Q5X with Dual Discrete Outputs and IO-Link Product Manual

Original Instructions
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ПРОМЭЛЕКТРОНИКА/ sales@prom-elec.com

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Chapter 1 Product Description

- Laser measurement sensor with a range of up to 10 m
- Bright output indicators and real-time distance feedback provide easy setup 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:

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

Models

Model	Sensing Range	Channel 1 Default	Channel 2 Default	Connection
Q5XKLAF2000-Q8	95 mm to 2000 mm (4 in to 78 in)	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 male quick-disconnect connector
Q5XKLAF3000-Q8	95 mm to 3000 mm (4 in to 118 in)			
Q5XKLAF5000-Q8	50 mm to 5000 mm (2 in to 196 in)			
Q5XKLAF10000-Q8	50 mm to 10000 mm (2 in to 393 in)			

Overview

The Q5X Laser Measurement Sensor offers 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.

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Features

The Q5X Laser Measurement Sensor has three major features.

Q5X Features



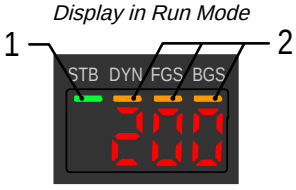
1. Two output indicators (amber)
2. Display
3. Buttons

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 **999P** indicates the sensor has not been taught.

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: The output is on

Off: The output is off

Stability Indicator (STB)

On—Stable signal within the specified sensing range

Flashing—Marginal signal (low excess gain), the target is outside the limits of the specified sensing range, or a multiple peak condition exists

Off—No target is 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

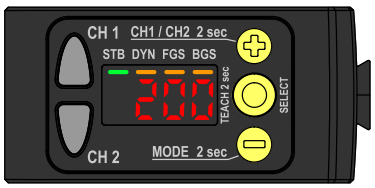
BGS on—Background suppression TEACH mode selected

DYN, FGS, and BGS all on—Dual TEACH mode selected

Buttons

Use the sensor buttons **(SELECT)(TEACH)**, **(+)(CH1/CH2)**, and **(-)(MODE)** to program the sensor.

Button Layout



(SELECT/TEACH)

Press to select menu items in Setup mode

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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.

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Chapter 2 Specifications

Power and Beam Specifications

Supply Voltage (Vcc)
10 V DC to 30 V DC (Class 2 supply) (10% max ripple within limits)

Supply Protection Circuitry
Protected against reverse polarity and transient overvoltages

Power and Current Consumption, exclusive of load
2000 mm and 3000 mm models: < 1 W
5000 mm model: < 1.4 W
10000 mm model: < 1.4 W

Sensing Beam
Visible red Class 2 laser models (see "Class 2 Laser Description and Safety Information" on page 10)

Sensing Range
2000 mm model: 95 mm to 2000 mm (3.74 in to 78.74 in)
3000 mm model: 95 mm to 3000 mm (3.74 in to 118.11 in)
5000 mm model: 50 mm to 5000 mm (2 in to 16.4 ft)
10000 mm model: 50 to 10000 mm (2 in to 32.8 ft)

Delay at Power Up
< 2.5 s

Boresighting
2000 mm model: ±43 mm at 2000 mm
3000 mm model: ± 65 mm at 3000 mm
5000 mm model: ±86 mm at 5000 mm
10000 mm model: ±172 mm at 10000 mm

Housing and Construction

Construction
Housing: ABS
Lens cover: PMMA acrylic
Lightpipe: polycarbonate

Connector
Integral 4-pin M12 male quick-disconnect connector

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

IO-Link Interface
IO-Link Revision V1.1
Smart Sensor Profile: Yes
Baud Rate: 38400 bps
Process Data In Length: 32 bits
Process Data Out Length: 8 bits
Minimum Cycle Time: 3.6 ms
IODD files: Provides all programming options of the display, plus additional functionality.

Environmental Rating
IP67 per IEC60529

Vibration
MIL-STD-202G, Method 201A (Vibration: 10 Hz to 55 Hz, 0.06 inch (1.52 mm) double amplitude, 2 hours each along X, Y and Z axes), with device operating

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

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

Storage Temperature
–25 °C to +70 °C (–13 °F to +158 °F)

Performance and Output Ratings

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

Response Speed
2000 mm model: User selectable 3, 5, 15, 25, or 50 ms
3000 mm model: User selectable
5000 mm model: User selectable 2, 5, 15, 50, or 250 ms
10000 mm model: User selectable 2, 5, 15, 50, or 250 ms

Ambient Light Immunity
2000 mm model:
5000 lux at 1 m
2000 lux at 2 m
5000 and 10000 mm models: 5000 lux

Temperature Effect (Typical) for 2000 mm and 3000 mm Models
< 0.5 mm/°C at < 500 mm
< 1.0 mm/°C at < 1000 mm
< 2.0 mm/°C at < 2000 mm
< 5 mm/°C for < 3000 mm

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Temperature Effect (Typical) for 5000 mm and 10000 mm Models

< 0.5 mm/°C for up to 3000 mm

< 0.75 mm/°C for up to 5000 mm

< 2.0 mm/C for up to 7500 mm

< 6.0 mm/C for up to 10000 mm

Remote Input

Allowable Input Voltage Range: 0 to Vsupply

Active High (internal weak pull-down): High state > (Vsupply – 2.25 V) at 2 mA maximum

Active Low (internal weak pull-up): Low state < 2.25 V at 2 mA maximum

Application Note

For optimum performance, allow 10 minutes for the sensor to warm up for the 2000 mm models and 20 minutes for the 5000 mm and 10000 mm models.

Advanced Capabilities

PULSE® PRO I/O

Output Rating

Current rating: 50 mA maximum

Black wire specifications per configuration		
IO-Link Push/Pull	Output High:	≥ Vsupply - 2.5 V
	Output Low:	≤ 2.5 V
PNP	Output High:	≥ Vsupply - 2.5 V
	Output Low:	≤ 1V (loads ≤ 1 MegΩ)
NPN	Output High:	≥ Vsupply - 2.5 V (loads ≤ 50 kΩ)
	Output Low:	≤ 2.5 V

White wire specifications per configuration		
PNP	Output High:	≥ Vsupply - 2.5 V
	Output Low:	≤ 2.5 V (loads ≤ 70 kΩ)
NPN	Output High:	≥ Vsupply - 2.5 V (loads ≤ 70 kΩ)
	Output Low:	≤ 2.5 V

Discrete Output Distance Repeatability

Distance (mm)	Repeatability (2000 mm Models)	Repeatability (3000 mm Models)
95 to 300	± 0.5 mm	± 0.5 mm
300 to 1000	± 0.25%	± 0.25%
1000 to 2000	± 0.25%	± 0.25%
2000 to 3000		± 1.0%

See the charts for the Repeatability of the 5000 mm and 10000 mm models.

Typical Excess Gain for the 2000 mm Model

High Excess Gain (Standard Excess Gain) Using a 90% White Card				
Response Speed (ms)	at 100 mm	at 500 mm	at 1000 mm	at 2000 mm
3	125	50	15	4
5	125	50	15	4
15	575 (175)	250 (75)	70 (25)	15 (6)
25	1000 (650)	450 (250)	125 (70)	30 (15)
50	2000 (1000)	900 (450)	250 (125)	60 (30)

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

Typical Excess Gain for the 3000 mm Model

High Excess Gain (Standard Excess Gain) Using a 90% White Card					
Response Speed (ms)	at 100 mm	at 500 mm	at 1000 mm	at 2000 mm	at 3000 mm
3	200	80	25	6	3
5	200	80	25	6	3
15	920	400	100	25	12
25	1600	700	200	50	25
50	3200	1400	400	100	50

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

Typical Excess Gain for the 5000 mm Model

Typical Excess Gain Using a 90% White Card (Performance Gain Mode)				
at 50 mm	at 600 mm	at 1000 mm	at 2000 mm	at 5000 mm
50	400	400	175	30

Excess gain is consistent for 15, 50, and 250 ms response speeds. Excess gain is approximately 10% lower in 2 ms and 5 ms response speed modes.

Excess gain in black gain mode is approximately three times higher than in performance gain mode. It is useful for low-reflectivity targets.

Excess gain in shiny gain mode is approximately one-third the excess gain of performance gain mode values. It is useful for highly reflective targets.

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Typical Excess Gain for the 10000 mm Model

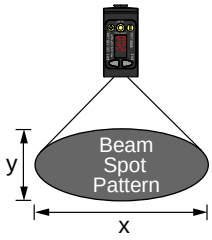
Typical Excess Gain Using a 90% White Card							
at 50 mm	at 600 mm	at 1000 mm	at 2000 mm	at 5000 mm	at 6000 mm	at 7500 mm	at 10000 mm
50	400	400	175	30	20	10	5

Excess gain is consistent for 15, 50, and 250 ms response speeds. Excess gain is approximately 10% lower in 2 ms and 5 ms response speed modes.

Excess gain in black gain mode is approximately three times higher than in performance gain mode. It is useful for low-reflectivity targets.

Excess gain in shiny gain mode is approximately one-third the excess gain of performance gain mode values. It is useful for highly reflective targets.

Beam Spot Size



Beam spot sizes are measured X × Y mm at specific distances.

2000 mm Models:

2.6 × 1.5 mm at 100 mm
4.2 × 2.5 mm at 1000 mm
6 × 3.6 mm at 2000 mm

3000 mm Models:

2.6 × 1.5 mm at 100 mm
4.2 × 2.5 mm at 1000 mm
6 × 3.6 mm at 2000 mm
7.8 × 4.7 mm at 3000 mm

5000 mm Models:

6 × 4 mm at 100 mm
11 × 7 mm at 2500 mm
15 × 11 mm at 5000 mm

10000 mm Models:

7 × 6 mm at 100 mm
16 × 11 mm at 2500 mm
25 × 19 mm at 5000 mm
32 × 25 mm at 7500 mm
41 × 31 mm at 10000 mm

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

Certifications

Certifications

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1831 Diegem, BELGIUM

Turck Banner LTD Blenheim House
Blenheim Court
Wickford, Essex SS11 8YT
GREAT BRITAIN

Industrial Control Equipment 3TJJ

Class 2 power; UL Environmental Rating: Type 1

IO-Link®

VCCI-CISPR 32

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

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Class 2 Laser Description and Safety Information



Laser light. Do not stare into the beam.

Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 56, dated May 8, 2019.

CLASS 2
LASER PRODUCT

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.

CAUTION:

- **Return defective units to the manufacturer.**
- 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 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.

Complies with IEC 60825-1:2014 and EN 60825-1:2014+A11:2021.

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 nm 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.

IMPORTANT: This laser device is not bore-sighted.

