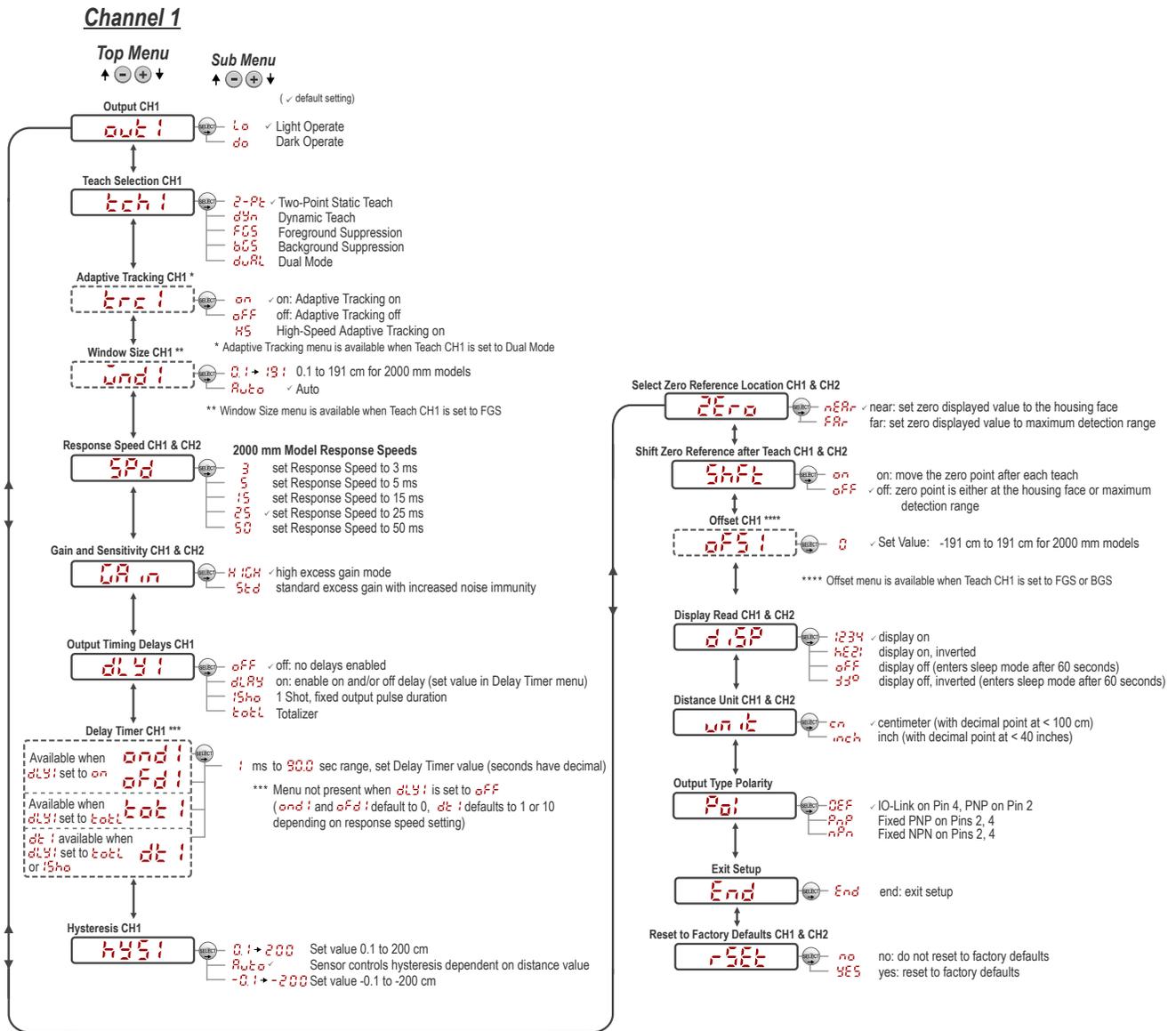


Figure 15. Sensor Menu Map—Channel 1

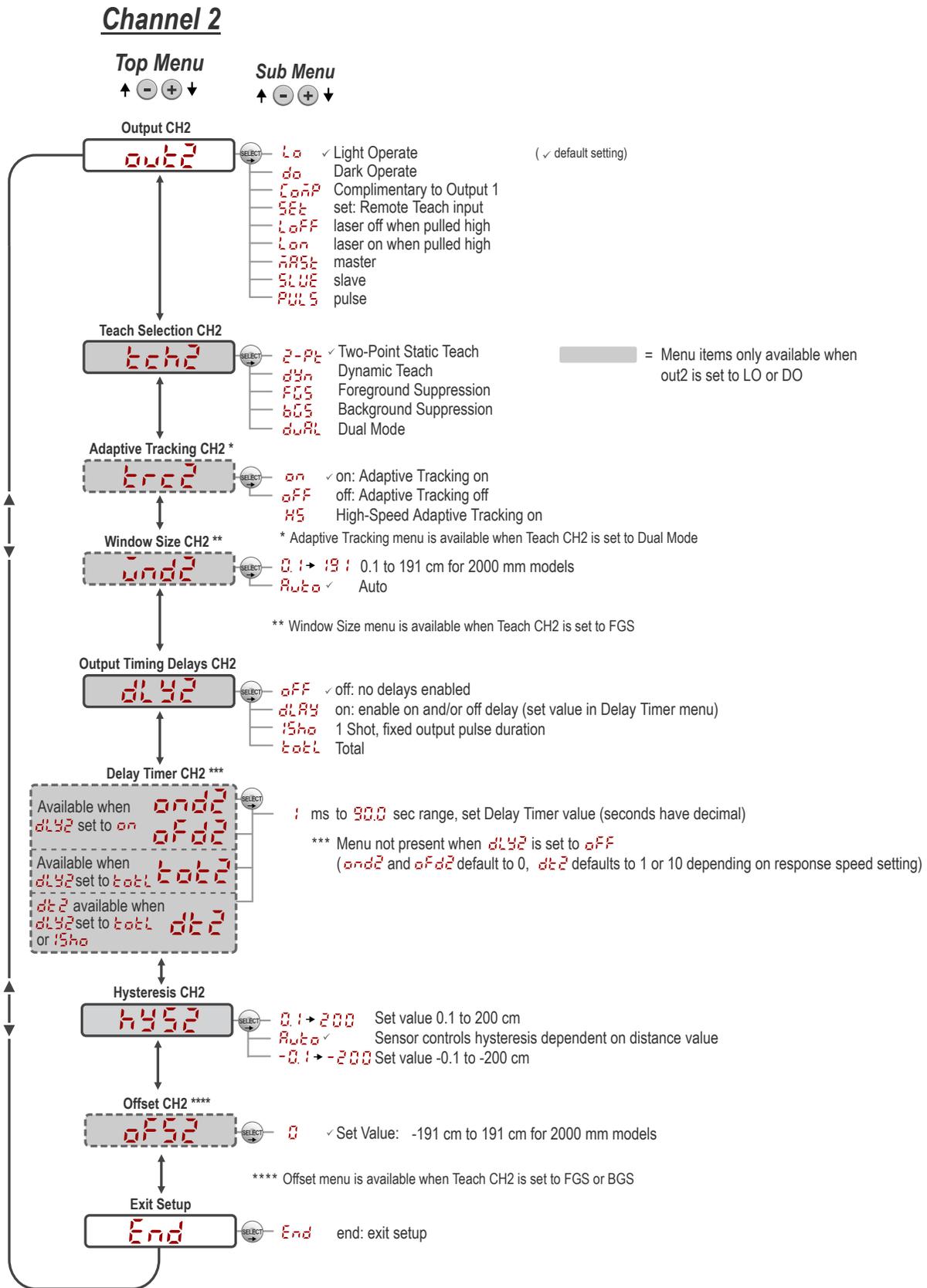


Figure 16. Sensor Menu Map—Channel 2

3.2.1 Output `out 1` `out 2`

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

The Output 1 menu is available in Channel 1. Use this menu to select light operate (LO) or dark operate (DO). The default output configuration is light operate. To switch between light operate and dark operate, select the desired menu option.

