QAL50 Series Analog Line Sensor

Datasheet

Compact, self-contained analog- and discrete-output edge-guiding sensor

- Compact, self-contained design
- Analyzes and compares target object position or width, relative to a reflective strip
- Fast 8 ms sensing response time
- Easy push-button programming options
- Five measurement modes: center guiding, edge position (beginning and end), area, and width measurement
- Output OFF-delay (6 options) for Discrete output
- External disable feature for remote gating control
- 4 LEDs plus 4-digit display show configuration and operating status
- Non-volatile memory for data retention
- 8-pin quick-disconnect with a 3-position swivel connector
- NPN or PNP discrete output plus 4 mA to 20 mA analog output, plus discrete Alarm
- Configurable for Light Operate or Dark Operate

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.

Models

Models	Sensing Range	**Connection**[1]	Supply Voltage	Output Type
QAL50INQ	200 mm (8 in)	8-pin Euro-style (M12) swivel QD connector	10 V dc to 30 Vdc	NPN Discrete plus 4 mA to 20 mA Analog
QAL50IPQ				PNP Discrete plus 4 mA to 20 mA Analog

Overview

The Banner QAL50 Series is an analog line sensor. It is used to reliably detect the position and area of a target, in relation to a fixed length of reflective tape. This sensing technology is useful for many types of industrial applications, including web edge detection.

The sensor has 3 push buttons (Set, + and -) for sensor programming and setup, plus several LEDs and a 4-digit display to indicate ongoing sensor status.

Output ON Amber
Discrete output is activated

Alarm Flashes Green
Insufficient signal

M1 and M2 light in **combination**

M1	M2	**Operating** Mode
OFF	OFF	Object begin – Object end
OFF	ON	Object center
ON	OFF	Width measurement
ON	ON	Area

4-digit display
Number of units of light returned to the receiver element (Run mode), and programming/setup status (Programming mode)

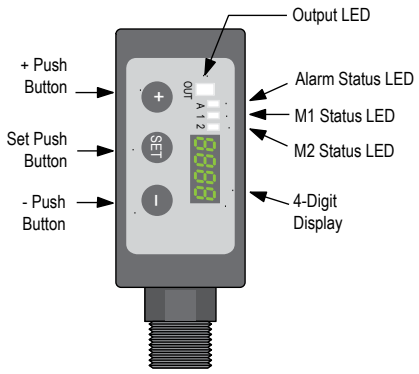


Figure 1. Sensor Features

[1] Models with a quick disconnect require a mating cordset.

Theory of **Operation**

The sensor emits a narrow line of infrared light at a permanently mounted strip of reflective material, included with the sensor. (For proper sensor operation, do not substitute another type of reflective material.) The light returned from this strip returns the maximum amount of light that the sensor can receive; this corresponds to a reading on the 4-digit display of 0000 (or no light blocked). If a target object obstructs any of the returned light, the sensor outputs respond accordingly, based on the quantity of returned light, the programmed operating mode, and the set threshold.

The sensor resolves the line of light from the reflective strip into 1,024 parts (0 to 1,023) and displays the result on the sensor's 4-digit display, according to the measuring mode selected. The number of units obscured by the target is partially dependent on the target's distance to the sensor and to the reflective material (see figure). For this reason, sensing is most reliable when the distance from sensor to target remains stable.

The same object can generate different obscured zones, depending on its position within the sensing area. This is particularly true when the Area operating mode is used.