Models with maximum range of 2000 mm

Class 2 Laser Characteristics

Output power: All models: < 1.0 mW
Laser wavelength: All models: 650 nm
Pulse duration: 20 µs to 2 ms

Models with a range of 2000 mm to 5000 mm

Class 2 Laser Characteristics

Output Power: All models: < 1.0 mW
Laser wavelength: All models: 650 nm
Pulse Duration: 20 µs to 2 ms

Models with maximum range ≥ 5000 mm

Class 2 Laser Characteristics

Output Power: All models: < 1.0 mW
Laser wavelength: All models: 650 nm
Pulse Duration: 3 µs

FCC Part 15 Class A for Unintentional Radiators

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio

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communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

(Part 15.21) Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

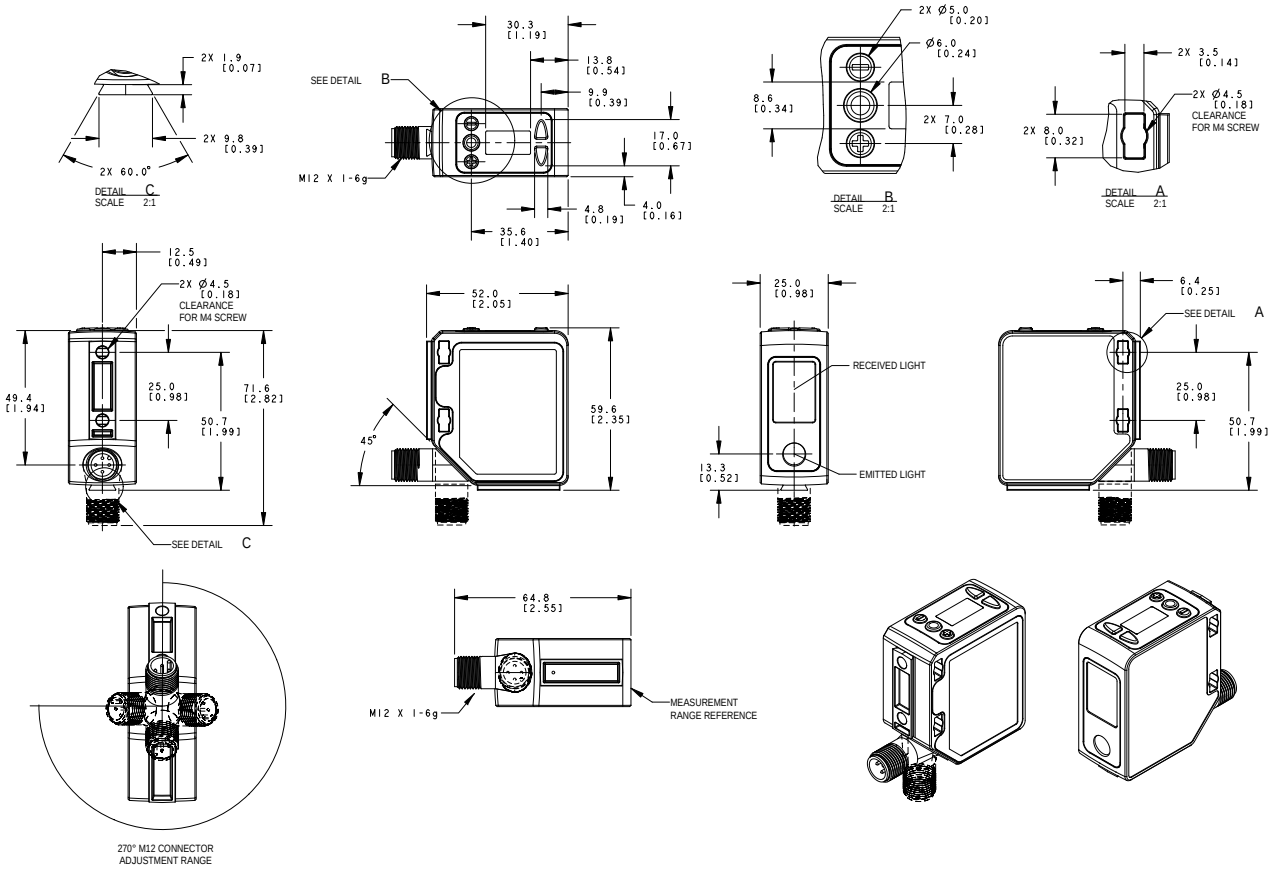
Industry Canada ICES-003(A)

This device complies with CAN ICES-3 (A)/NMB-3(A). Operation is subject to the following two conditions: 1) This device may not cause harmful interference; and 2) This device must accept any interference received, including interference that may cause undesired operation.

Cet appareil est conforme à la norme NMB-3(A). Le fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne peut pas occasionner d'interférences, et (2) il doit tolérer toute interférence, y compris celles susceptibles de provoquer un fonctionnement non souhaité du dispositif.

Dimensions

All measurements are listed in millimeters [inches], unless noted otherwise. The measurements provided are subject to change.



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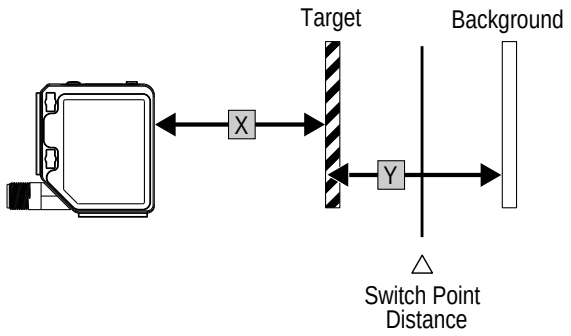
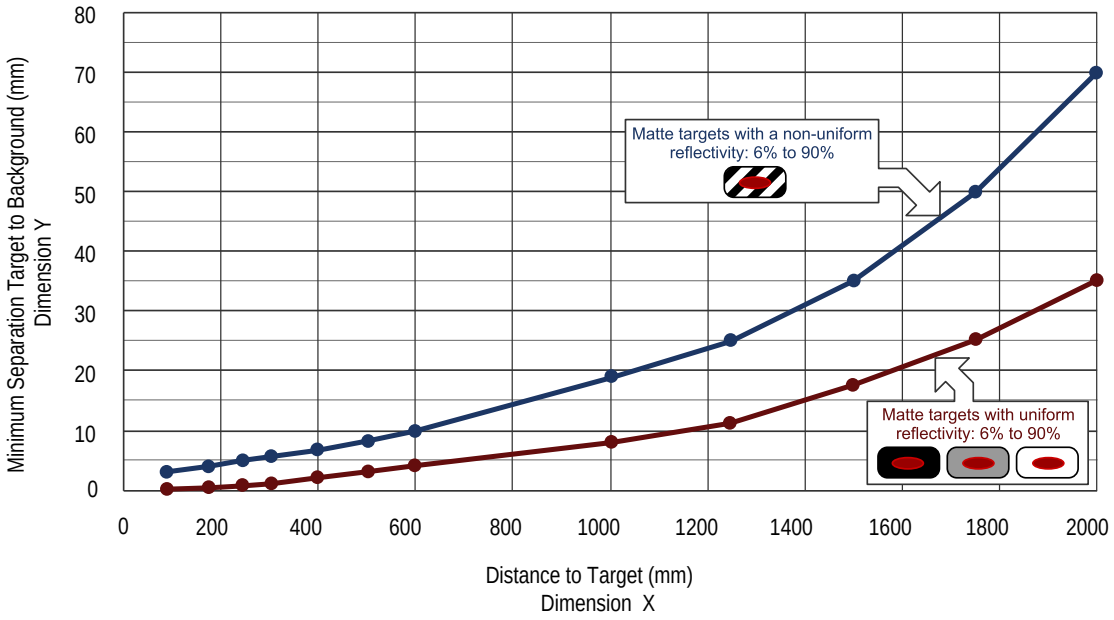
Performance Curves

Minimum object separation distance (90% to 6% reflectance) for the 2000 mm models



Typical performance curves for the 2000 mm models



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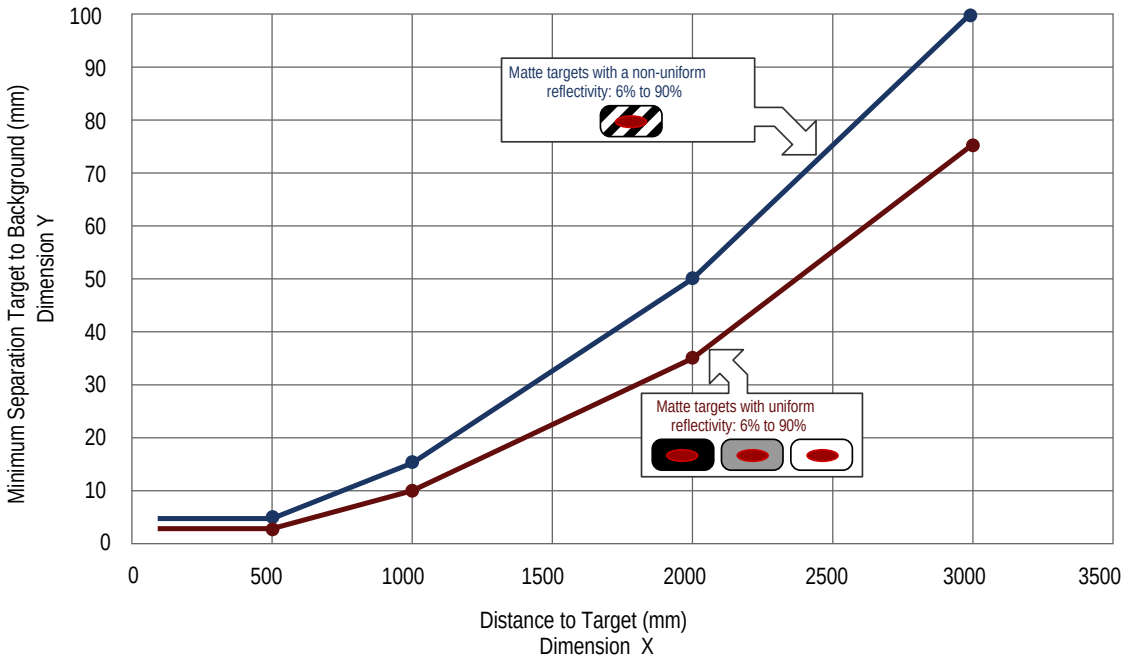
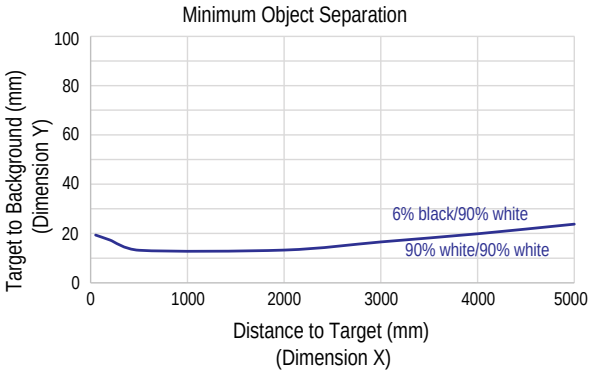
Typical performance curves for the 3000 mm models

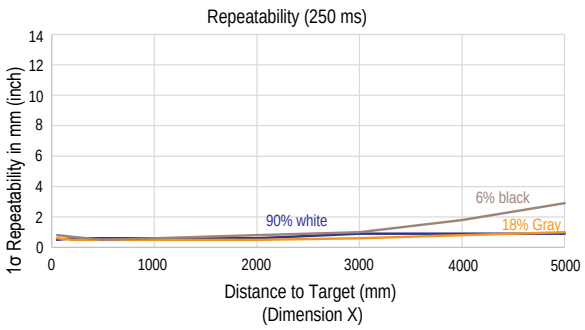


Typical performance curves for the 5000 mm models

Minimum Object Separation for 250 ms Response Time



Repeatability for 250 ms Response Time



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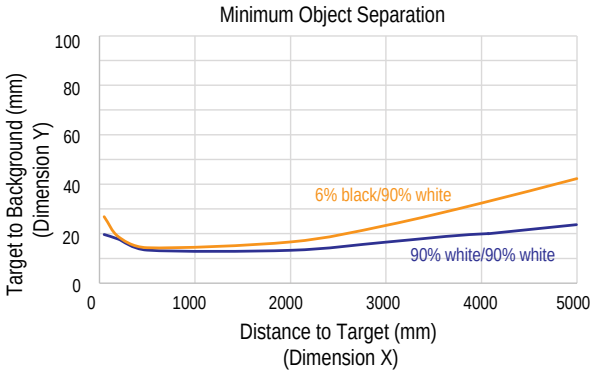
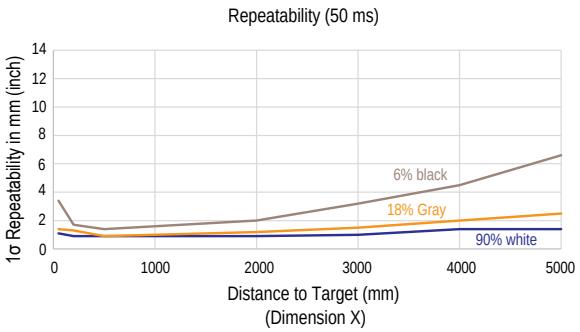
Minimum Object Separation for 50 ms Response Time