- `lo` – Light operate
- `do` – Dark operate

The Output 2 menu is available in Channel 2. Use this menu to set the output configuration for Channel 2. The default is light operate.

- `lo` – Light operate
- `do` – Dark operate
- `comp` – Complementary to output 1
- `set` – Remote TEACH input
- `loff` – Laser off when pulled high
- `lon` – Laser on when pulled high
- `rst` – Master sync line output for two-sensor cross-talk avoidance
- `slve` – Slave sync line output for two-sensor cross-talk avoidance
- `puls` – Pulse Frequency Modulation (PFM) output (see [Pulse Frequency Modulation \(PFM\) Output](#) on page 27)

To configure the sensor for master-slave operation, see [Sync Master/Slave](#) on page 27.

3.2.2 TEACH Mode `tch 1` `tch 2`

Use this menu to select the TEACH mode. The default is two-point TEACH. For Channel 2, this menu is available when the output is set to light operate or dark operate.

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

- `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](#) on page 21 for additional information and remote input TEACH instructions.

3.2.3 Adaptive Tracking `trc 1` and `trc 2`

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 sensor (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.

3.2.4 Window Size **und1 und2**

Use this menu to manually set a window size for subsequent TEACH operations. This menu is available only if one-point window (foreground suppression) mode is selected. The default selection is Auto, where the foreground suppression (FGS) window size is automatically calculated.

This setting is automatically applied during any subsequent teach operation. The window size value represents a \pm cm value, so the total window size is twice this value. For example, a window set of 10 cm gives a 20 cm window centered around the taught point. The window size can also be changed directly from Run mode after changing the setting to any value except Auto. For Channel 2, the output must be set to light operate or dark operate.

Values: 0.1 cm to 191 cm

3.2.5 Response Speed **SPd** —2000 mm Models

Use this menu to select the response speed.

Default: 25 milliseconds

Table 1: Tradeoffs

Response Speed	Response Speed in Sync Mode	Repeatability	Ambient Light Rejection	Excess Gain
3 ms	6 ms	1000 μ s	Disabled	See Excess Gain in Specifications on page 30
5 ms	10 ms	1600 μ s	Enabled	
15 ms	30 ms	3 ms	Enabled	
25 ms	50 ms	5 ms	Enabled	
50 ms	100 ms	10 ms	Enabled	

3.2.6 Gain and Sensitivity `GA n`

Use this menu to set the excess gain mode. This menu is only available when a 15, 25, or 50 millisecond response speed is selected. It is not available for 3 or 5 millisecond response speeds.

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

3.2.7 Output Timing Delays `dLY 1 dLY2`

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. For Channel 2, this menu is available when the output is set to light operate or dark operate.



Note: The number that follows `dLY` on the display indicates which channel is selected.

- `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
- `totL` – Totalizer – enables an output after a defined number of targets are counted

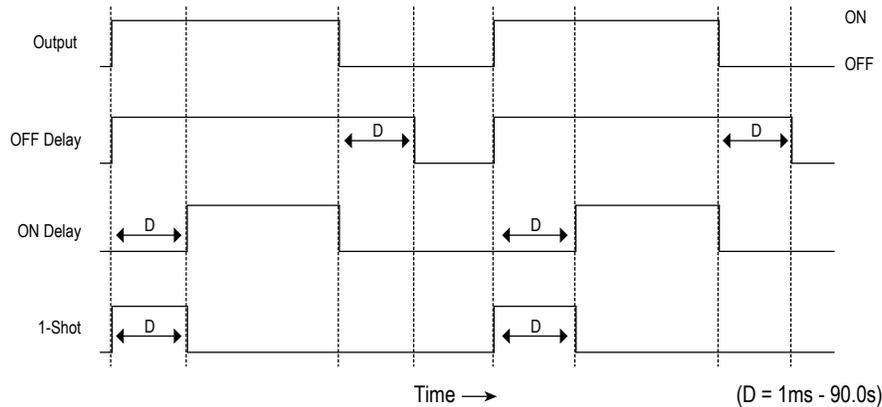


Figure 17. Output Timing Delays

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 / dt 2` – 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)

`totL`

- `dt 1 / dt 2` – Output duration
- `tot 1 / tot 2` – Number of counts before an output change

Delay Timers *and1 and2 ofd1 ofd2 dt1 dt2*

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

For *and* and *ofd*, the default is 0.

For *dt1*, the defaults are:

- 10 milliseconds for 15, 25, and 50 millisecond response speeds
- 1 millisecond for 3 and 5 milliseconds response speeds

Use \oplus and \ominus to scroll through the values. Millisecond values do not include the decimal point; seconds values include the decimal point.

- 1 to 999 ms (when *dt1* is selected, the 1 to 9 ms range is available for 3 and 5 ms response times)
- 1.0 to 90.0 s

Totalizer *tot1*

The totalizer function changes the output only after counting a designated number of targets. After selecting this function, *dt1* or *dt2* become available to define the output duration and *tot1* or *tot2* to define required number of counts before the output changes.

For *tot1* and *tot2*, the default is 1 count.

For *dt1* and *dt2*, the default is 10 milliseconds. Use \oplus and \ominus to scroll through the values. Values in millisecond do not include the decimal point; values in seconds include the decimal point.

- 1 to 999 ms (when *dt1* or *dt2* is selected, the 1 to 9 ms range is available for 1.5, 2, 3, and 5 ms response times)
- 1.0 to 90.0 s

From Run mode, press **SELECT** to change the display to show the current totalizer count. Pressing **SELECT** again changes the display back to the measured distance.

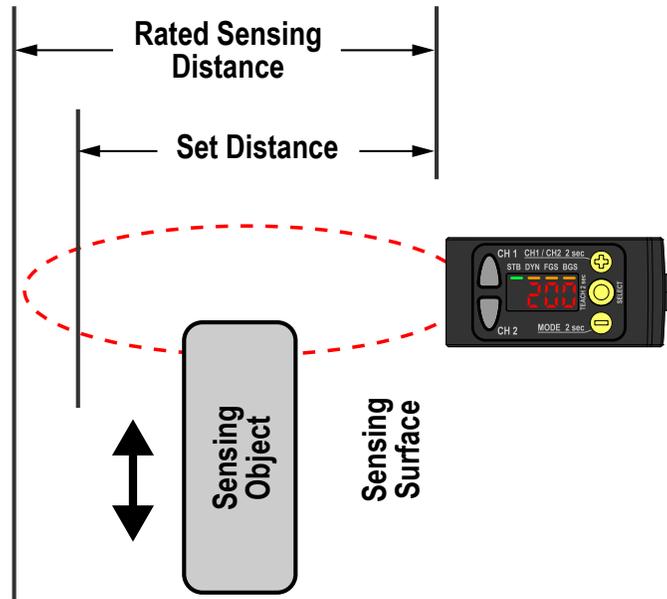
The totalizer count automatically resets after re-teaching the switch point distance or turning the sensor off.