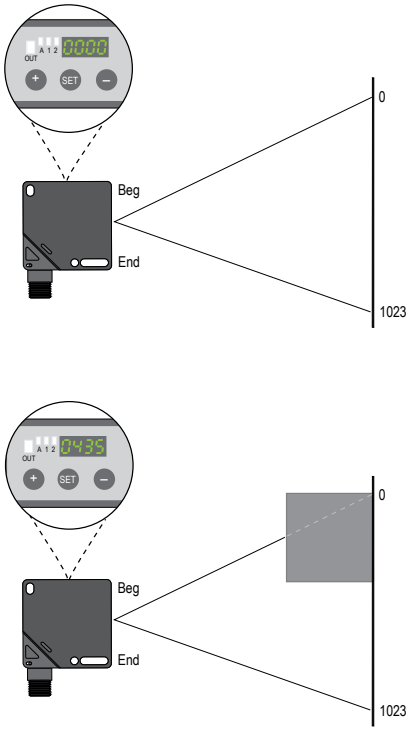


Figure 2. Sensor Operation

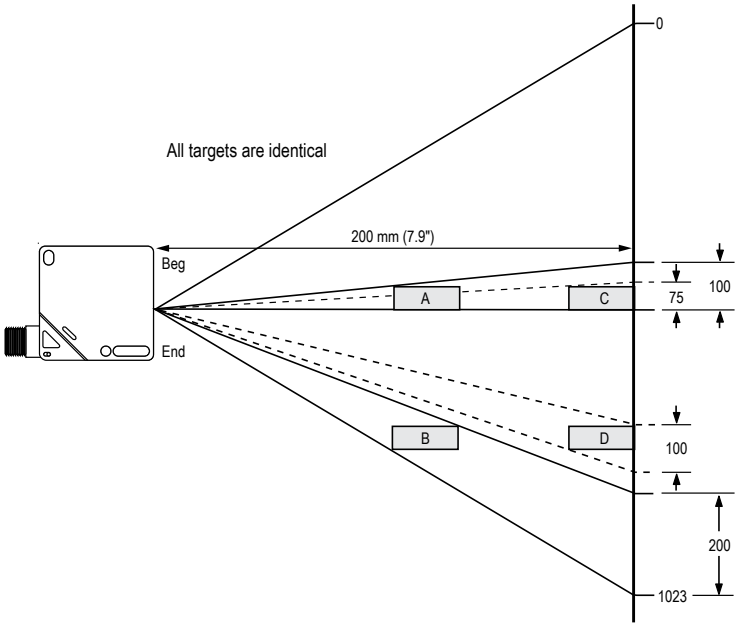


Figure 3. The effect of sensor/target positioning on the amount of blocked light

Alarm Output

If the sensor does not receive enough reflected light (due to dirt on the lens, for example), the Alarm output will conduct.

- Alarm is ON when field is totally blocked (retro tape is either absent or the entire 150 mm sensing area is completely blocked)
- Alarm will be delayed by the OFF-delay time set

Operating Modes

The sensor operates using any of five operating modes:

Object Begin
: Detects the position of the first target edge (closest to 0).

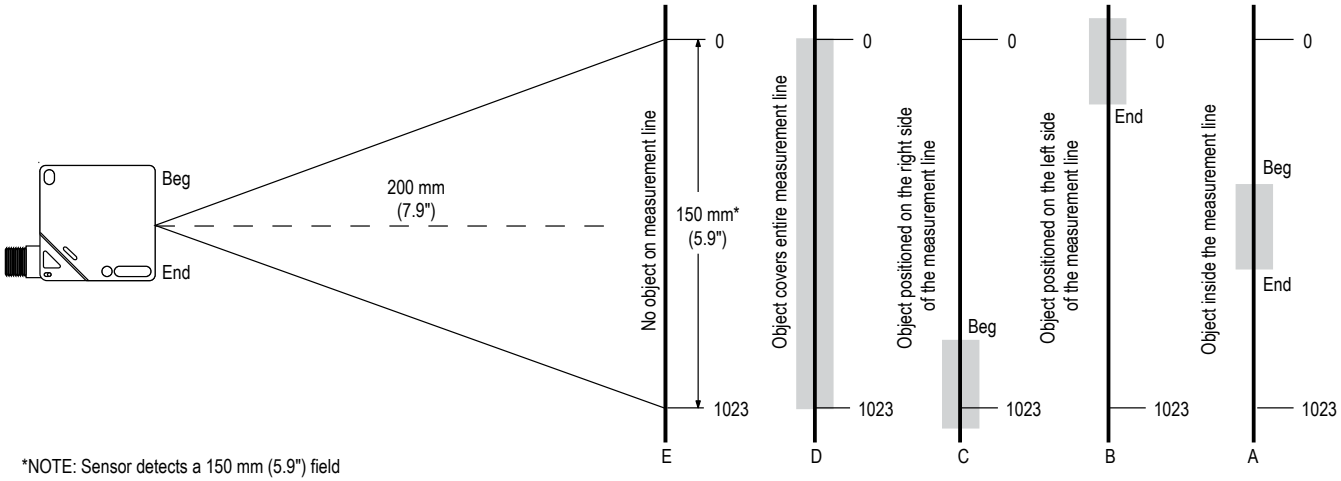
Object End
: Detects the position of the second target edge (closest to 1023).