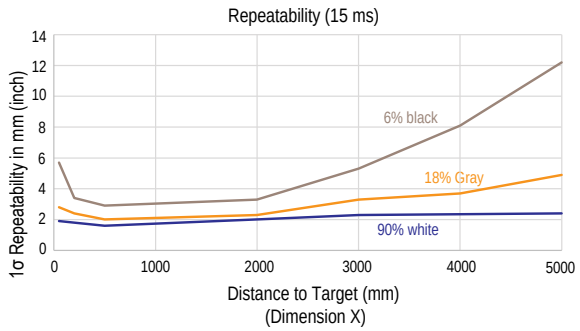
Repeatability for 50 ms Response Time



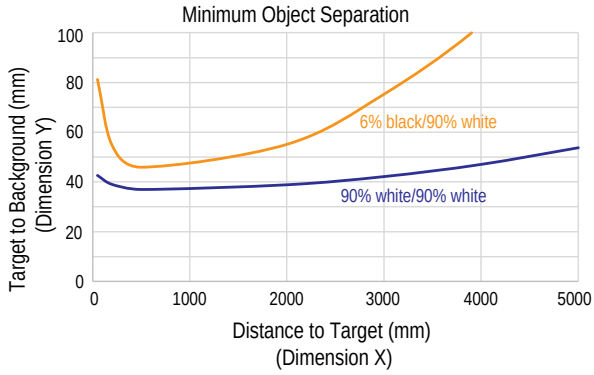
Minimum Object Separation for 15 ms Response Time



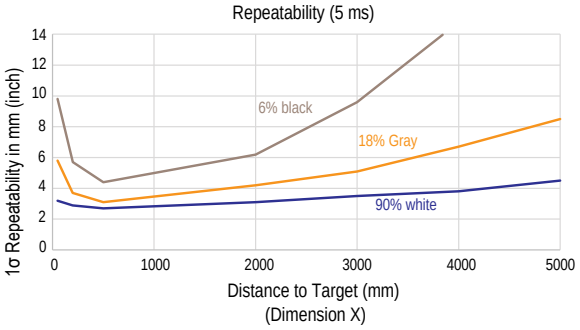
Repeatability for 15 ms Response Time



Minimum Object Separation for 5 ms Response Time



Repeatability for 5 ms Response Time



The Repeatability and Minimum Object Separation for 2 ms mode is approximately twice that of 5 ms mode.

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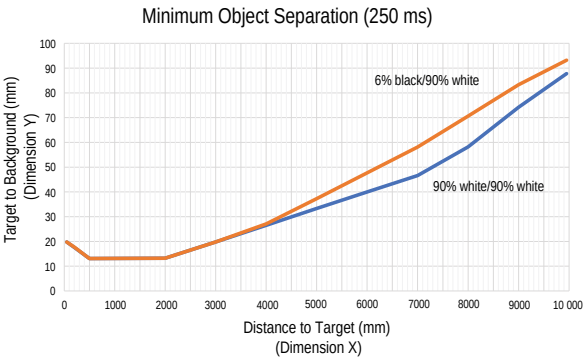
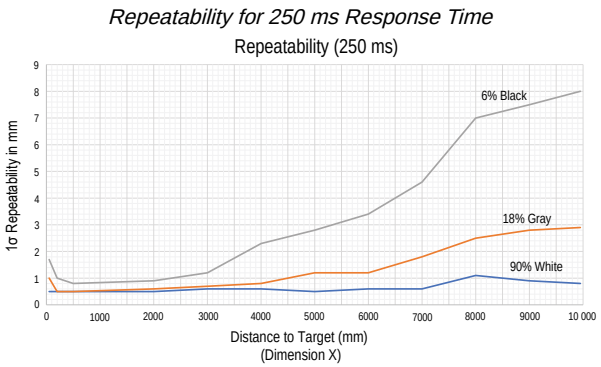
Typical performance curves for the 10000 mm models

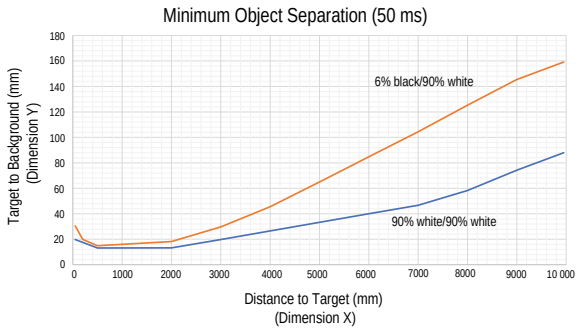
Minimum Object Separation for 250 ms Response Time



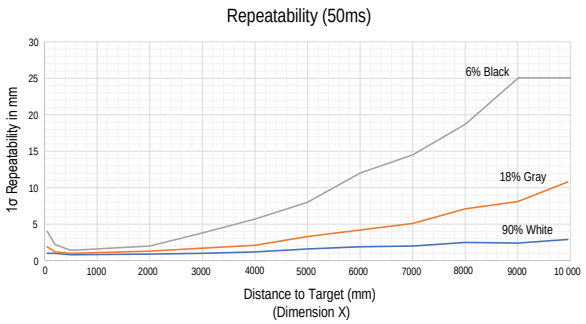
Repeatability for 250 ms Response Time



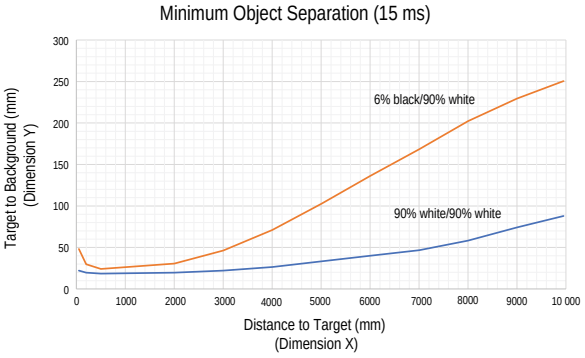
Minimum Object Separation for 50 ms Response Time



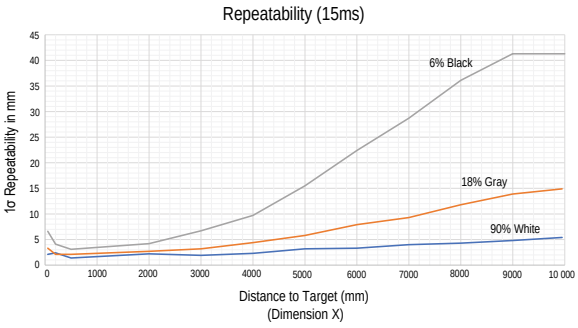
Repeatability for 50 ms Response Time



Minimum Object Separation for 15 ms Response Time



Repeatability for 15 ms Response Time



Continued on page 15

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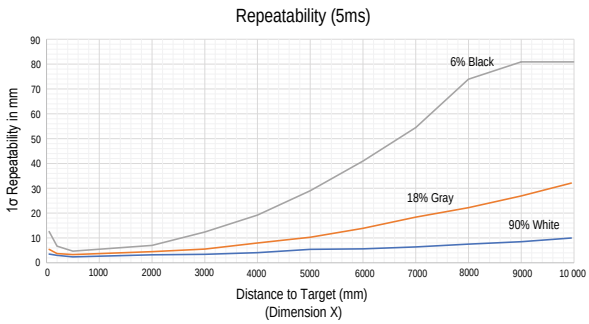
Continued from page 15

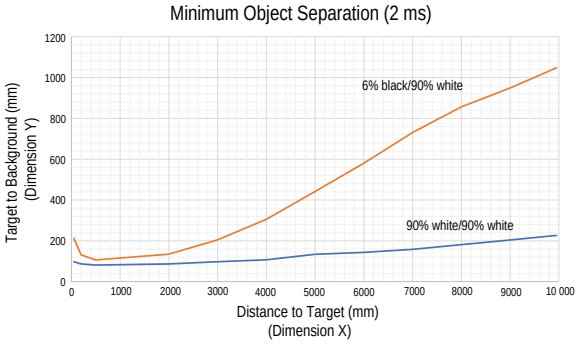
Minimum Object Separation for 5 ms Response Time



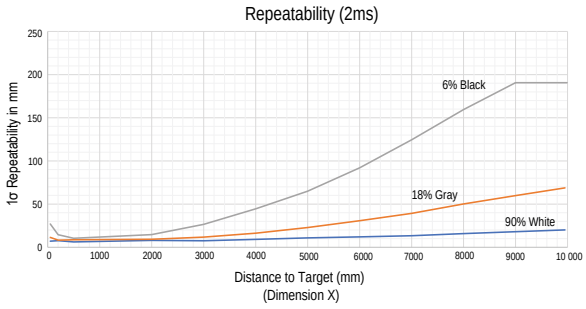
Repeatability for 5 ms Response Time



Minimum Object Separation for 2 ms Response Time



Repeatability for 2 ms Response Time



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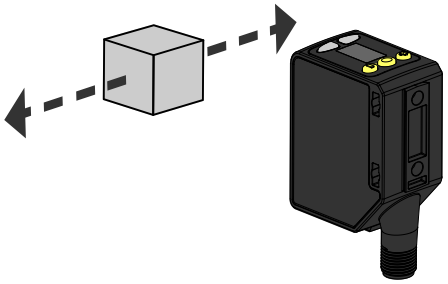
Chapter 3 Installation

Sensor Orientation for the Triangulation Models

Optimize detection reliability and minimum object separation performance with correct sensor-to-target orientation.

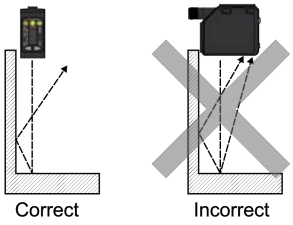
To ensure reliable detection, orient the sensor as shown in relation to the target to be detected.

Optimal Orientation of Target to Sensor

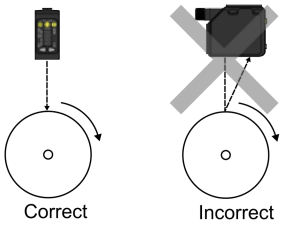


See the following figures for examples of correct and incorrect sensor-to-target orientation as certain placements may pose problems for sensing some targets. The Q5X can be used in the less preferred orientation and at steep angles of incidence and still provide reliable detection performance due to its high excess gain. For the minimum object separation distance required for each case, refer to "Q5X Dual Discrete with IO-Link Performance Curves" on page 12.

