Quick Start Guide

Class 1 laser CMOS analog sensor with an analog output. Patent pending.

This guide is designed to help you set up and install the Q4X Analog Sensor. For complete information on programming, performance, troubleshooting, dimensions, and accessories, please refer to the Instruction Manual at www.bannerengineering.com. Search for p/n 185624 to view the Instruction Manual. Use of this document assumes familiarity with pertinent industry standards and practices.

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

**WARNING: Not To Be Used for Personnel Protection**

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

Features

**Figure 1. Sensor Features—Threaded Barrel Models**

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

**Figure 2. Sensor Features—Flush Mount Models**

Display and Indicators

The display is a 4-digit, 7-segment LED. The main screen is the Run Mode screen, which shows the current distance to the target in millimeters.

**Figure 3. Display in Run Mode**

1. Stability Indicator (STB = Green)
2. Active TEACH Indicators
   - 2-PT = Two-Point TEACH (Amber)
   - 1-PT = One-Point TEACH (Amber)
3. Display Value Indicator (MM = Amber)

Output Indicator

- On—Displayed distance is within the taught analog output window
- Off—Displayed distance is outside of the taught analog output window

Active TEACH Indicators (2PT and 1PT)

- 2-PT on—Two-point TEACH mode selected (default)
- 1-PT on—One-point TEACH mode selected

Stability Indicator (STB)

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

Display Value Indicator (MM)

- On—Display shows the distance in millimeters (default)
- Off—Display shows the analog output value

Buttons

Use the sensor buttons (SELECT) (TEACH), (+) (DISP), and (-) (MODE) to program the sensor.
Laser Description and Safety Information

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

**Class 1 Lasers**

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

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

Installation

**Install the Safety Label**

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

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

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

Sensor Orientation

Optimize detection reliability and performance with correct sensor-to-target orientation. To ensure reliable detection, orient the sensor as shown in relation to the target to be detected.
See the following figures for examples of correct and incorrect sensor-to-target orientation as certain placements may pose problems for sensing some targets.

Mount the Sensor

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

Wiring Diagram

Note: Open lead wires must be connected to a terminal block.
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 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 185624 for more information.

Setup Mode

1. Access Setup mode and the sensor menu from Run mode by pressing and holding MODE for longer than 2 seconds.
2. Use and to navigate through the menu.
3. Press SELECT to select a menu option and access the submenus.
4. Use and to navigate through the submenus.
5. Select a submenu option.
   - Press SELECT to select a submenu option and return to the top menu.
   - 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.
Q4X Stainless Steel Analog Laser Sensor

**Top Menu**

- Teach Process Selection
  - two-point teach
  - one-point teach

- Base Measurement Rate
  - set Base Measurement Rate to 0.3 ms
  - set Base Measurement Rate to 0.5 ms
  - set Base Measurement Rate to 1.0 ms
  - set Base Measurement Rate to 2.5 ms
  - set Base Measurement Rate to 5.0 ms

- Averaging
  - average 1 measurement for analog output
  - average 2 measurements for analog output
  - average 4 measurements for analog output
  - average 8 measurements for analog output
  - average 16 measurements for analog output
  - average 32 measurements for analog output
  - average 64 measurements for analog output
  - average 128 measurements for analog output
  - average 256 measurements for analog output
  - average 512 measurements for analog output

- Slope
  - positive slope
  - negative slope

- Select Zero Reference Location
  - near: set zero displayed value to end of 18 mm barrel
  - far: set zero displayed value to maximum detection range

- Shift Zero Reference after Teach
  - on: move the zero point after each teach
  - off: zero point is either at end of barrel or maximum detection range

- Loss of Signal
  - current models
    - (3.5 mA)
  - voltage models
    - (0 V)
    - (10.5 V)

- Input Wire Function
  - set: Remote Teach input
  - laser off when pulled low
  - laser on when pulled low
  - master
  - slave
  - trigger

- Trigger Mode
  - average measurement
    - range (max. dist - min. dist)
    - max. distance
    - min. distance
    - track max. distance
    - track min. distance
    - sample measurement
  - *Trigger Mode appears when Input Wire Function is set to “trigger”*

- Display Read
  - display on
  - display on, inverted
  - display off (enters sleep mode after 60 seconds)
  - display off, inverted (enters sleep mode after 60 seconds)

- Exit Setup
  - end: select to exit setup

- Reset to Factory Defaults
  - no: do not reset to factory defaults
  - yes: reset to factory defaults

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**Sub Menus**

- **(default setting)**

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**Figure 10. Sensor Menu Map**
Basic TEACH Instructions

Use the following instructions to teach the Q4X 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.

