Quick Start Guide

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

This guide is designed to help you set up and install the Q5X Laser Triangulation Sensor with Background Suppression. For complete information on programming, performance, troubleshooting, dimensions, and accessories, please refer to the Instruction Manual at www.bannerengineering.com. Search for p/n 208794 to view the Instruction Manual. Use of this document assumes familiarity with pertinent industry standards and practices.

WARNING: Not To Be Used for Personnel Protection

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

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 9999 indicates the sensor has not been taught.

Output Indicator
- On—Output is on
- Off—Output is off

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

Active TEACH Indicators (DYN, FGS, and BGS)
- DYN—Dynamic (Amber)
- FGS—Foreground Suppression (Amber)
- BGS—Background Suppression (Amber)
Buttons

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

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

(+)(CH1/CH2)
• Press to navigate the sensor menu in Setup mode
• Press to change setting values; press and hold to increase numeric values
• Press and hold for longer than 2 seconds to switch between Channel 1 and Channel 2

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

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

Laser Description and Safety Information

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

Class 2 Laser Models

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

For Safe Laser Use - Class 2 Lasers
• Do not stare at the laser.
• Do not point the laser at a person’s eye.
• Mount open laser beam paths either above or below eye level, where practical.
• Terminate the beam emitted by the laser product at the end of its useful path.

Reference IEC 60825-1:2007, Section 8.2.

Class 2 Lasers

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

Class 2 Laser Safety Notes

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

Output: < 1.0 mW
Laser wavelength: 640 to 670 nm
Pulse Duration: 20 µs to 2 ms

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Installation

Sensor Orientation

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

![Figure 3. Optimal Orientation of Target to Sensor](image)

See the following figures for examples of correct and incorrect sensor-to-target orientation as certain placements may pose problems for sensing some targets. The Q5X can be used in the less preferred orientation and at steep angles of incidence and still provide reliable detection performance due to its high excess gain. For the minimum object separation distance required for each case, refer to Performance Curves on page 10.

![Correct Orientation](image)

Incorrect

Correct

Figure 4. Orientation by a wall

![Correct Orientation](image)

Incorrect

Correct

Figure 5. Orientation for a moving object

![Correct Orientation](image)

Incorrect

Correct

Figure 6. Orientation for a height difference

![Correct Orientation](image)

Vertical Orientation

Reflective Surface (optional)

Figure 7. Orientation for a color or luster difference

![Correct Orientation](image)

Figure 8. Orientation for highly reflective target

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.

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*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.*
Wiring Diagram

![Wiring Diagrams](image1)

**Figure 9. Channel 2 as PNP Discrete or PFM Output**

**Figure 10. Channel 2 as Remote Input**

**Key**
1. Brown
2. White
3. Blue
4. Black

**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. Refer to the Instruction Manual (p/n 208794) for details regarding use as a remote input or pulse frequency modulation (PFM) output.

![Wiring Diagrams](image2)

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

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

![Wiring Diagrams](image3)

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

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

**Cleaning and Maintenance**

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

**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 the Instruction Manual, p/n 208794 for more information.

**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 **ch 1**, indicates the channel that is selected. For menu items without a number (excluding submenu items), these menu options are only available from Channel 1 and the settings apply to both channels.

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**Channel 1**

**Top Menu**

- **Teach Selection CH1**
- **Output CH1**
- **Gain and Sensitivity CH1 & CH2**
- **Response Speed CH1 & CH2**
- **Delay Timer CH1***
- **Hysteresis CH1***
- **Select Zero Reference Location CH1 & CH2**
- **Shift Zero Reference after Teach CH1 & CH2**
- **Display Read CH1 & CH2**
- **Distance Unit CH1 & CH2**
- **Reset to Factory Defaults CH1 & CH2**

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**Sub Menu**

- **Light Operate**
- **Dark Operate**
- **2-Pt - Two-Point Static Teach**
- **FGS - Foreground Suppression**
- **BGS - Background Suppression**
- **Det. Mode - Dual Mode**

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**Figure 15. Sensor Menu Map—Channel 1**
Q5X Laser Triangulation Sensor with Background Suppression

### Channel 2

#### Top Menu
- Output CH2
- Teach Selection CH2
- Adaptive Tracking CH2*
- Window Size CH2 **
- Output Timing Delays CH2
- Delay Timer CH2 ***
- Hysteresis CH2
- Offset CH2 ****
- Exit Setup