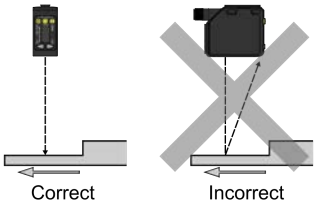
Orientation by a wall



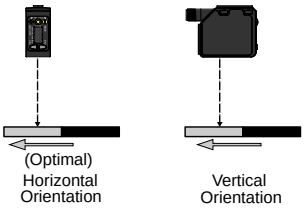
Orientation for a moving object



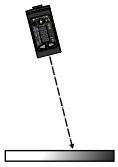
Orientation for a height difference



Orientation for a color or luster difference



Orientation for highly reflective target[1]



[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.*

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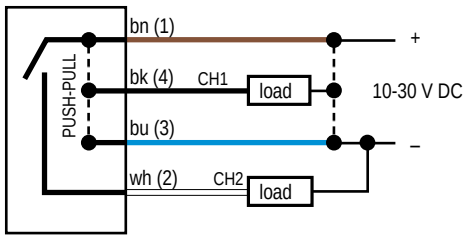
Mount the Device

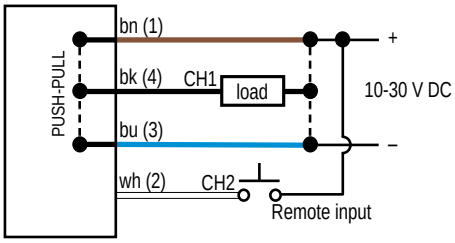
1. If a bracket is needed, mount the device onto the bracket.
2. Mount the device (or the device and the bracket) to the machine or equipment at the desired location. Do not tighten the mounting screws at this time.
3. Check the device alignment.
4. Tighten the mounting screws to secure the device (or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

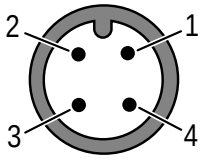
Wiring Diagram

Channel 2 as PNP Discrete or PFM Output



Channel 2 as Remote Input

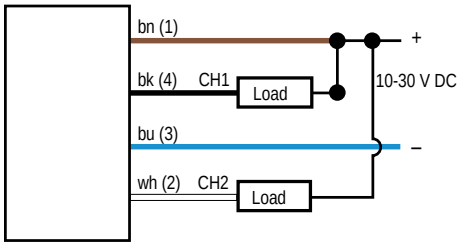




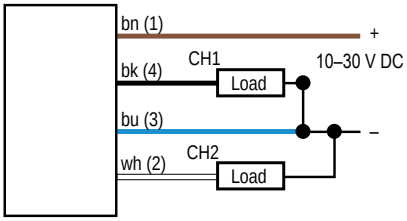
NOTE: Open lead wires must be connected to a terminal block.

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

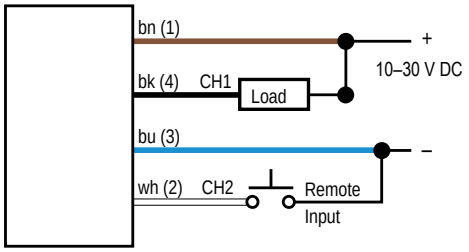
Channel 1 = NPN Output, Channel 2 = NPN Output



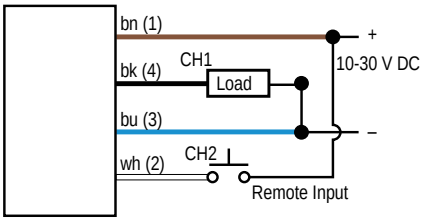
Channel 1 = PNP Output, Channel 2 = PNP Output



Channel 1 = NPN Output, Channel 2 = NPN Remote Input



Channel 1 = PNP Output, Channel 2 = PNP Remote Input



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Clean Sensor with Compressed Air and Water

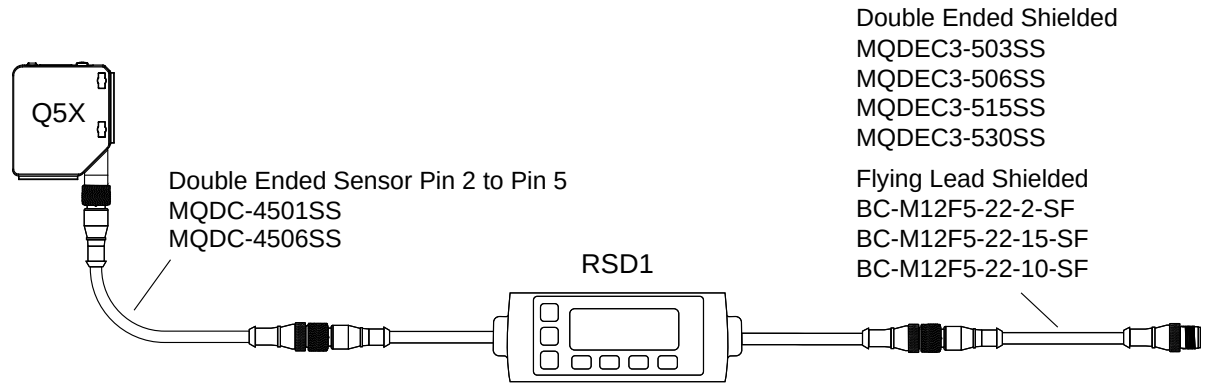
Handle the sensor with care during installation and operation. Sensor windows soiled by fingerprints, dust, water, oil, etc. create stray light that may degrade the peak performance of the sensor.

Blow the window clear using filtered, compressed air, then clean as necessary using only water and a lint-free cloth. Do not use any other chemicals for cleaning.

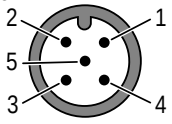
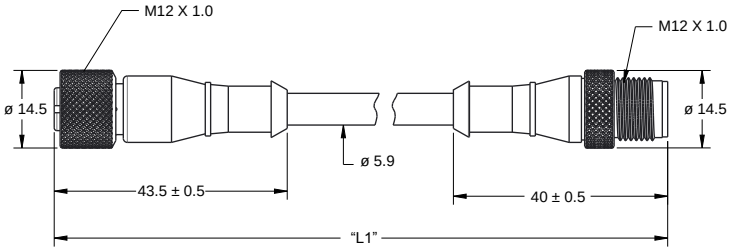
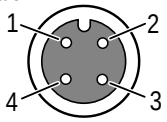
Connecting to RSD1

The following diagram depicts the connection of the Q5X to the optional RSD1 accessory.

Q5X to RSD1



Use these cordsets to connect the RSD1 to the Q5X sensor.

Double-Ended 4-Pin M12 Female to 5-Pin M12 Male Cordsets				
Model	**Length "L1"**	**Style**	**Pinout**	
MQDC-4501SS	0.30 m (0.98 ft)	Female Straight / Male Straight	Male 	1 = Brown 2 = Not Used 3 = Blue 4 = Black 5 = White
MQDC-4506SS	1.83 m (6.00 ft)			
			Female 	1 = Brown 2 = White 3 = Blue 4 = Black

Use these cordsets to connect the RSD1 to any PLC or IO block.

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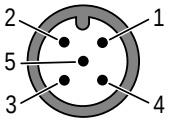
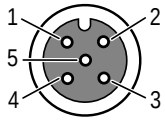
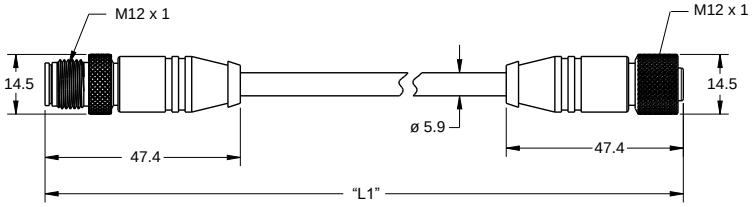
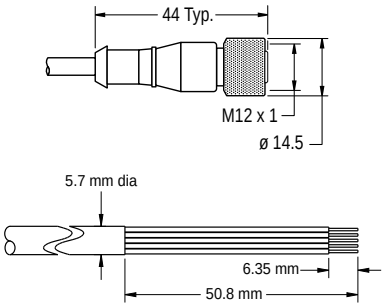
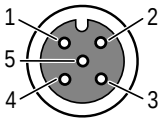
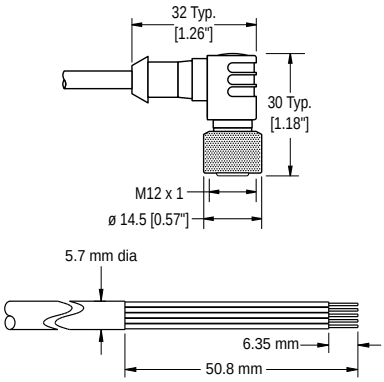
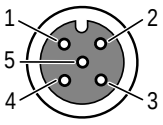
5-Pin Double-Ended M12 Female to M12 Male Shielded Cordset				
Model	**Length "L1"**	**Style**	**Pinout (Male)**	**Pinout (Female)**
MQDEC3-503SS	0.91 m (2.99 ft)	Female Straight/Male Straight		
MQDEC3-506SS	1.83 m (6 ft)			
MQDEC3-515SS	4.58 m (15 ft)			
MQDEC3-530SS	9.2 m (30.2 ft)			
			1 = Brown 2 = White 3 = Blue	4 = Black 5 = Gray

5-pin Single-Ended M12 Female Shielded Cordsets (datasheet p/n 236184)				
Model	**Length**	**Dimensions (mm)**	**Pinout (Female)**	
BC-M12F5-22-1-SF	1 m (3.28 ft)			1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
BC-M12F5-22-2-SF	2 m (6.56 ft)			
BC-M12F5-22-5-SF	5 m (16.4 ft)			
BC-M12F5-22-8-SF	8 m (26.25 ft)			
BC-M12F5-22-10-SF	10 m (30.81 ft)			
BC-M12F5-22-15-SF	15 m (49.2 ft)			

5-pin Single-Ended M12 Female Right-Angle Shielded Cordsets (datasheet p/n 236184)				
Model	**Length**	**Dimensions (mm)**	**Pinout (Female)**	
BC-M12F5A-22-1-SF	1 m (3.28 ft)			1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray
BC-M12F5A-22-2-SF	2 m (6.56 ft)			
BC-M12F5A-22-5-SF	5 m (16.4 ft)			
BC-M12F5A-22-8-SF	8 m (26.25 ft)			
BC-M12F5A-22-10-SF	10 m (30.81 ft)			
BC-M12F5A-22-15-SF	15 m (49.2 ft)			

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Button Map from RSD1 to Sensor

The sensor may be optionally connected to the Banner RSD1 remote display accessory. Refer to this table for the RSD1 button association with your sensor.

Button association between the RSD1 and the Q4X/Q5X sensors

Device	Up Button	Down Button	Enter Button	Escape Button
RSD1				
Q4X and **Q5X**				N/A

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Remote Input Instructions 35
TEACH Procedures 35
Pulse Frequency Modulation (PFM) Output (PULS) 42
Sync Master/Slave 42

Chapter 4 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 35 for more information.

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.

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.

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 **tch1**, 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.