Object Center
: Measures the position of the target's center.

Width
: Measures the distance between the first and last target edges.
If two or more objects are in the field of view at one time, the sensor reports the object closest to 1023.

Area
: Measures the sum of all obscured areas in the measurement zone.

Figure 4 on page 3 shows the sensor output according to the possible object position inside the measurement zone.

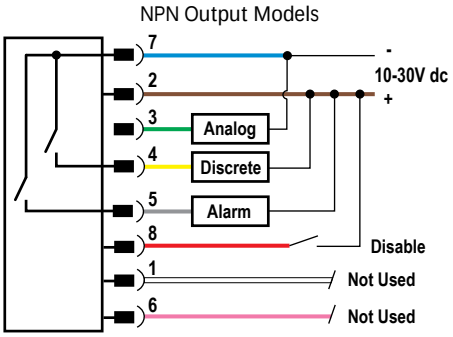


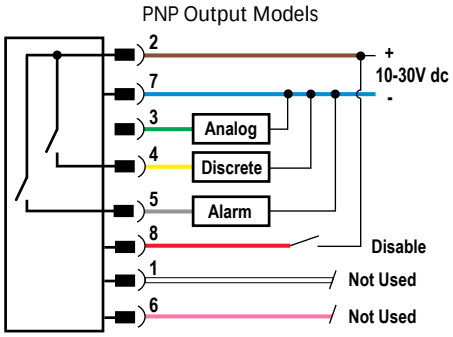
*NOTE: Sensor detects a 150 mm (5.9") field at 200 mm (7.9"). For reliable operation, tape length must be at least 160 mm (6.3").

Operating Mode	E	D	C	B	A
First Object Edge	0	0	Beg	End	Beg
Last Object Edge	0	0	Beg	End	End
Center	0	0	0	0	(End + Beg) / 2
Width	0	0	0	0	End – Beg
Area	0	1023	1023 – Beg	End	End – Beg

Figure 4. Comparison of sensor operating modes

Wiring Diagrams





See *Program the Sensor* on page 3 and *Table 1* on page 4 for information on disabling push buttons/outputs.

Program the Sensor

Program the sensor using two major steps: Teaching of the thresholds (the target present or absent conditions) and setup of the sensor parameters (Operating Mode and Discrete output OFF-Delay).

OFF-Delay Setup

Setup mode permits setting an output OFF-delay value up to 40 milliseconds, for smoothing the output. This value represents the time interval, following termination of sensing, during which the outputs remain active. The OFF-delay setting applies to both the Alarm and Discrete outputs.

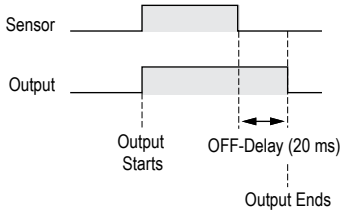


Figure 5. OFF-delay (d_20): output continues for an interval after sensing stops

Push **Button** Lockout

To disable the push buttons for security, power down the sensor and connect the red wire of the sensor to +V dc power. When the sensor is powered up with the remote wire connected to dc voltage for at least 1 second, the push buttons are disabled. To enable push buttons, power down the sensor, disconnect the red wire and power up the sensor. See *Table 1* on page 4.

Output Disable

Outputs may be externally disabled for remote gating control (synching to another sensor, for example). See *Table 1* on page 4 for more information.