3.2.8 Hysteresis *hys1* and *hys2*

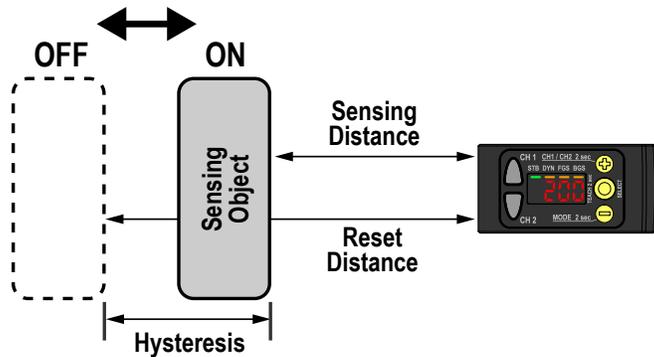
Use this menu to set the hysteresis distance around the switch point.

- *Auto* – The sensor automatically selects a recommended minimum hysteresis distance relative to the current switch point distance,
- to *200* – Enter a user-selectable value (cm) of hysteresis distance relative to the current switch point distance.

Set Distance—The distance from the reference surface that allows stable use, including the effects of temperature and voltage, to the (standard) sensing object transit position. This is approximately 70% to 80% of the normal (rated) sensing distance.



Hysteresis (Differential Travel)—With respect to the distance between the standard sensing object and the sensor, the difference between the distance at which the sensor operates and the distance at which the sensor resets.



Note: Smaller hysteresis values cause the output to switch state with less differential travel. A larger hysteresis value makes the output state to remain unchanged with larger differential travel. Negative hysteresis values allow the operator to move the hysteresis to either side of the switch point.

3.2.9 Zero Reference Location **ZERO**

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

3.2.10 Shift the Zero Reference Location after a TEACH **SHIFT**

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 **Zero** 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. Shifting the zero reference location only affects the readout on the display and does not affect the output.

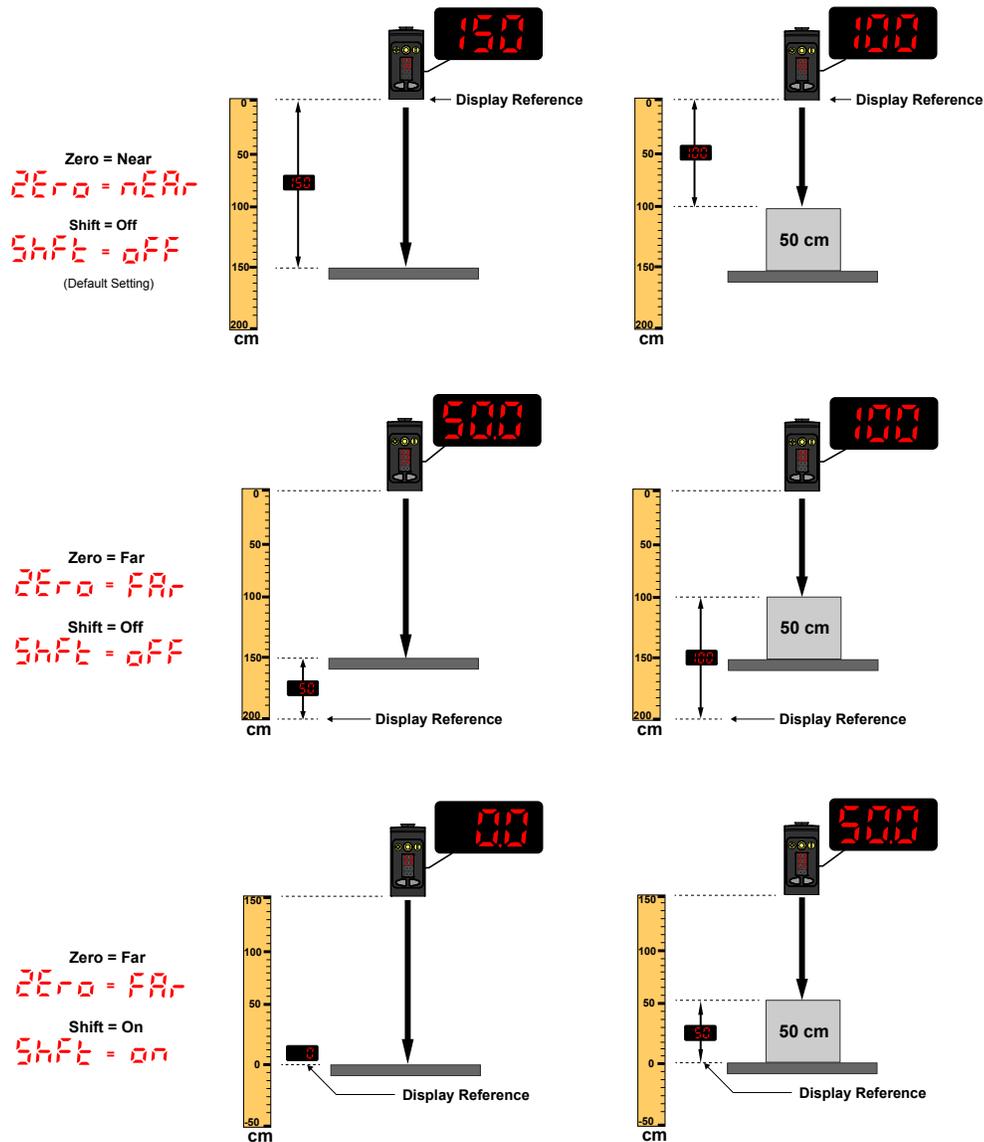


Figure 18. Example Zero and Shift settings

3.2.11 Offset **oFS1** **oFS2**

Use this menu to set an offset from the taught surface during a TEACH procedure.. This menu is available only if one-point window (foreground suppression) mode or one-point background suppression mode is selected. For Channel 2, the output must be set to light operate or dark operate.



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

The offset is automatically calculated or manually defined as a consistently applied value. **Auto** is the default option. Use +/- to select a value. Values increase or decrease by up to 191 cm (2000 mm models).

For BGS mode, the default is **Auto** because the Q5X automatically selects where to position the switch point. For FGS mode, the default is 0 because the window is centered around the taught target.

A positive offset value always shifts the switch point location or the FGS window towards the sensor.

The taught surface must be inside of the defined sensing range. When the teach mode is set to FGS, some portion of the window must be located within the sensing range. When the teach mode is set to BGS, the offset value must be within the defined sensing range. If an offset value falls outside of the sensing range, a message displays. See the applicable TEACH procedure for more information.

3.2.12 Display View *d,SP*

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

- *1234* – Right-reading
- *hE21* – Inverted
- *oFF* – Right-reading and the display enters sleep mode after 60 seconds
- *330* – 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.

3.2.13 Units *unit*

Use this menu to set the displayed units to centimeters (cm) or inches (").

- *cm* – centimeter (with a decimal point at < 60 centimeters)
- *inch* – inch (with a decimal point at < 24 inches)

3.2.14 Output Type Polarity *Pol*

Use this menu to select the output polarity.