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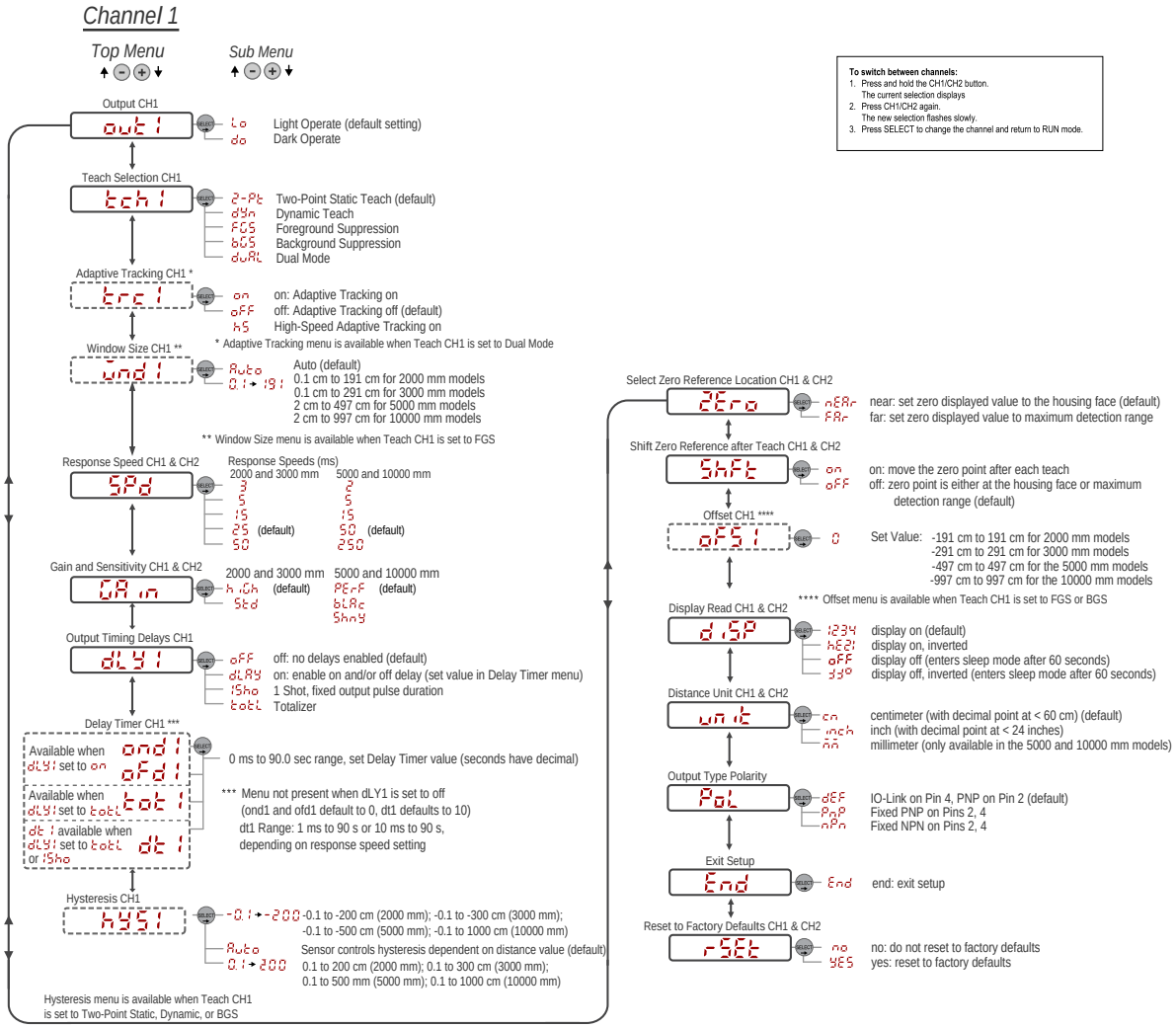
Sensor Menu Map—Channel 1



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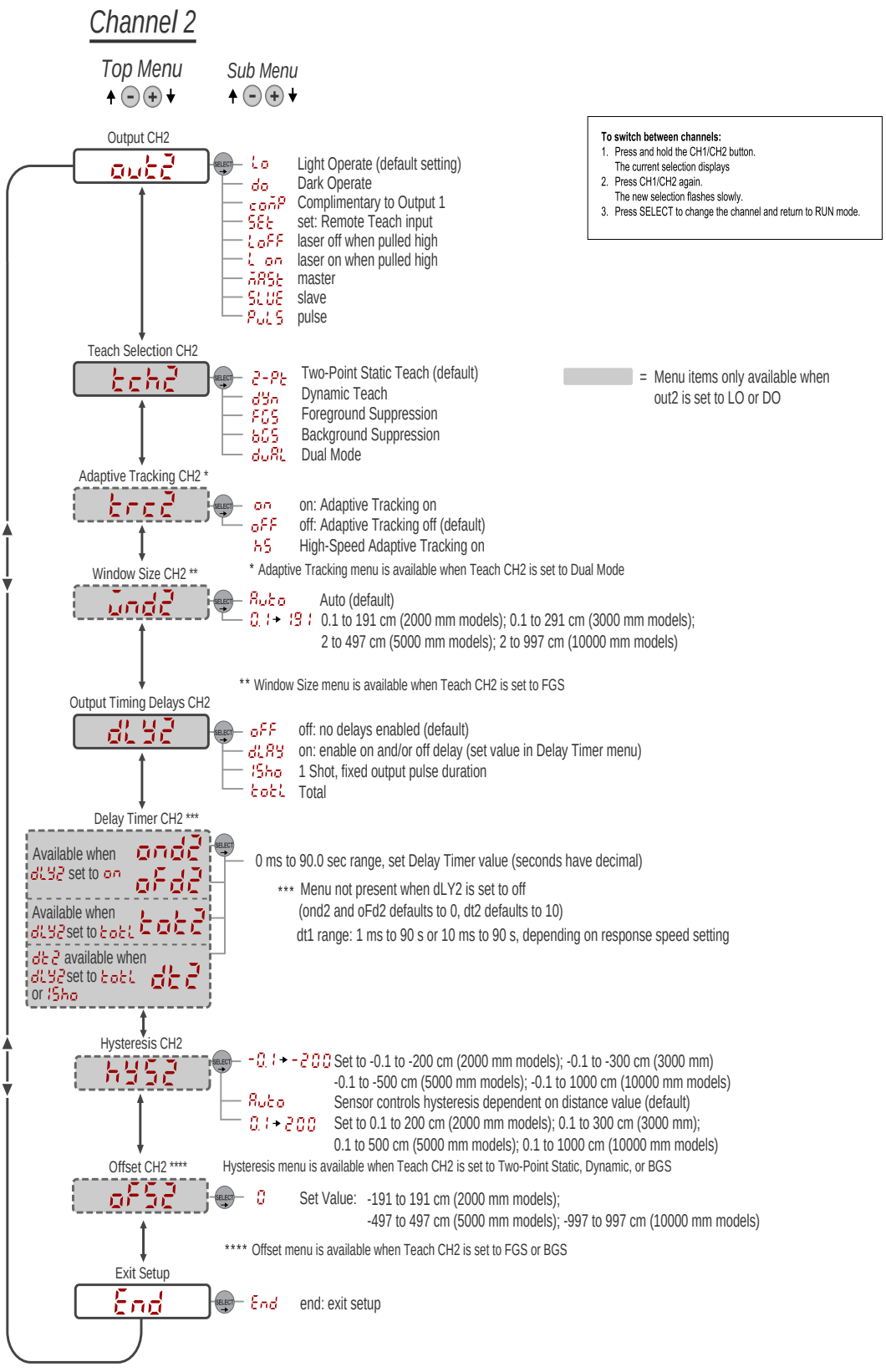
Sensor Menu Map—Channel 2



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Output (out1 and out2)

The Output 1 and Output 2 menus differ between Channel 1 and Channel 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
- L on —Laser on when pulled high
- MASt —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 (PULS)" on page 42)

To configure the sensor for master-slave operation, see "Sync Master/Slave " on page 42.

TEACH Mode (tch1 and tch2)

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
- FOS —One-point window (foreground suppression)
- bOS —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 35 for additional information and remote input TEACH instructions.

Adaptive Tracking (trc1 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 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.

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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 (default)
- oFF —Adaptive Tracking Off

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 that 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 unstable, 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.

Window Size (wnd1 and wnd2)

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 ±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:

2000 mm models: 0.1 cm to 191 cm
5000 mm models: 2 cm to 497 cm

Response Speed (SPd)

Use this menu to select the response speed.

Default:

2000 mm models: 25 ms
5000 mm and 10000 mm models: 50 ms

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2000 mm Models

Response Speed	Response Speed in Sync Mode	Repeatability	Ambient Light Rejection	Excess Gain
3 ms	6 ms	1000 µs	Disabled	See Excess Gain in "Q5X Dual Discrete with IO-Link Specifications" on page 7
5 ms	10 ms	1600 µs	Enabled	
15 ms	30 ms	3 ms	Enabled	
25 ms	50 ms	5 ms	Enabled	
50 ms	100 ms	10 ms	Enabled	

5000 mm and 10000 mm Models

Response Speed	Response Speed in Sync Mode	Excess Gain
2 ms	4 ms	See Excess Gain in "Q5X Dual Discrete with IO-Link Specifications" on page 7
5 ms	10 ms	
15 ms	30 ms	
50 ms	100 ms	
250 ms	500 ms	

Gain and Sensitivity (GAin)

Use this menu to set the excess gain mode.

For 2000 mm models—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

For 5000 mm models—

- PErF—Performance gain mode provides the best performance on the typical range of dark to shiny targets
- bLAc—Black gain mode provides the maximum excess gain and best performance when looking at extremely dark targets with little reflectivity
- ShnY—Shiny gain mode provides the best performance when looking at extremely reflective surfaces.

Output Timing Delays (dLY1 and 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

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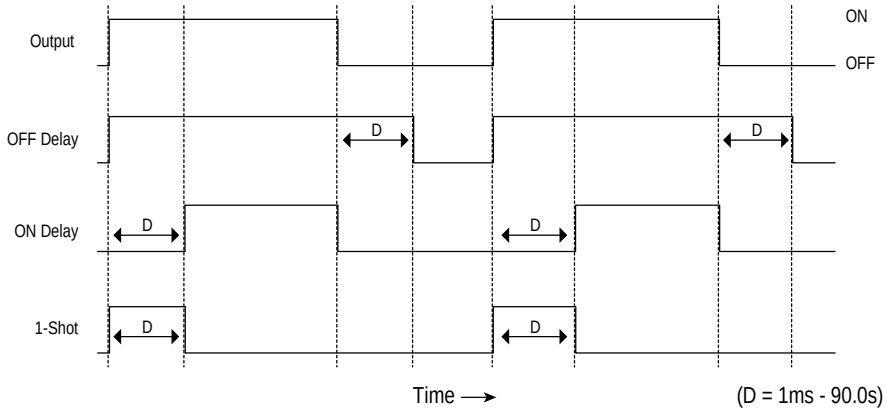
Output Timing Delays



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

- dt1 / dt2 —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

- dt1 / dt2 —Output duration
- tot1/tot2 —Number of counts before an output change

Delay Timers (ond1, ond2, 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 default is 10 milliseconds for all response speeds

Use **+** and **-** to scroll through the values. Values in milliseconds do not include the decimal point; values in seconds 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 (totL)

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 the required number of counts before the output changes.

For **tot1** and **tot2** , the default is 1 count and the maximum is 9999 counts.

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For **dt1** and **dt2**, the default is 10 milliseconds. Use ⊕ and ⊖ to scroll through the values. Values in milliseconds 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.