Table 1: Enabling/disabling push buttons and outputs via the red wire hookup

Status		Red Wire Hookup Following Power-Up
Push **Buttons**	Outputs	
Enabled	Enabled	-V
Enabled	Disabled	-V for 1 second, then +V
Disabled	Enabled	+V for 1 second, then -V
Disabled	Disabled	+V

Sensor Setup

Setup procedures can set all sensor parameters except the thresholds.

There is a 10-second time-out. If new settings are not made for each step within 10 seconds, sensor returns to RUN mode with settings saved up to that time.

0.04 seconds ≤ “click” ≤ 0.8 seconds

1. Press and hold Set for longer than 6 seconds to access the menu.
   The Menu displays on the 4-digit display: ՈEnu
2. Select the operating mode.
   a) Click + or - to display the current mode.
      The current mode displays in the 4-digit display: bEG
   b) Click Set to scroll through selections.
      The 4-digit display scrolls through the Operating Mode options: End, Uidt, ArEA, bEG and CEnt.
   c) When the desired mode displays, click + or – to save the selection and proceed to Select OFF-Delay.
      The sensor saves the selection and advances to the next step.
3. Select the Output OFF-Delay.
   a) Click Set to scroll through selections.

      The 4-digit display scrolls through the OFF-Delay options: d_00, d_05, d_10, d_20, d_30, and d_40.
   b) When the desired delay displays, click + or - to save the selection and proceed to Display Current Threshold.
      The sensor saves the selection and advances to the next step.
4. Display Current Threshold.
   a) Click + or – to access Threshold 1.
      Threshold 1 displays: tH_1.
   b) Click Set to display Threshold 1 value.
      Threshold 1 value displays.
   c) Click + or – to access Threshold 2.
      Threshold 2 displays: tH_2.
   d) Click Set to display Threshold 2 value.
      Threshold 2 value displays.
5. Click + or – to view the status of the viewed area.
   Operating area complete, displays: FuLL

   Operating area partially obstructed but some zones need not be detected, displays: rEdu

6. Return to the default settings.
   a) Click + or –.
      The sensor displays: rESE.
   b) Press and hold Set for longer than 0.5 seconds.
      The sensor display flashes for 2 seconds: rESE.

      The sensor exits Menu and returns automatically to Run mode with the following default settings:
      - Beginning object mode
      - 0 delay
      - Th1 threshold 100
      - Th2 threshold 200
7. Save the settings.
   a) Click + or –.
      The sensor displays: SAvE and the sensor is ready to save the settings.
   b) Press and hold Set for longer than 0.5 seconds.
      The sensor saves the selection and returns to Run mode.

TEACH Threshold

Make sure that the reflective material remains clean during programming and sensing. If lint or other material is on the reflective strip, the sensor cannot return to zero and sensing will be unreliable.

To change to Light Operate mode (output conducts when the target is absent), teach Threshold 1 closer to 1023 and teach Threshold 2 closer to 0.

There is a 10-second time-out. If new settings are not made for each step within 10 seconds, the sensor returns to Run mode with settings saved up to that point.

0.04 seconds ≤ “click” ≤ 0.8 seconds

1. Press and hold + or - for longer than 2 seconds.
   Threshold 1 displays: tH_1.
2. Click + or -.
   Threshold 2 displays: tH_2.
3. Click Set to Display Threshold Value
   The current threshold value displays.
4. Click + or - to increase or decrease threshold value.
   The threshold value adjusts; the new value displays.

   The count value increases or decreases by 1 count for each button click.

   The count value increases or decreases by 10 counts when steady pressure is applied.
5. To save the new value, press and hold Set for longer than 0.5 seconds or wait for the 10-second time-out.
   The sensor saves the threshold value and returns to Run mode[2].
6. Repeat the procedure to teach the second threshold, if needed.

TEACH Independent Limits

This method uses the target itself to define the count values.

The relative positions of Limit 1 and Limit 2 determine Dark Operate or Light Operate selection.

Dark Operate
Limit 1 closer to 0
Limit 2 closer to 1,023

Light Operate
Limit 1 closer to 1,023
Limit 2 closer to 0

There is a 10-second time-out. If new settings are not made for each step within 10 second, sensor returns to Run mode. (If both limits have been taught when the sensor times out, the new settings will be saved. If limit 2 has not been taught when the sensor times out, new settings will not be saved.)