   Complete steps 4 and 5 only if required for the selected TEACH mode:
4. Present the second target.
5. Press TEACH to teach the target. The target is taught and the sensor returns to Run mode.

Manual Adjustments

Manually adjust the distance set for the 0 V (4 mA) and 10 V (20 mA) values using the + and - buttons. The available adjustments vary depending on the TEACH mode selected.

Locking and Unlocking the Sensor Buttons

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

- $\text{Loc}$ — The sensor is unlocked and all settings can be modified (default).
- $\text{loc}$ — The sensor is locked and no changes can be made.
- $\text{loc}$ — The value associated with 0 V (4 mA) and 10 V (20 mA) can be changed by teaching or manual adjustment, but no sensor settings can be changed through the menu.

When in $\text{loc}$ mode, $\text{loc}$ displays when the (SELECT)(TEACH) button is pressed. The analog point displays when (+)(DISP) or (-)(MODE) are pressed, but $\text{loc}$ displays if the buttons are pressed and held.

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

To enter $\text{loc}$ mode, hold + and press - four times. To enter $\text{loc}$ mode, hold + and press - seven times. Holding + and pressing - four times unlocks the sensor from either lock mode and the sensor displays $\text{Loc}$.
Specifications

Sensing Beam
Visible red Class 1 laser, 655 nm

Supply Voltage (Vcc)
12 to 30 V dc

Power and Current Consumption, exclusive of load
< 675 mW

Sensing Range—Threaded Barrel Models
500 mm models: 25 mm to 500 mm (0.98 in to 19.68 in)
300 mm models: 25 mm to 300 mm (0.98 in to 11.81 in)
100 mm models: 25 mm to 100 mm (0.98 in to 3.94 in)

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

Analog Output Configuration
0 to 10 V or 4 to 20 mA, depending on model

Output Rating
Analog Voltage Outputs (Q4X..U Models): 2.5 kΩ minimum load resistance
Analog Current Outputs (Q4X..I Models): 1 kΩ maximum load resistance at 24 V; maximum load resistance = [(Vcc – 4.5)/0.02 Ω]

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

Supply Protection Circuity
Protected against reverse polarity and transient overvoltages

Analog Resolution—Threaded Barrel Models
300 mm and 500 mm models:
25 mm to 100 mm: < 0.3 mm
100 mm to 300 mm: < 1 mm
500 mm models only: 300 to 500 mm: < 1.75 mm
100 mm models:
25 mm to 100 mm: < 0.15 mm

Analog Resolution—Flush Mount Models
310 mm models:
35 mm to 110 mm: < 0.3 mm
110 mm to 310 mm: < 1 mm
110 mm models:
35 mm to 110 mm: < 0.15 mm

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

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Threaded Barrel Models</th>
<th>Flush Mount Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>35</td>
<td>2.6 mm x 1.0 mm</td>
</tr>
<tr>
<td>150</td>
<td>160</td>
<td>2.3 mm x 0.9 mm</td>
</tr>
<tr>
<td>300</td>
<td>310</td>
<td>2.0 mm x 0.8 mm</td>
</tr>
<tr>
<td>500</td>
<td></td>
<td>1.9 mm x 1.0 mm</td>
</tr>
</tbody>
</table>

Beam Spot Size—100/110 mm Models

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Threaded Barrel Models</th>
<th>Flush Mount Models</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>35</td>
<td>2.4 mm x 1.0 mm</td>
</tr>
<tr>
<td>100</td>
<td>110</td>
<td>1.8 mm x 0.7 mm</td>
</tr>
</tbody>
</table>

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

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

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

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

Analog Linearity
Analog linearity performance matches accuracy performance curve (see Performance Curves—Threaded Barrel Models on page 8 and Performance Curves—Flush Mount Models on page 9).