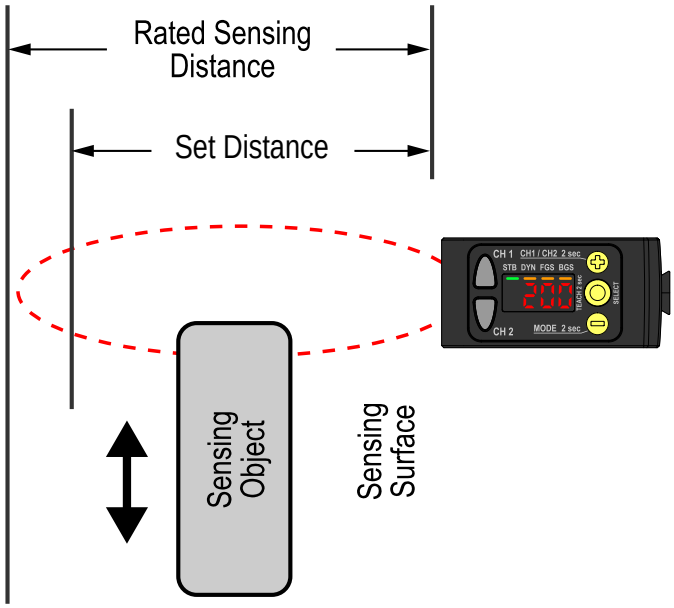
Hysteresis (hYS1 and hYS2)

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.

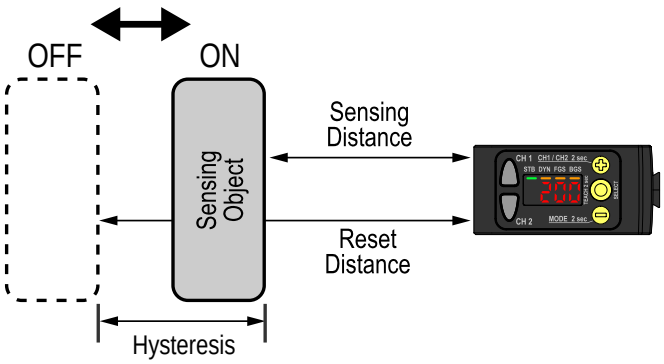
Set Distance—The distance from the reference surface that allows stable use, including the effects of temperature and voltage, to the (standard) sensing object transit position. This is approximately 70% to 80% of the normal (rated) sensing distance.

Set 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.

Hysteresis (Differential Travel)



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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.

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 is the front of the sensor and the measurement increases further from the sensor.
- FAr —0 is the maximum range and the measurement increases closer to the sensor.

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 **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.

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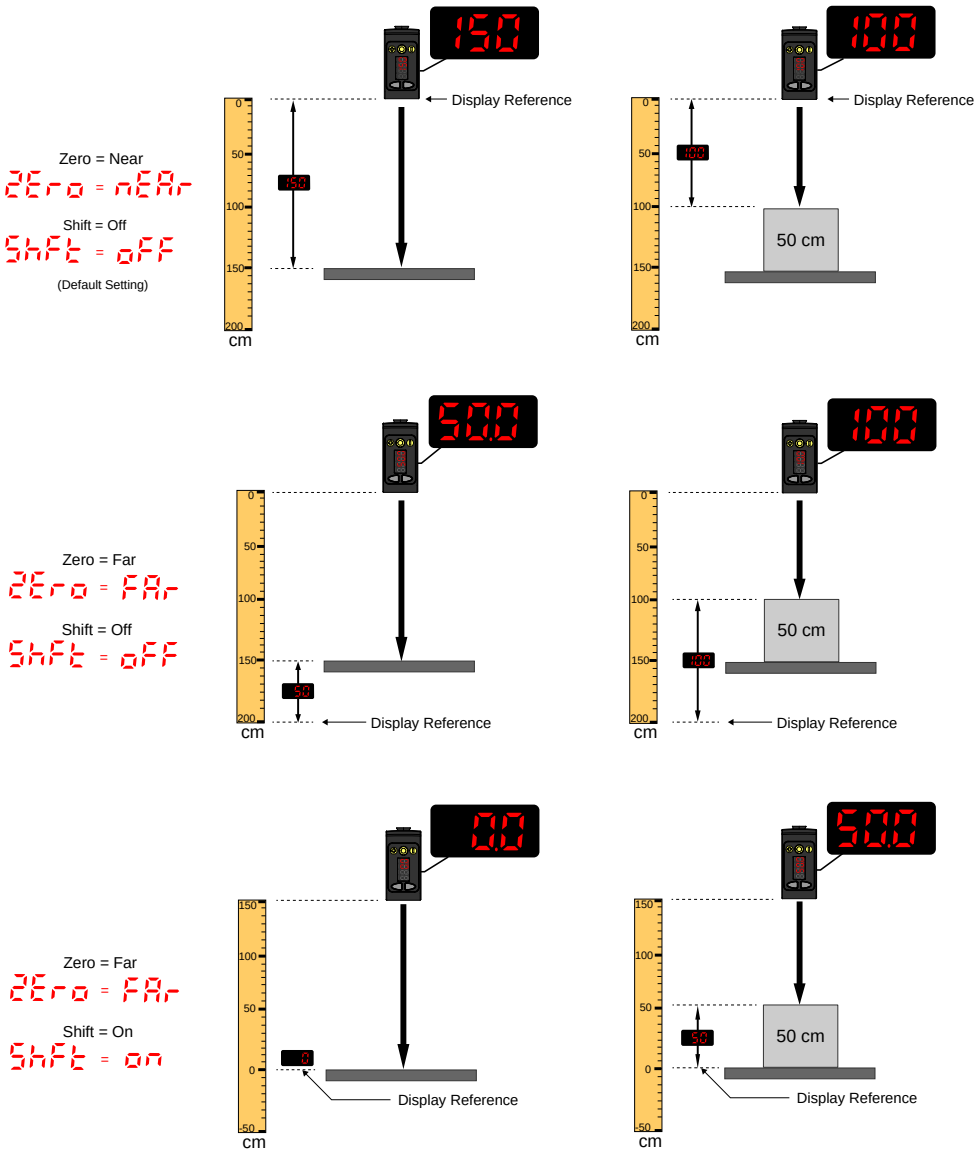
Example Zero and Shift settings



Offset (oFS1 and 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 for 2000 mm models and up to 497 cm for 5000 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.

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Display View (diSP)

Use this menu to select the display view.

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

- 1234—Normal (default setting). When **1234** is inverted, the display is in inverted view model (rotated 180°).
- oFF —Normal and the display enters sleep mode after 60 seconds. When **oFF** is inverted, the display view is inverted (rotated 180°) and the display enters sleep mode after 60 seconds.

Units (unIt)

Use this menu to set the displayed units to centimeters (cm), inches ("), millimeters (mm).

- cm —centimeter (with a decimal point at < 60 centimeters)
- inch—inch (with a decimal point at < 24 inches)
- mm — millimeter

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

Exit Setup Mode (End)

Use this menu to end Setup mode.

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

Reset to Factory Defaults (rSEt)

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

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

Factory Default Settings for the Q5X Dual Discrete with IO-Link

The 2000 mm model and the 5000 mm model have different factory default settings.

Factory Default Settings

Setting	2000 mm Model Factory Default	5000 mm Model Factory Default
Delay Timers (dLY)	oFF —No delay	oFF —No delay
Display View (diSP)	1234 —Normal, no sleep mode	1234 —Normal, no sleep mode
Gain and Sensitivity (GAin)	hiGh —High excess gain mode	PErF
Output (out1, out2)	Lo —Light Operate	Lo —Light Operate
Response Speed (SPd)	25 —25 ms	50 —50 ms
Shift the Zero Reference Location after a TEACH (ShFt)	oFF —0 = the front of the sensor	oFF —0 = the front of the sensor
TEACH Mode (tch)	2-Pt —Two-point TEACH	2-Pt —Two-point TEACH
Zero Reference Location (zEro)	nEAr —Measurement increases further from sensor	nEAr —Measurement increases further from sensor

Continued on page 33

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Continued from page 32

Setting	2000 mm Model Factory Default	5000 mm Model Factory Default
Hysteresis (hYS)	Auto —Sensor controls value	Auto —Sensor controls value
Display Units (unit)	cm —Centimeters	cm —Centimeters
Output Polarity (PoL)	dEF —Default: IO-Link on pin 4 and PNP on pin 2	dEF —Default: IO-Link on pin 4 and PNP on pin 2

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.

Remote Input

Use the remote input to program the sensor remotely.

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

The remote input provides limited programming options. The remote input is either Active High or Active Low depending on the polarity setting. If the polarity is set to **def** or **PNP**, the remote input is Active High. If polarity is set to **NPN**, the remote input is Active Low.

For Active High, connect the white wire to 24 V DC with a remote switch connected between the wire and 24 V DC.

For Active Low, connect the white 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 activating the remote input for longer than 2 seconds.

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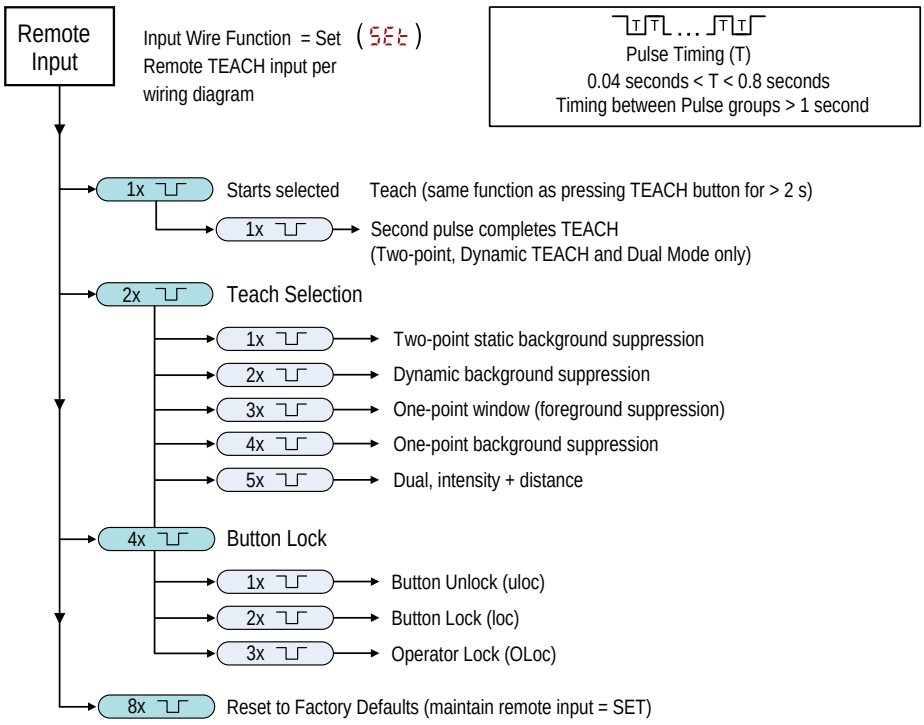
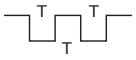
Remote Input Map



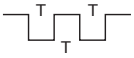
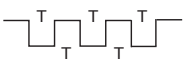
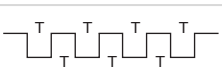
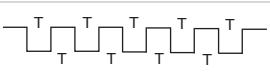
Select the TEACH Mode Using the Remote Input

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

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Reset to Factory Defaults Using the Remote Input

Follow the instructions below to reset the Q5X to factory defaults using Remote Input.

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

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

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.
- 0Loc —The switch point value can be changed by teaching or manual adjustment, but no sensor settings can be changed through the menu.

When the sensor is in either **Loc** or **0Loc** 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 **0Loc** 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

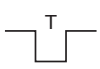
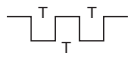
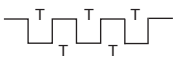
To enter **Loc** mode, hold **+** and press **-** four times. To enter **0Loc** mode, hold **+** and press **-** seven times. Holding **+** and pressing **-** four times unlocks the sensor from either lock mode and the sensor displays **uLoc**.