0.04 seconds ≤ “click” ≤ 0.8 seconds

1. Position the target at the first limit.
   The sensor is ready to learn limit 1.
2. TEACH limit 1.
   a) Press Set for 2 seconds.
      The sensor display flashes briefly and then displays the current count for target/position presented.
   b) Click + or – to adjust the value.

      The count value increases or decreases by 1 count for each button click.

      The count value increases or decreases by 10 counts when steady pressure is applied.
   c) Click Set.

      The display flashes. The sensor holds limit 1 and waits for limit 2.

[2] Remembering Settings: Settings are saved in the sensor’s “EEPROM” memory; settings are maintained, even after the sensor is powered off.

3. Define and TEACH limit 2.
   a) Position the target at the second limit.
      The sensor displays the current count for the target and position presented.
   b) Click Set.
   c) Click + or – to adjust the value.
      The count value increases or decreases by 1 count for each button click.

      The count value increases or decreases by 10 counts when steady pressure is applied.
4. To save the new values, press and hold Set for longer than 0.5 seconds or wait for the 10-second time-out.
   The sensor saves the threshold values and returns to Run mode[3].

Specifications

Sensing Beam
Infrared, 875 nm

Sensing Range
200 mm (8 in) typical
Measurement Field: 150 mm long at 200 mm

Supply Voltage
10 V dc to 30 V dc, 2 V pp maximum ripple
70 mA maximum at 30 V dc (excluding output current)

Supply **Protection** Circuitry
Protected against reverse polarity, overvoltage, and transient voltages

Resolution
0.15 mm

Linearity
< 1%

Output **Configuration**
4 mA to 20 mA analog output plus either PNP or NPN output, depending on model, plus a PNP or NPN alarm output 30 V dc maximum
Saturation Voltage: < 2 V

Output **Rating**
100 mA maximum load at 25°C

Output **Protection**
Protected against output short-circuit, continuous overload, transient overvoltages, and false pulse on power-up

Output Response
Time 8 ms (130 Hz)

Adjustments
3 push buttons (Set, + and -)
Operating mode, delay and threshold, light/dark operate
Manual adjustment of thresholds
Default Settings: Beg. mode, no delay, threshold 1 at 100, threshold 2 at 200, dark operate

Indicators
4-Digit LCD Display: Indicates light units received, programming status
Amber Output LED: ON when output is conducting
Green Alarm LED: Flashes when insufficient signal is received
M1 and M2 Green Channel Output Status LEDs: Indicate current Operating Mode (see *Overview* on page 1)

Construction
ABS shock-resistant housing; glass window and lens

Environmental **Rating**
IEC IP62 (Type 1 enclosure)

Connections
8-pin Euro-style (M12) swivel quick-disconnect fitting; 2 m (6.5 ft), 5 m (15 ft) or 9 m (30 ft) cable available separately

Operating Conditions
Temperature: –10 °C to +55 °C (+14 °F to +131 °F)
Storage Temperature –20 °C to +70 °C (–4 °F to +158 °F)
90% at +50 °C maximum relative humidity (non-condensing)

Data **Retention**
EEPROM nonvolatile memory

Minimum Sensing **Conditions**
Minimum Object Sensed: 0.9 mm long
Minimum Tape Length: 160 mm (6.3 in)

Ambient Light **Rejection**
According to EN 60947-5-2

Shock Resistance
Approx. 30 G; 6 shocks per axis (EN60068-2-27)

Vibration
0.5 mm (0.02 in) amplitude; 10 Hz to 55 Hz frequency; for each axis (EN60068-2-27)

Application Note
If the tape becomes dirty, the sensor cannot go to zero.