#### Sub Menu
- Light Operate
- Dark Operate
- Complimentary to Output 1
- Laser off when pulled high
- Laser on when pulled high
- Master
- Slave
- Pulse
- Auto
- High-Speed Adaptive Tracking on
- Off: Adaptive Tracking off
- Adaptive Tracking menu is available when Teach CH2 is set to Dual Mode
- Window Size menu is available when Teach CH2 is set to FGS
- Delay Timer value (seconds have decimal)
- Delay Timer menu is not present when CH2 is set to LO or DO
- Hysteresis menu is available when Teach CH2 is set to Two-Point Static, Dynamic, or BGS
- Offset menu is available when Teach CH2 is set to FGS or BGS
- End

** Menu items only available when out2 is set to LO or DO
* Adaptive Tracking menu is available when Teach CH2 is set to Dual Mode
** Window Size menu is available when Teach CH2 is set to FGS

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Figure 16. Sensor Menu Map—Channel 2
Basic TEACH Instructions

Use the following instructions to teach the Q5X sensor. The instructions provided on the sensor display vary depending on the type of TEACH mode selected. Two-point TEACH is the default TEACH mode.

1. Press and hold TEACH for longer than 2 seconds to start the selected TEACH mode.
2. Present the target.
3. Press TEACH to teach the target. The target is taught and the sensor waits for the second target, if required by the selected TEACH mode, or returns to Run mode.
4. Complete these steps only if it is required for the selected TEACH mode.
   a) Present the second target.
   b) Press TEACH to teach the target. The target is taught and the sensor returns to Run mode.

See the Instruction Manual for detailed instructions and other available TEACH modes. The TEACH modes include:

- Two-point static background suppression $^{2-}$-Pr — 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.
- Dynamic background suppression $^{d}$yn — Dynamic TEACH sets a single switch point during machine run conditions. The sensor takes multiple samples and the switch point is set between the minimum and the maximum sampled distances.
- One-point window (foreground suppression) $^{F}$os — One-point window sets a window (two switch points) centered around the taught target distance.
- One-point background suppression $^{b}$os — One-point background suppression sets a single switch point in front of the taught target distance. Objects beyond the taught switch point are ignored.
- Dual intensity + distance $^{d}$or — Dual mode records the distance and amount of light received from the reference surface. See Dual Mode Reference Surface Considerations on page 10 for more information about selecting a 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.

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.

Locking and Unlocking the Sensor Buttons

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

- $^{u}$loc — The sensor is unlocked and all settings can be modified (default).
- loc — The sensor is locked and no changes can be made.
- $^{d}$loc — The switch point value can be changed by teaching or manual adjustment, but no sensor settings can be changed through the menu.

Note: When the sensor is in either loc or dloc 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 \textit{Loc} mode, \textit{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.

To enter \textit{Loc} mode, hold \textcircled{+} and press \textcircled{-} four times. To enter \textit{Loc} mode, hold \textcircled{-} and press \textcircled{+} seven times. Holding \textcircled{-} and pressing \textcircled{+} four times unlocks the sensor from either lock mode and the sensor displays \textit{uloc}.

### Specifications

**Sensing Beam**
Visible red, Class 2 laser, 650 nm

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

**Power and Current Consumption, exclusive of load**
< 1 W

**Sensing Range**
95 mm to 2000 mm (3.74 in to 78.74 in)

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

**Output Rating**
Current rating: 50 mA maximum

<table>
<thead>
<tr>
<th>Black wire specifications per configuration</th>
<th>Output High</th>
<th>Output Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO-Link Push/Pull</td>
<td>( \geq \text{Vsupply} - 2.5 \text{ V} )</td>
<td>( \leq 2.5 \text{ V} )</td>
</tr>
<tr>
<td>PNP</td>
<td>( \geq \text{Vsupply} - 2.5 \text{ V} )</td>
<td>( \leq 1 \text{ V} ) (loads ( \leq 1 \text{ M\Omega} ))</td>
</tr>
<tr>
<td>NPN</td>
<td>( \geq \text{Vsupply} - 2.5 \text{ V} ) (loads ( \leq 50 \text{ k\Omega} ))</td>
<td>( \leq 2.5 \text{ V} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>White wire specifications per configuration</th>
<th>Output High</th>
<th>Output Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>PNP</td>
<td>( \geq \text{Vsupply} - 2.5 \text{ V} )</td>
<td>( \leq 2.5 \text{ V} ) (loads ( \leq 70 \text{ k\Omega} ))</td>
</tr>
<tr>
<td>NPN</td>
<td>( \geq \text{Vsupply} - 2.5 \text{ V} ) (loads ( \leq 70 \text{ k\Omega} ))</td>
<td>( \leq 2.5 \text{ V} )</td>
</tr>
</tbody>
</table>