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 **btn** 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		**0Loc** displays and the sensor returns to Run mode

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. **CnCL** momentarily displays when a TEACH procedure is canceled.

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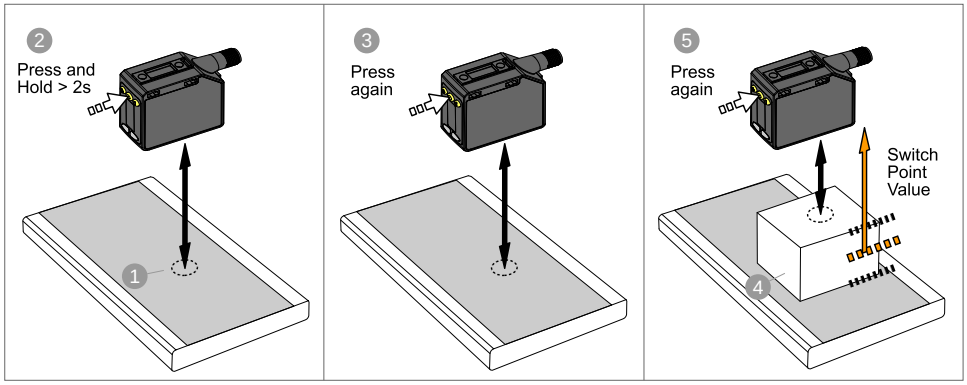
After any teach operation starts, the display temporarily flashes CH1 or CH2 to confirm which channel is currently selected.

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.

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.

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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.		

See for the minimum object separation.

Expected TEACH Behavior for Two-Point Static Background Suppression

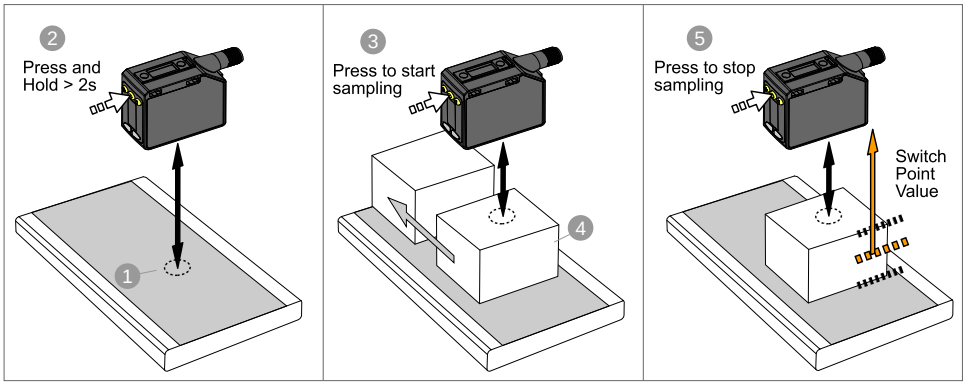
Condition	TEACH Result	Display
Two valid distances that are greater than or equal to the horizontal minimum object separation	Sets a switch point between the two taught distances.	The switch point distance flashes on the display.
Two valid distances that are less than the horizontal minimum object separation	Sets a switch point in front of the furthest taught distance equal to the uniform reflectivity minimum object separation.	**bGS** 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 for the currently selected channel at 197 cm.	**FuLL** and the switch point distance flash alternately on the display.

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.

Dynamic Background Suppression



NOTE: The sensor must be set to **tch** = **dYn** to use the following instructions. The DYN indicator is amber to indicator 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.

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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.		

See "Q5X Dual Discrete with IO-Link Performance Curves" on page 12 for the minimum object separation.

Expected TEACH Behavior for Dynamic Background Suppression

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 equal to the uniform reflectivity minimum object separation.	**bGS** 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 for the currently selected channel at 120 cm.	**bGS** and the switch point distance flash alternately on the display.

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 "Q5X Dual Discrete with IO-Link Performance Curves" on page 12.

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

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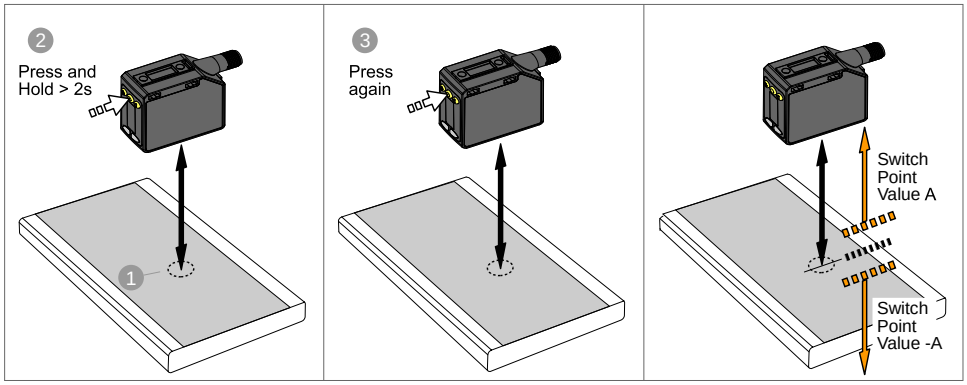
One-Point Window (Foreground Suppression)



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 (**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 ± window size flashes rapidly and the sensor returns to Run mode.
Remote Input	Single-pulse the remote input.		

See "Q5X Dual Discrete with IO-Link Performance Curves" on page 12 for the minimum object separation.

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Expected TEACH Behavior for One-Point Window (Foreground Suppression)

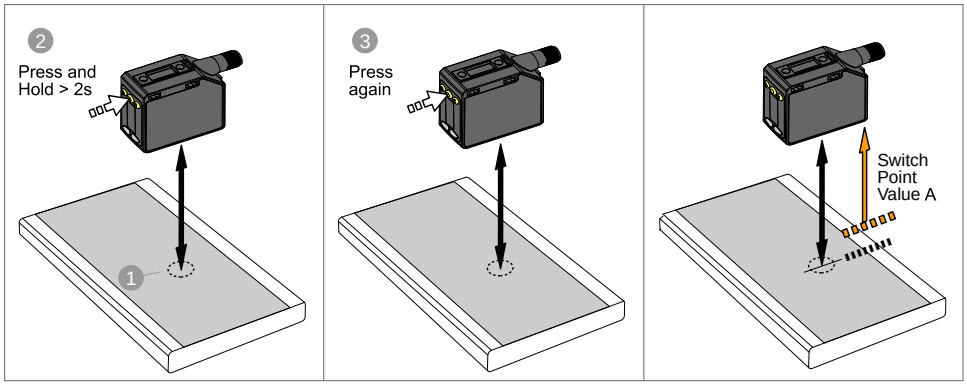
Condition	TEACH Result	Display
One valid TEACH point with both switch points in range (with offset, if applicable)	Sets a window (two switch points) centered around the taught distance. The ± window size is equal to the non-uniform reflectivity minimum object separation. The two switch points always 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 ± 10 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 both switch points outside of the range	Sets a window (two switch points) centered around 150 cm. The window size is ± 10 cm.	**oFSt** and the window center point distance flash alternately on the display.

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 "Q5X Dual Discrete with IO-Link Performance Curves" on page 12.

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 (**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.

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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 is 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.		

See "Q5X Dual Discrete with IO-Link Performance Curves" on page 12 for the minimum object separation.

Expected TEACH Behavior for One-Point Background Suppression

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 equal to the non-uniform reflectivity 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.	**oFSt** and the switch point distance flash alternately on the display.

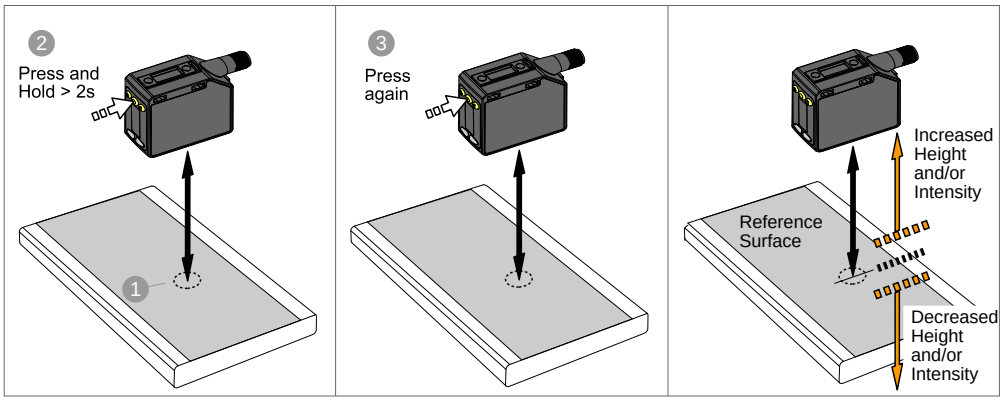
Dual (Intensity + Distance) (duAL)

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 45.

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 (**out2** = **SEt**).



1. Present the target.

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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 is 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.		

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 50% 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.

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 Hz 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. There is a 2 second delay before the sensor sets the output to 50 Hz to indicate loss of signal. During the 2 seconds, the output will hold the last PFM value. To find the Pulse Frequency Modulation (PFM) Output, set **out2** to **PULS**.

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 to: **out2 › nASt**.

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2. Configure the second sensor as the slave; navigate: **out2 › SLUE**.
3. Connect the white wires of the two sensors together.

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Chapter Contents

Chapter 5 IO-Link Interface

IO-Link® [2]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 for the 2000 mm models; 217156 for the 5000 mm models) 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.

[2] IO-Link® is a registered trademark of PROFIBUS Nutzerorganisation e.V.

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Dual Mode Reference Surface Considerations 45
Dual Mode Considerations for Clear and Transparent Object Detection 46
Abbreviations 47

Chapter 6 Additional Information

Dual (Intensity + Distance) Mode

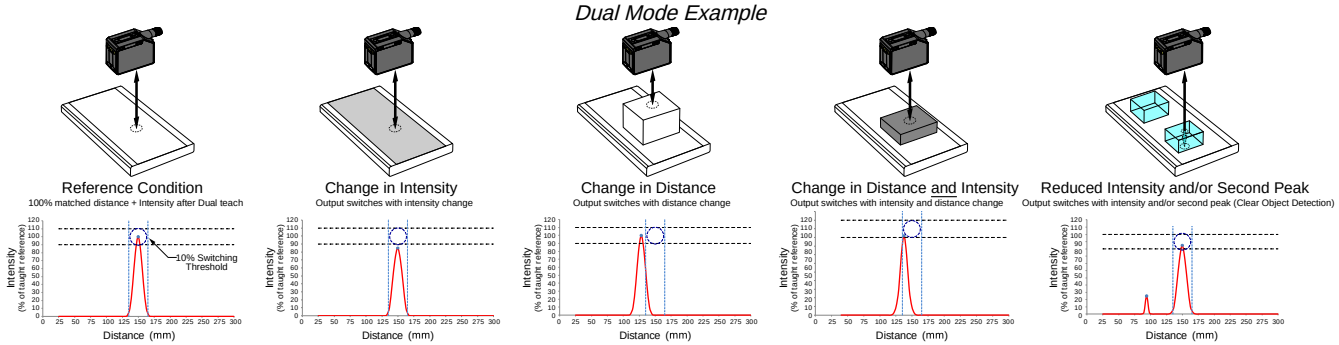
Dual TEACH mode, dual intensity + distance window, expands the applications the Q5X can solve by combining distance-based detection with light intensity thresholds.

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. 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 50% match to the reference condition (50P); this sets the threshold 50% 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).

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.