- *DEF* (Default) – Push-Pull IO-Link on pin 4 and solid state PNP on pin 2
- *PNP* – Solid state PNP on pins 2 and 4
- *NPN* – Solid state NPN on pins 2 and 4

3.2.15 Exit Setup Mode *End*

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

3.2.16 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 (<i>dlY</i>)	<i>oFF</i> – No delay
Display View (<i>d,SP</i>)	<i>1234</i> – Right-reading, no sleep mode
Gain and Sensitivity (<i>GA in</i>)	<i>HIGH</i> – High excess gain mode
Output (<i>out 1, out 2</i>)	<i>LO</i> – Light Operate
Response Speed (<i>SPd</i>)	<i>25</i> – 25 ms
Shift the Zero Reference Location after a TEACH (<i>SHft</i>)	<i>oFF</i> – 0 = the front of the sensor

Setting	Factory Default
TEACH Mode (<i>teach</i>)	<i>2-PT</i> – Two-point TEACH
Zero Reference Location (<i>zero</i>)	<i>near</i> – Measurement increases further from sensor
Hysteresis (<i>hys</i>)	<i>Auto</i> – Sensor controls value
Display Units (<i>unit</i>)	<i>cm</i> – Centimeters
Output Polarity (<i>pol</i>)	<i>def</i> – Default: IO-Link on pin 4 and PNP on pin 2

3.3 Manual Adjustments

Manually adjust the sensor switch point using the  and  buttons.

1. From Run mode, press either  or  one time. The selected channel displays briefly, then 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

Remote input is available from the Channel 2 menu. Set **Out2** to **Set**.

Use the remote input to program the sensor remotely. The remote input provides limited programming options and is Active high. For Active high, connect the white 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 high for longer than 2 seconds.

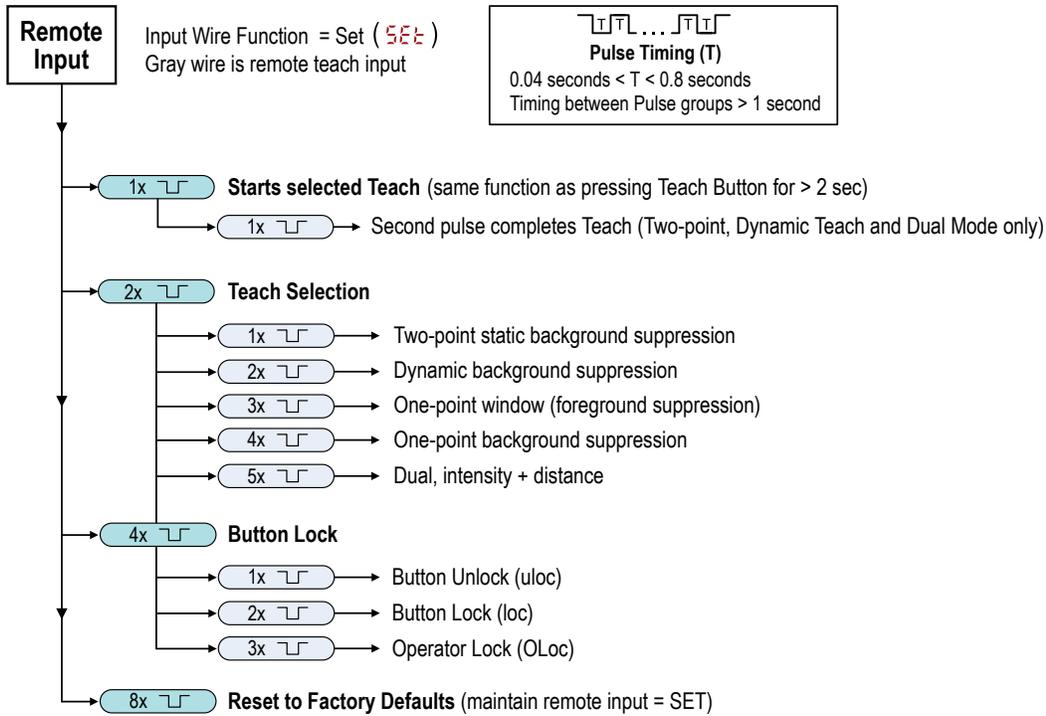


Figure 19. Remote Input Map

3.4.1 Select the TEACH Mode Using the Remote Input

1. Access the TEACH selection.

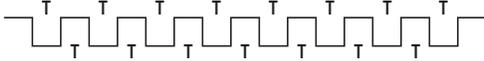
Action		Result
Double-pulse the remote input.		teach displays.

2. Select the desired TEACH mode.

Action		Result
Pulse s	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:

- **wLoc** – 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.



Note: When the sensor is in either **Loc** or **OLoc** mode, the active channel can be changed using (+) (CH1/CH2).

When in **Loc** mode, **Loc** displays when the (SELECT)(TEACH) button is pressed. The switch point displays when (+) (CH1/CH2) or (-)(MODE) are pressed, but **Loc** displays if the buttons are pressed and held.

When in **OLoc** mode, **Loc** displays when (-)(MODE) is pressed and held. To access the manual adjust options, briefly press and release (+)(CH1/CH2) 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 **wLoc**.

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 btn displays.

2. Lock or unlock the sensor buttons.

Action		Result
Single-pulse the remote input to unlock the sensor.		wLoc 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 high for longer than 2 seconds. **Cancel** momentarily displays when a TEACH procedure is canceled.

After any teach operation starts, the display temporarily flashes CH1 or CH2 to confirm which channel is currently selected.

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.

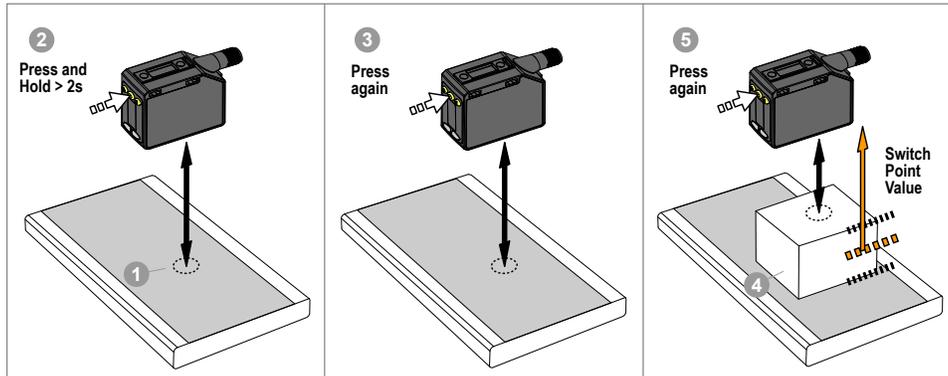


Figure 20. Two-Point Static Background Suppression (Light Operate shown)

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 (**out2 = 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.
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. Set , 2nd , and the current distance measurement flash alternately on the display. The DYN, FGS, and BGS indicators flash.
Remote Input	Single-pulse the remote input. 	

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 24 on page 33 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.	bcs 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.	obut and the switch point distance flash alternately on the display.
Two invalid TEACH points	Sets a switch point for the currently selected channel at 200 cm.	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.