Required Overcurrent **Protection**

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

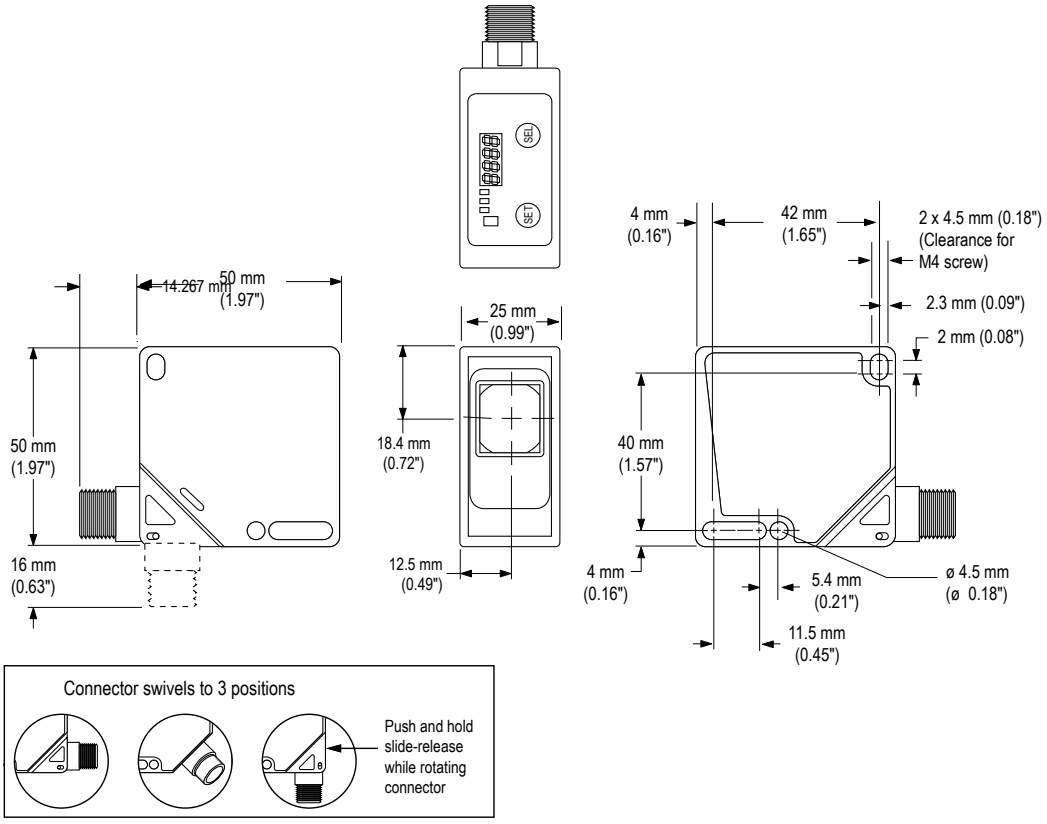
Overcurrent protection is required to be provided by end product application per the supplied table.
Overcurrent protection may be provided with external fusing or via Current Limiting, Class 2 Power Supply.
Supply wiring leads < 24 AWG shall not be spliced.
For additional product support, go to *www.bannerengineering.com*.

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

Certifications
c UL us LISTED Industrial Control Equipment 3TJJ

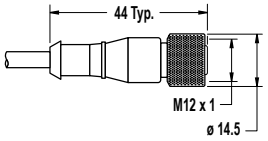
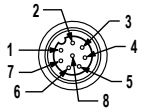
[3] Remembering Settings: Settings are saved in the sensor's "EEPROM" memory; settings are maintained, even after the sensor is powered off.

Dimensions



Accessories

Cordsets

8-Pin Threaded M12/Euro-Style Cordsets with Open-Shield				
Model	Length	Style	Dimensions	Pinout (Female)
MQDC2S-806	1.83 m (6 ft)	Straight		 1 = White, 2 = Brown, 3 = Green, 4 = Yellow, 5 = Gray, 6 = Pink, 7 = Blue, 8 = Red
MQDC2S-815	4.57 m (15 ft)			
MQDC2S-830	9.14 m (30 ft)			
MQDC2S-850	15.2 m (50 ft)			

Self-Adhesive **Retroreflective** Tape

Model	Size
BRT-TVLG-1-36	25 mm × 0.9 m (1 in x 35.4 in) Note: For proper operation, do not substitute other retroreflective tape.

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

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