Dual Mode Reference Surface Considerations

Optimize reliable detection by applying these principles 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

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- 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.

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.

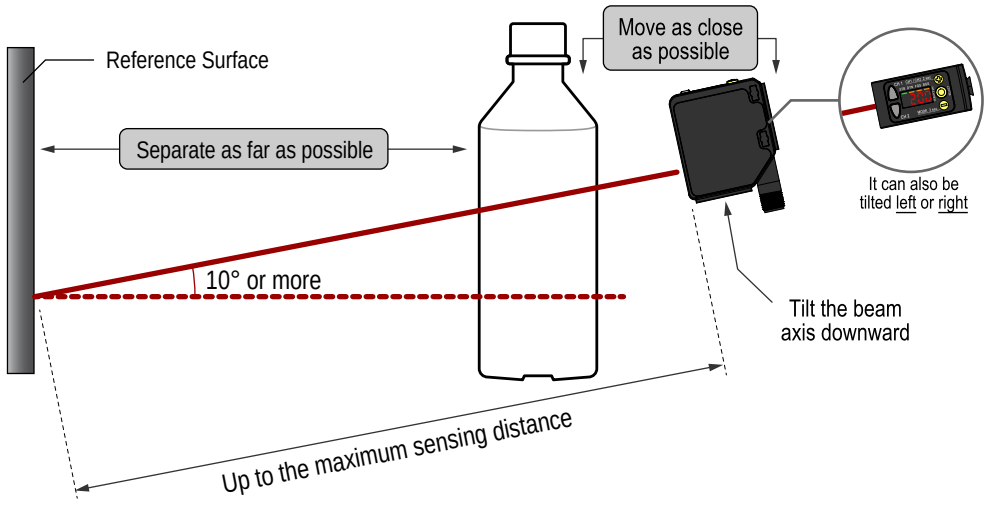
The Q5X sensor can be taught non-ideal reference surfaces, such as surfaces outside of the sensor range or very dark surfaces. Teaching non-ideal reference surfaces may enable applications other than transparent or clear object detection, but best results for transparent or clear object detection require 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:

Match percentage to taught reference point

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

Example mounting considerations



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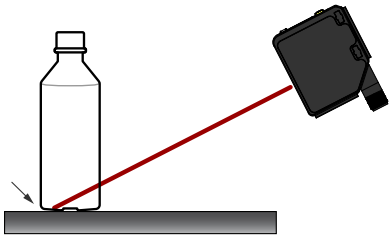
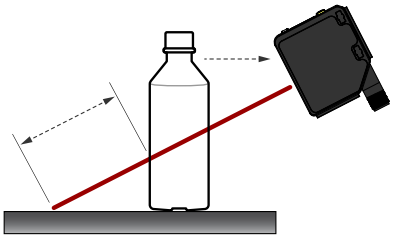
Common problems and solutions for detecting clear objects—Object too close

PROBLEM:
The object is close to the reference surface

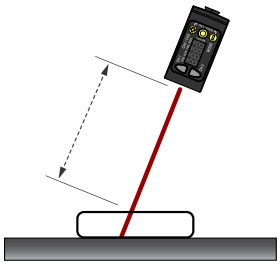


SOLUTION:
Move the target closer to the sensor

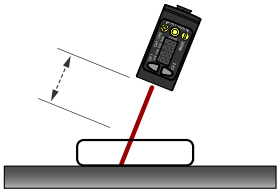


Common problems and solutions for detecting clear objects—Sensor too far

PROBLEM:
The sensor is far from the object



SOLUTION:
Move the sensor closer to the target



Abbreviations

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

Sensor display definitions

Abbreviation	Description
----	No valid signal in range
999P	The sensor has not been taught
1Sho	One-shot
1St	First
2nd	Second
2-Pt	Two-point TEACH (static background suppression)
Auto	Automatic
bGS	One-point background suppression
btn	Button
CnCL	Cancel
comP	Complementary output
d.SP	Display read
dLAY	Delay

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Abbreviation	Description
dLY1 , dLY2	Output timing delay (Channel 1, Channel 2)
do	Dark operate
dt1 , dt2	Delay timer (Channel 1, Channel 2)
duAL	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

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Abbreviation	Description
rSEt	Reset to factory defaults
SAVE	Save
SEt	Set or 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
tch1, tch2	TEACH process selection (Channel 1, Channel 2)
totL	Totalizer
tot1, tot2	Total counts
uLoc	Unlock/unlocked
unit	Unit
uuuu	Saturated signal (too much light)
Wnd1, Wnd2	Window size (Channel 1, Channel 2)
YES	Yes
zEro	Zero—select the zero reference location

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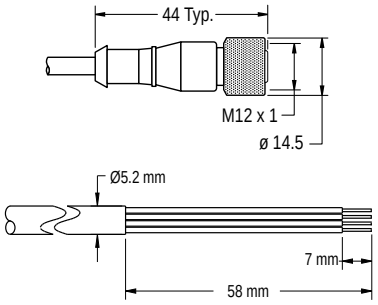
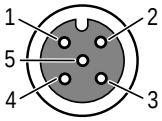
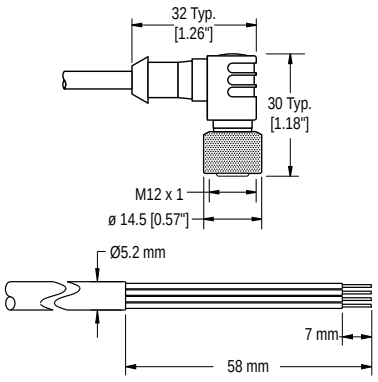
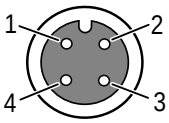
RSD1 Remote Display 52

Chapter 7 Accessories

Cordsets

4-pin Single-Ended M12 Female Cordsets (datasheet p/n 235937)				
Model	**Length**	**Dimensions (mm)**	**Pinout (Female)**	
BC-M12F4-22-1	1 m (3.28 ft)			1 = Brown 2 = White 3 = Blue 4 = Black 5 = Unused
BC-M12F4-22-2	2 m (6.56 ft)			
BC-M12F4-22-5	5 m (16.4 ft)			
BC-M12F4-22-8	8 m (26.25 ft)			
BC-M12F4-22-10	10 m (30.81 ft)			
BC-M12F4-22-15	15 m (49.2 ft)			
BC-M12F4-22-20	20 m (65.61 ft)			
BC-M12F4-22-25	25 m (82.02 ft)			
BC-M12F4-22-30	30 m (98.42 ft)			

4-pin Single-Ended M12 Female Right-Angle Cordsets (datasheet p/n 235937)				
Model	**Length**	**Dimensions (mm)**	**Pinout (Female)**	
BC-M12F4A-22-1	1 m (3.28 ft)			1 = Brown 2 = White 3 = Blue 4 = Black 5 = Unused
BC-M12F4A-22-2	2 m (6.56 ft)			
BC-M12F4A-22-5	5 m (16.4 ft)			
BC-M12F4A-22-8	8 m (26.25 ft)			
BC-M12F4A-22-10	10 m (30.81 ft)			
BC-M12F4A-22-15	15 m (49.2 ft)			

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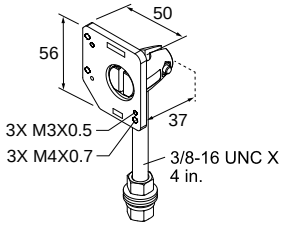
Brackets

All measurements are listed in millimeters, unless noted otherwise. The measurements provided are subject to change.

SMBQ5X..

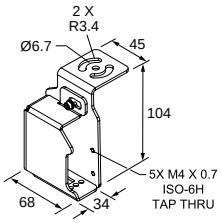
- Swivel bracket with tilt and pan movement for precision adjustment
- Easy sensor mounting to extruded rail T-slots
- Metric and inch size bolts are available
- Side mounting of some sensors with the 3 mm screws included with the sensor

B = 7 × M3 × 0.5
Bolt thread (A): 3/8 - 16 × 2¼ in for SMBQ5XFA: M10 - 1.5 × 50 for SMBQ5XFAM10; n/a; no bolt included. Mounts directly to 12 mm (½ in) rods for SMBQ5XFAM12



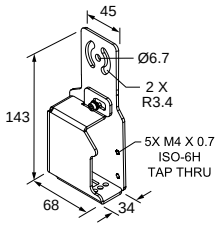
SMBAMSQ5XIPRA

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



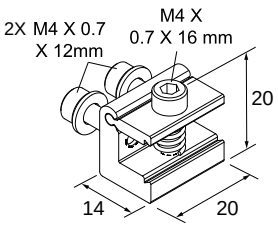
SMBAMSQ5XIPP

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



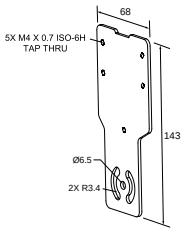
SMBQ5XDT

- 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



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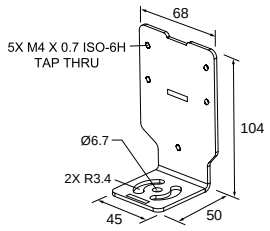
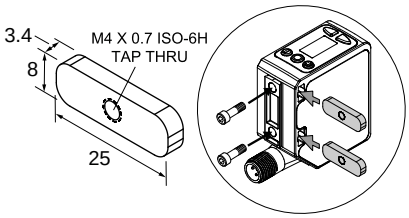
SMBAMSQ5XRA

- 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

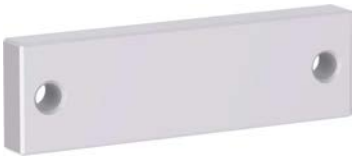


Reference Targets

All measurements are listed in millimeters, unless noted otherwise. The measurements provided are subject to change.

BRT-Q4X-60X18

- Reference target for clear object detection or dual-mode applications
- FDA-grade acetal material
- CAD Files: DXF, PDF, IGS, STP



BRT-Q4X-60X50

- Reference target for clear object detection or dual-mode applications
- FDA-grade acetal material
- CAD Files: DXF, PDF, IGS, STP



RSD1 Remote Display

Use the optional RSD1 for remote monitoring and configuring compatible devices.

Refer to the RSD1 instruction manual (p/n 199621) or quick start guide (p/n 199622) for more information. See "Accessories" on page 50 for the required cordsets.

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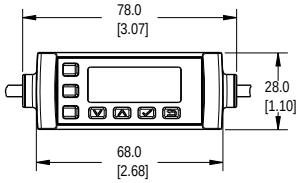
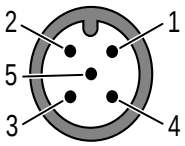
RSD1 Remote Display				
Model	**Output A and B**	**Dimensions**	**Male**	**Wiring**
RSD1QP	Configurable			1. Brown 2. White 3. Blue 4. Black 5. Gray

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Chapter 8 Product Support and Maintenance

Troubleshooting

Use the following table to correct any error codes that appear in the Q5X.

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
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

Clean Sensor with Compressed Air and Water

Handle the sensor with care during installation and operation. Sensor windows soiled by fingerprints, dust, water, oil, etc. 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. Do not use any other chemicals for cleaning.

Repairs

Contact Banner Engineering for troubleshooting of this device. **Do not attempt any repairs to this Banner device; it contains no field-replaceable parts or components.** If the device, device part, or device component is determined to be defective by a Banner Applications Engineer, they will advise you of Banner's RMA (Return Merchandise Authorization) procedure.

> **IMPORTANT:** If instructed to return the device, pack it with care. Damage that occurs in return shipping is not covered by warranty.

Contact Us

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