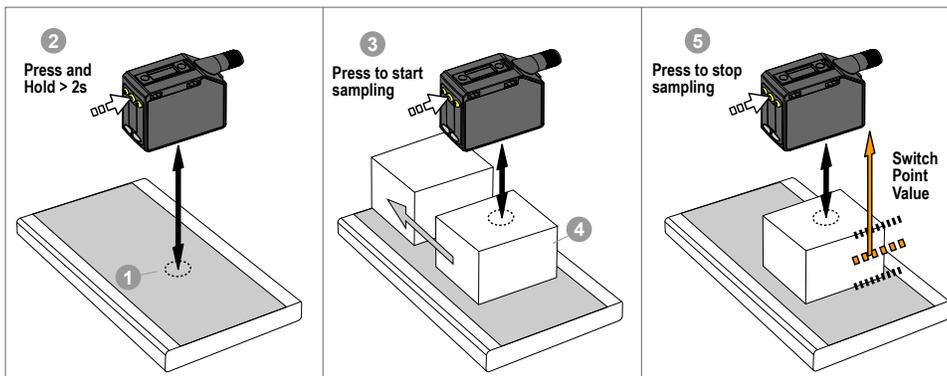


Figure 21. Dynamic Background Suppression

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 ($out2 = SET$).

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 Set 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 24 on page 33 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.	b05 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.	ab0t and the switch point distance flash alternately on the display.
Two invalid TEACH points	Sets a switch point for the currently selected channel at 200 cm.	b05 and the switch point distance flash alternately on the display.

3.6.3 One-Point Window (Foreground Suppression) FGS

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 24](#) on page 33.

Manually adjust the window size from Run mode using \oplus and \ominus .

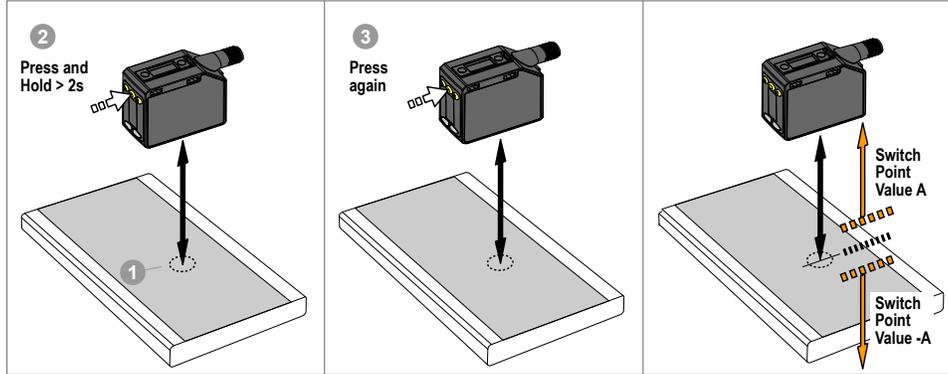


Figure 22. One-Point Window (Foreground Suppression)

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-LF 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 (out2 = 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 \pm 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 24 on page 33 for the minimum object separation.

Condition	TEACH Result	Display
One valid TEACH point with both switch points in range (with offset, if applicable)	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.
One invalid TEACH Point	Sets a window (two switch points) centered around 150 cm. The window size is ± 7.5 cm.	----- and the window center point distance flash alternately on the display.
One valid TEACH point with one switch point within range and one switch point out of range (with offset, if applicable)	Sets a window (two switch points) that is centered at the TEACH point (after offset, if applicable) with one switch point at the maximum range.	----- and the ± window size flash alternately on the display.
One valid TEACH point that, after the offset, results in a both switch points outside of the range	Sets a window (two switch points) centered around 150 cm. The window size is ± 7.5 cm.	ofst and the window center point distance flash alternately on the display.

3.6.4 One-Point Background Suppression b05

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 24 on page 33.

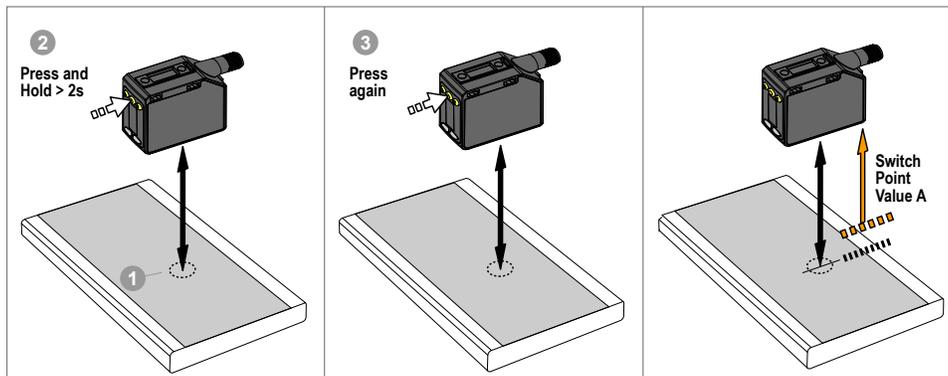


Figure 23. One-Point Background Suppression

Note: The sensor must be set to tch = b05 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 (out2 = 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 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 24 on page 33 for the minimum object separation.

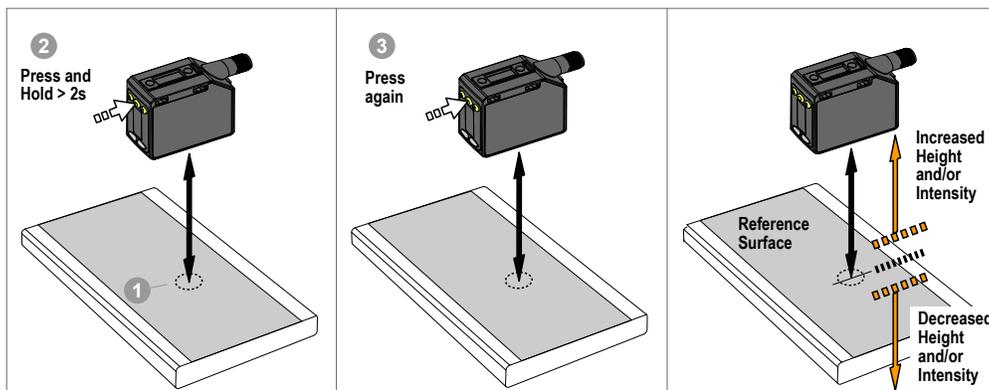
Condition	TEACH Result	Display
One valid TEACH point If an Offset is applied, the TEACH point is still valid	Sets a switch point in front of the taught distance by the vertical minimum object separation.	The switch point distance flashes on the display.
One invalid TEACH point	Sets a switch point at 120 cm.	BGS and the switch point distance flash alternately on the display.
One valid TEACH point that, after offset, becomes invalid	Sets a switch point at 120 cm.	OFFST 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, see [Additional Information](#) on page 34.

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

Note: To program the sensor using remote input, remote input must be enabled (**out2 = 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 \pm 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.
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 Pulse Frequency Modulation (PFM) Output **PULS**

The Q5X can generate pulses whose frequency are proportional to the sensor's measured distance, thereby providing a method for representing an analog signal with only a discrete counter. The sensing range of the sensor is scaled from 100 to 600 Hz (100 Hz equals the near range limit of the sensor, 600 Hz equals the far sensing range limit). An output of 50 Hz represents a Loss of Signal (**LOS**) condition where there is no target or the target is out of the sensor's range.

3.8 Sync Master/Slave

Two Q5X 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: `out2 > MAST` .
2. Configure the second sensor as the slave; navigate: `out2 > SLVE` .
3. Connect the white wires of the two sensors together.

4 IO-Link Interface

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

For the latest IO-Link protocol and specifications, see www.io-link.com.

Each IO-Link device has an IODD (IO Device Description) file that contains information about the manufacturer, article number, functionality etc. This information can be easily read and processed by the user. Each device can be unambiguously identified via the IODD as well as via an internal device ID. Download the Q5X's IO-Link IODD package (p/n 206833) from Banner Engineering's website at www.bannerengineering.com.