Response Speed
Total response speed varies from 0.5 ms to 2560 ms, depending on base measurement rate and averaging settings. See Instruction Manual for more information.

Delay at Power Up
< 750 ms

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

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

Connector
Integral 5-pin M12/Euro-style male quick disconnect (QD)

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

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

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

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

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Size (Horizontal x Vertical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded Barrel Models</td>
<td>Flush Mount Models</td>
</tr>
<tr>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>150</td>
<td>160</td>
</tr>
<tr>
<td>300</td>
<td>310</td>
</tr>
<tr>
<td>500</td>
<td></td>
</tr>
</tbody>
</table>

Beam Spot Size—100/110 mm Models

<table>
<thead>
<tr>
<th>Distance (mm)</th>
<th>Size (Horizontal x Vertical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threaded Barrel Models</td>
<td>Flush Mount Models</td>
</tr>
<tr>
<td>25</td>
<td>35</td>
</tr>
<tr>
<td>100</td>
<td>110</td>
</tr>
</tbody>
</table>

Operating Conditions
35% to 95% relative humidity

<table>
<thead>
<tr>
<th>Min. Ambient Temp (°C)</th>
<th>Max. Ambient Temp (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vcc</td>
<td>Q4X..U (0-10V)</td>
</tr>
<tr>
<td>12</td>
<td>50</td>
</tr>
<tr>
<td>24</td>
<td>45</td>
</tr>
<tr>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

* For 4–20 mA models only: Max. Ambient Sensor Temp (°C) = 50 – (Vcc – 12)/2
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>

Certifications

- Class 2 power
- UL Environmental Rating: Type 1
- ECOLAB chemical compatibility certified

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Performance Curves—Threaded Barrel Models

Accuracy (90% to 6% reflectance)

<table>
<thead>
<tr>
<th>DISTANCE (mm)</th>
<th>Accuracy (± mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25</td>
<td>0.05</td>
</tr>
<tr>
<td>50</td>
<td>0.25</td>
</tr>
<tr>
<td>75</td>
<td>0.40</td>
</tr>
<tr>
<td>100</td>
<td>0.50</td>
</tr>
</tbody>
</table>

Figure 11. 100 mm Models

Accuracy (± mm) for distances 0 to 100 mm with accuracy values ranging from 0 to 1.25.

Repeatability (90% to 6% reflectance)

<table>
<thead>
<tr>
<th>DISTANCE (mm)</th>
<th>Repeatability (± mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>25</td>
<td>0.05</td>
</tr>
<tr>
<td>50</td>
<td>0.10</td>
</tr>
<tr>
<td>75</td>
<td>0.15</td>
</tr>
<tr>
<td>100</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Figure 14. 100 mm Models

Graphs showing accuracy and repeatability for distances 0 to 100 mm with various averaging levels.
## Temperature Effects

**Figure 17:** 100 mm and 300 mm models

**Figure 18:** 500 mm models

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## Performance Curves—Flush Mount Models

### Accuracy (90% to 6% reflectance)

**Figure 19:** 110 mm Models

**Figure 20:** 310 mm Models

### Repeatability (90% to 6% reflectance)

**Figure 21:** 110 mm Models

**Figure 22:** 310 mm Models
### Temperature Effects

<table>
<thead>
<tr>
<th>DISTANCE (mm)</th>
<th>Temperature Effect (± mm / °C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>50</td>
<td>0.05</td>
</tr>
<tr>
<td>100</td>
<td>0.10</td>
</tr>
<tr>
<td>150</td>
<td>0.15</td>
</tr>
<tr>
<td>200</td>
<td>0.20</td>
</tr>
<tr>
<td>250</td>
<td>0.25</td>
</tr>
<tr>
<td>300</td>
<td>0.30</td>
</tr>
<tr>
<td>350</td>
<td>0.35</td>
</tr>
</tbody>
</table>

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