**Remote Input**
Allowable Input Voltage Range: 0 to Vsupply
Active High (internal weak pull-down): High state \( \geq \) (Vsupply – 2.25 V) at 2 mA maximum
Active Low (internal weak pull-up): Low state < 2.25 V at 2 mA maximum

**Beam Spot Size**

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Size (x y) (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2.6 x 1.5</td>
</tr>
<tr>
<td>1000</td>
<td>4.2 x 2.5</td>
</tr>
<tr>
<td>2000</td>
<td>6 x 3.6</td>
</tr>
</tbody>
</table>

Beam spot size is calculated as 1.6 times the D40 measured value

**Boresighting**
\( \pm 43 \text{ mm at 2000 mm} \)

**Response Speed**
User selectable: 3, 5, 15, 25, or 50 ms

**Delay at Power Up**
< 2.5 s

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

**Ambient Light Immunity**
Up to 5000 lux at 1000 mm
Up to 2000 lux at 2000 mm

**Connector**
Integral 4-pin M12/Euro-style quick disconnect

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

**Temperature Effect (Typical)**
< 0.5 mm/°C at < 500 mm
< 2.0 mm/°C at < 2000 mm

**Discrete Output Distance Repeatability**

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Repeatability</th>
</tr>
</thead>
<tbody>
<tr>
<td>95 to 300</td>
<td>( \pm 0.5 \text{ mm} )</td>
</tr>
<tr>
<td>300 to 1000</td>
<td>( \pm 0.25% )</td>
</tr>
<tr>
<td>1000 to 2000</td>
<td>( \pm 0.5% )</td>
</tr>
</tbody>
</table>

**Supply Protection Circuitry**
Protected against reverse polarity and transient overvoltages

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

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

**Environmental Rating**
IEC IP67 per IEC60529

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

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

Overcurrent protection is required to be provided by end product application per the supplied table. Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply. Supply wiring leads < 24 AWG shall not be spliced.

For additional product support, go to www.bannerengineering.com.

```
<table>
<thead>
<tr>
<th>Supply Wiring (AWG)</th>
<th>Required Overcurrent Protection (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>5.0</td>
</tr>
<tr>
<td>22</td>
<td>3.0</td>
</tr>
<tr>
<td>24</td>
<td>2.0</td>
</tr>
<tr>
<td>26</td>
<td>1.0</td>
</tr>
<tr>
<td>28</td>
<td>0.8</td>
</tr>
<tr>
<td>30</td>
<td>0.5</td>
</tr>
</tbody>
</table>
```

**Shock**

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

**Operating Conditions**

-10 °C to +50 °C (+14 °F to +122 °F)

35% to 95% relative humidity

**Storage Temperature**

-25 °C to +70 °C (+13 °F to +158 °F)

**Certifications**

Industrial Control Equipment

Class 2 power

UL Environmental Rating: Type 1

**Excess Gain**

```
<table>
<thead>
<tr>
<th>Response Speed (ms)</th>
<th>Excess Gain at 100 mm</th>
<th>Excess Gain at 500 mm</th>
<th>Excess Gain at 1000 mm</th>
<th>Excess Gain at 2000 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>150</td>
<td>50</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>150</td>
<td>50</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>725 (225)</td>
<td>250 (75)</td>
<td>70 (25)</td>
<td>15 (6)</td>
</tr>
<tr>
<td>25</td>
<td>1250 (800)</td>
<td>450 (250)</td>
<td>125 (70)</td>
<td>30 (15)</td>
</tr>
<tr>
<td>50</td>
<td>2500 (1250)</td>
<td>900 (450)</td>
<td>250 (125)</td>
<td>60 (30)</td>
</tr>
</tbody>
</table>
```

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

![Graph showing performance curves for minimum separation target to background distance against distance to target.]

Dual Mode Reference Surface Considerations

Optimize reliable detection by applying these principals when selecting your reference surface, positioning your sensor relative to the reference surface, and presenting your target. The robust detection capabilities of the Q5X allows successful detection even under non-ideal conditions in many cases. Typical reference surfaces are metal machine frames, conveyor side rails, or mounted plastic targets. Contact Banner Engineering if you require assistance setting up a stable reference surface in your application. For detailed instructions for detecting clear or transparent objects, refer to the Instruction Manual, p/n 208794.

1. Select a reference surface with these characteristics where possible:
   - Matte or diffuse surface finish
   - Fixed surface with no vibration
   - Dry surface with no build-up of oil, water, or dust
2. Position the reference surface between 200 mm (20 cm) and the maximum sensing range.
3. Position the target to be detected as close to the sensor as possible, and as far away from the reference surface as possible.
4. Angle the sensing beam relative to the target and relative to the reference surface 10 degrees or more.
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