Banner has also developed Add On Instruction (AOI) files to simplify ease-of-use between the Q5X, multiple third-party vendors' IO-Link masters, and the Logix Designer software package for Rockwell Automation PLCs. Three types of AOI files for Rockwell Allen-Bradley PLCs are listed below. These files and more information can be found at www.bannerengineering.com.

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

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

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

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

5 Specifications

Sensing Beam

Visible red, Class 2 laser, 650 nm

Supply Voltage (Vcc)

10 to 30 V dc (Class 2 supply) (10% max ripple within limits)

Power and Current Consumption, exclusive of load

< 1 W

Sensing Range

95 mm to 2000 mm (3.74 in to 78.74 in)

Output Configuration

Channel 1: IO-Link, Push/pull output, configurable PNP or NPN output
 Channel 2: Multi-function remote input/output, configurable PNP or NPN, or pulse frequency modulated output

Output Rating

Current rating: 50 mA maximum

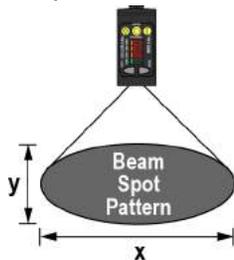
Black wire specifications per configuration		
IO-Link Push/Pull	Output High:	$\geq V_{supply} - 2.5 V$
	Output Low:	$\leq 2.5V$
PNP	Output High:	$\geq V_{supply} - 2.5 V$
	Output Low:	$\leq 1V$ (loads $\leq 1 \text{ Meg}\Omega$)
NPN	Output High:	$\geq V_{supply} - 2.5 V$ (loads $\leq 50 \text{ k}\Omega$)
	Output Low:	$\leq 2.5 V$

White wire specifications per configuration		
PNP	Output High:	$\geq V_{supply} - 2.5 V$
	Output Low:	$\leq 2.5 V$ (loads $\leq 70 \text{ k}\Omega$)
NPN	Output High:	$\geq V_{supply} - 2.5 V$ (loads $\leq 70 \text{ k}\Omega$)
	Output Low:	$\leq 2.5 V$

Remote Input

Allowable Input Voltage Range: 0 to V_{supply}
 Active High (internal weak pull-down): High state > ($V_{supply} - 2.25 V$) at 2 mA maximum
 Active Low (internal weak pull-up): Low state < 2.25 V at 2 mA maximum

Beam Spot Size



Distance (mm)	Size (x × y) (mm)
100	2.6 × 1.5
1000	4.2 × 2.5
2000	6 × 3.6

Beam spot size is calculated as 1.6 times the D4σ measured value

Response Speed

User selectable: 3, 5, 15, 25, or 50 ms

Delay at Power Up

< 2.5 s

Maximum Torque

Side mounting: 1 N·m (9 in·lbs)

Ambient Light Immunity

Up to 5000 lux at 1000 mm
 Up to 2000 lux at 2000 mm

Connector

Integral 4-pin M12/Euro-style quick disconnect

Construction

Housing: ABS
 Lens cover: PMMA acrylic
 Lightpipe and display window: polycarbonate

Temperature Effect (Typical)

< 0.5 mm/°C at < 500 mm
 < 1.0 mm/°C at < 1000 mm
 < 2.0 mm/°C at < 2000 mm

Discrete Output Distance Repeatability

Distance (mm)	Repeatability
95 to 300	$\pm 0.5 \text{ mm}$
300 to 1000	$\pm 0.25\%$
1000 to 2000	$\pm 0.5\%$

Supply Protection Circuitry

Protected against reverse polarity and transient overvoltages

IO-Link Interface

Supports Smart Sensor Profile: Yes
 Baud Rate: 38400 bps
 Process Data Widths: 16 bits
 IODD files: Provides all programming options of the display, plus additional functionality.

Application Note

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

Environmental Rating

IEC IP67 per IEC60529

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 unit operating

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

Shock

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

Operating Conditions

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

Storage Temperature

-25 °C to +70 °C (-13 °F to +158 °F)

Certifications



Class 2 power
UL Environmental Rating: Type 1

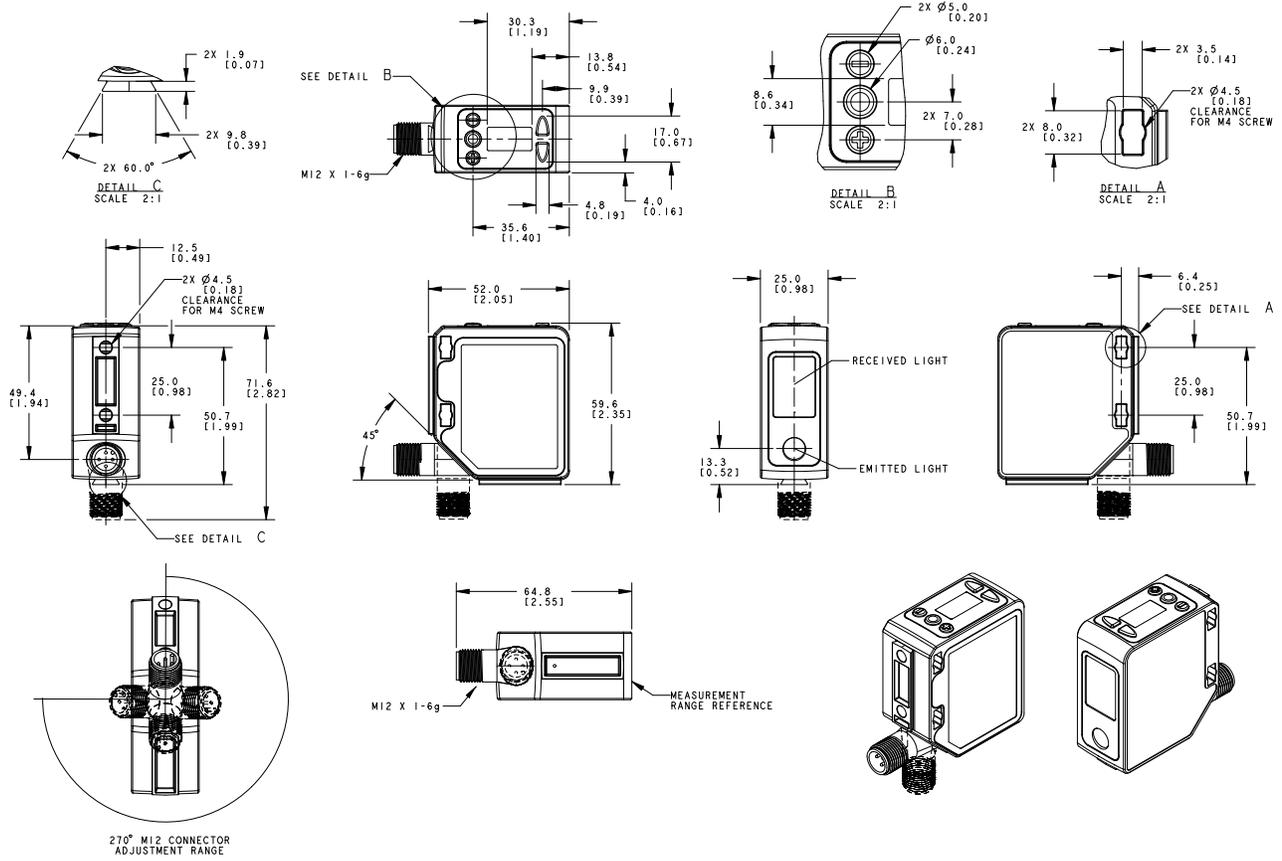


Excess Gain

Response Speed (ms)	Excess Gain Using a 90% White Card ²			
	at 100 mm	at 500 mm	at 1000 mm	at 2000 mm
3	150	50	15	4
5	150	50	15	4
15	725 (225)	250 (75)	70 (25)	15 (6)
25	1250 (800)	450 (250)	125 (70)	30 (15)
50	2500 (1250)	900 (450)	250 (125)	60 (30)

² Standard excess gain available in 15, 25, and 50 ms response speeds; standard excess gain provides increase noise immunity.

5.1 Dimensions



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

5.2 Performance Curves

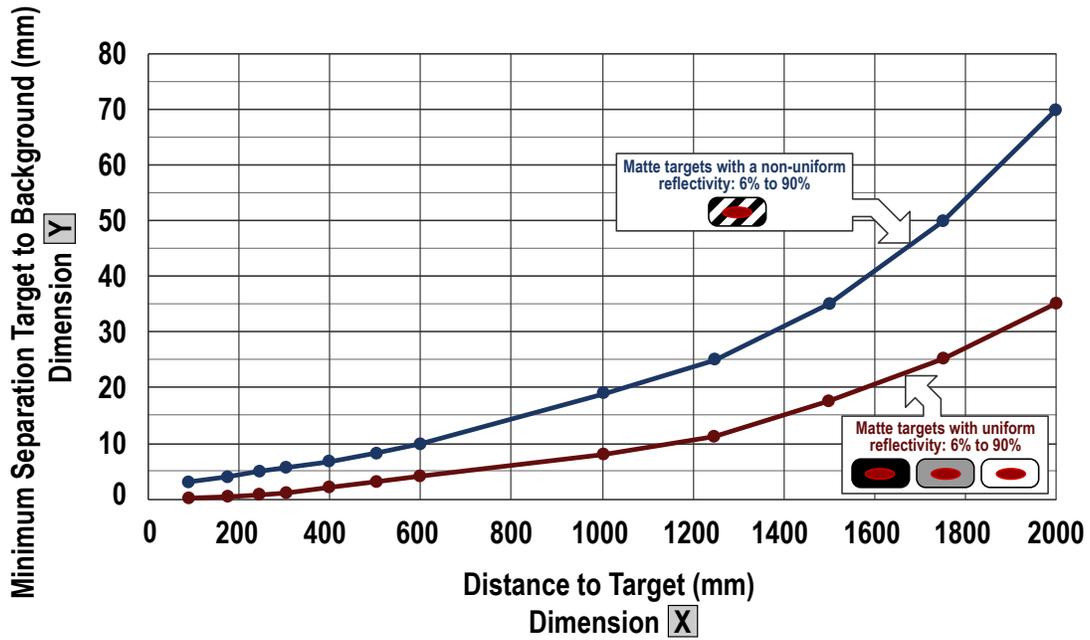


Figure 24. Minimum Object Separation Distance (90% to 6% reflectance)

6 Additional Information

6.1 Dual (Intensity + Distance) Mode

In background suppression (DYN, 1-pt, 2-pt) and foreground suppression (FGS) TEACH modes, the Q5X 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 Q5X can solve by combining distance-based detection with light intensity thresholds. In dual TEACH mode, the user teaches the Q5X 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 Q5X 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 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 $\frac{2}{2}$ and the percent match.

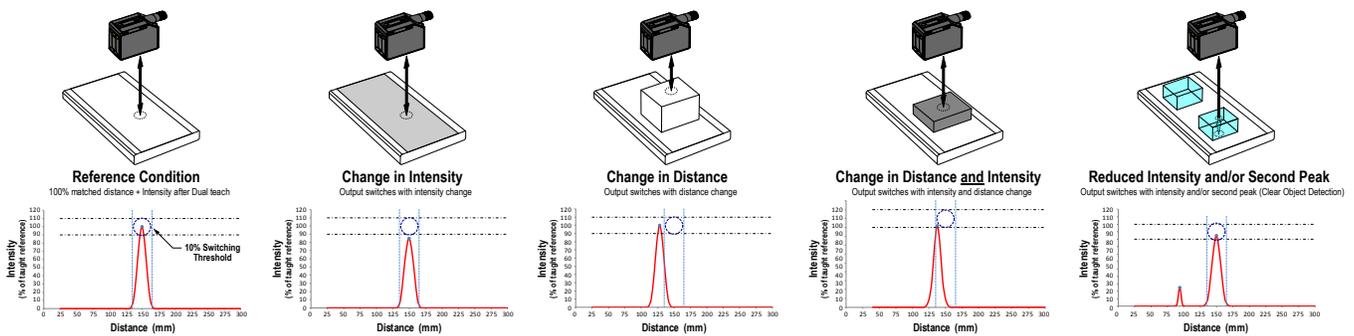


Figure 25. Dual Mode Example

The Q5X 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.

6.2 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 Q5X 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 200 mm (20 cm) and the maximum sensing range.
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.

6.3 Dual Mode Considerations for Clear and Transparent Object Detection

The Q5X 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 Q5X 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

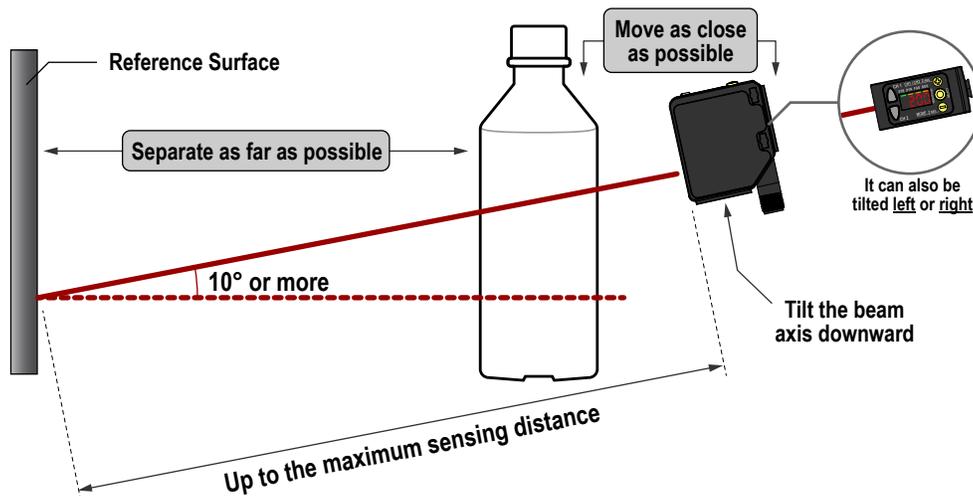
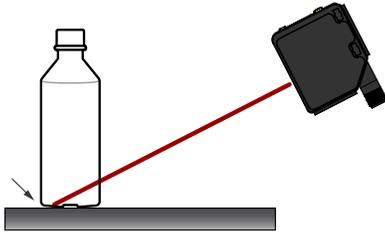


Figure 26. Example mounting considerations

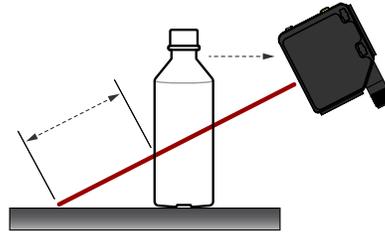
PROBLEM:

The object is close to the reference surface



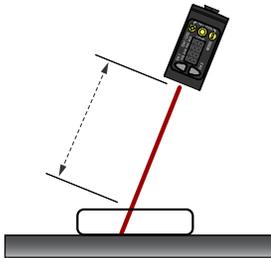
SOLUTION:

Move the target closer to the sensor



PROBLEM:

The sensor is far from the object



SOLUTION:

Move the sensor closer to the target

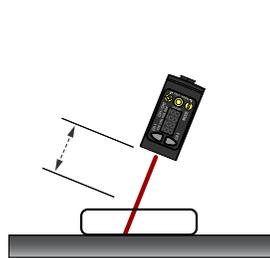


Figure 27. Common problems and solutions for detecting clear objects

6.4 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)
Auto	Automatic
bOS	One-point background suppression
btn	Button
CanCL	Cancel
Comp	Complementary output
d.SP	Display read
dLAY	Delay
dLY1, dLY2	Output timing delay (Channel 1, Channel 2)

Abbreviation	Description
do	Dark operate
dt1 , dt2	Delay timer (Channel 1, Channel 2)
duRL	Dual mode
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
FOS	One-point window (foreground suppression)
FULL	Full range
GAIN	Excess gain
HIGH	High excess gain mode
HS	High speed tracking
HYS	Hysteresis
Lo	Light operate
L on	Laser on
Loc	Lock/locked
LoFF	Laser off
MASt	Master
NEAR	Near zero reference location—the front of the sensor is 0 and the measurement increase as the target moves further away from the sensor
objt	Object
ofd1 , ofd2	Off delay timer (Channel 1, Channel 2)
oFF	Off
oFS1 , oFS2	Offset (Channel 1, Channel 2)
oFSt	An applied offset resulted in an invalid switch point
on	On
ond1 , ond2	On delay timer (Channel 1, Channel 2)
out1 , out2	Output (Channel 1, Channel 2)
Pol	Output type polarity
PULS	Pulse frequency modulation
rSEt	Reset to factory defaults
SAVE	Save
SEt	Set or Input wire = remote teach function

Abbreviation	Description
SHFT	Shift the Zero Reference Location after a TEACH
SLVE	Slave
SPD	Response speed
Std	Standard excess gain mode
Strt	Start
StoP	Stop
tch1, tch2	TEACH process selection (Channel 1, Channel 2)
tot1	Totalizer
tot1, tot2	Total counts
uloc	Unlock/unlocked
unit	Unit
www	Saturated signal (too much light)
wnd1, wnd2	Window size (Channel 1, Channel 2)
YES	Yes
ZEro	Zero—select the zero reference location

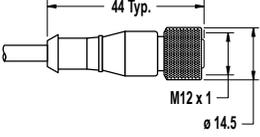
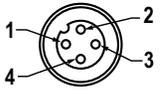
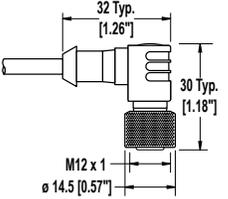
7 Troubleshooting

Table 7: Error Codes

Error Code	Description	Resolution
----	No valid signal in range	Reposition the sensor or the target
uuuu	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
ErrE	EEPROM fault	Contact Banner Engineering to resolve
ErrL	Laser fault	Contact Banner Engineering to resolve
ErrC	Output short-circuited	Check the wiring for an electrical short circuit and to ensure that the wiring is correct
ErrS	System fault	Contact Banner Engineering to resolve

8 Accessories

8.1 Cordsets

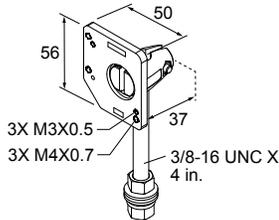
4-Pin Threaded M12/Euro-Style Cordsets				
Model	Length	Style	Dimensions	Pinout (Female)
MQDC-406	1.83 m (6 ft)	Straight		 <p>1 = Brown 2 = White 3 = Blue 4 = Black</p>
MQDC-415	4.57 m (15 ft)			
MQDC-430	9.14 m (30 ft)			
MQDC-450	15.2 m (50 ft)			
MQDC-406RA	1.83 m (6 ft)	Right-Angle		
MQDC-415RA	4.57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

8.2 Brackets

All measurements are listed in millimeters, unless noted otherwise.

SMBQ5X..

- 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

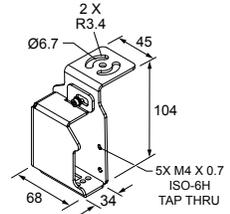


B = 7 × M3 × 0.5

Model	Bolt Thread (A)
SMBQ5XF A	3/8 - 16 × 2¼ in
SMBQ5XFAM10	M10 - 1.5 × 50
SMBQ5XFAM12	n/a; no bolt included. Mounts directly to 12 mm (½ in) rods

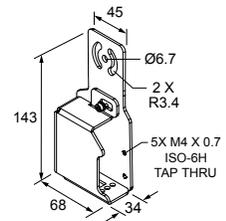
SMBAMSQ5XIPRA

- Enclosed bracket
- 13-ga. Stainless steel with borosilicate glass window
- Right angle mount plate



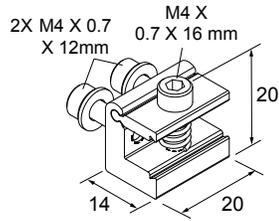
SMBAMQ5XIPP

- Enclosed bracket
- 13-ga stainless steel with a borosilicate glass window
- Flat mount plate



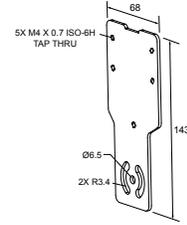
SMBQ5XDT

- Clamp bracket mounts to sensor dovetail
- Translation adjustment for sensor alignment
- Aluminum clamp - 6.5mm maximum plate thickness



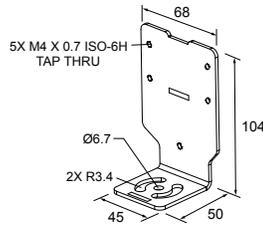
SMBAMSQ5XP

- Flat SMBAMS series bracket
- Articulation slots for 30 deg rotation
- 13-ga. 304 stainless steel



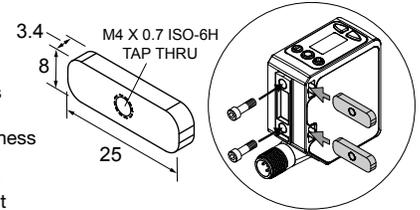
SMBAMSQ5XRA

- Right-angle SMBAMS series bracket
- Articulation slots for 30 deg rotation
- 13-ga. 304 stainless steel



SMBQ5XM4F

- Fixing plates for mounting to back of sensor
- Stainless steel plates
- Customer supplied mounting plate thickness minimum 2 mm maximum 4 mm with screws included in kit

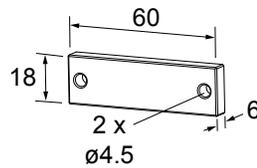


8.3 Reference Targets

All measurements are listed in millimeters, unless noted otherwise.

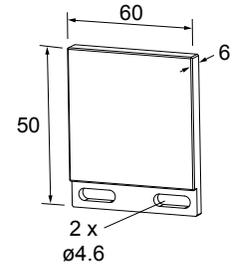
BRT-Q4X-60X18

- 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



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