



## Features

- Fast, easy-to-use TEACH-Mode programming; no potentiometer adjustments
- Selectable dual NPN or PNP outputs via DIP switch
- Access to bank of 8 DIP switches through sealed cover for superior user functionality
- Rugged encapsulated design for harsh environments
- Unique housing design allows for multiple mounting configurations
- Choose models with integral 2 m (6.5') or 9 m (30') cable, or with Mini-style or Euro-style quick-disconnect fitting
- Wide operating range of -20° to +70°C (-4° to +158°F)
- Temperature compensation



## Models

Models	Sensing Range	Cable*	Supply Voltage	Output
QT50UDB	200 mm to 8 m (8" to 26')	5-wire, 2 m (6.5') cable	10 to 30V dc	Dual NPN or PNP selectable
QT50UDBQ6		5-pin Euro-style QD		
QT50UDBQ		5-pin Mini-style QD		

\* NOTES:

- 9 m cables are available by adding suffix "w/30" to the model number of a cabled sensor (e.g., QT50UDB w/30).
- A model with a QD connector requires a mating cable; see page 11.

Information about analog-output models is available on Banner's website: [www.bannerengineering.com](http://www.bannerengineering.com)



### WARNING . . . Not To Be Used for Personnel Protection

**Never use these products as sensing devices for personnel protection. Doing so could lead to serious injury or death.**

These sensors do NOT include the self-checking redundant circuitry necessary to allow their use in personnel safety applications. A sensor failure or malfunction can cause either an energized or de-energized sensor output condition. Consult your current Banner Safety Products catalog for safety products which meet OSHA, ANSI and IEC standards for personnel protection.

# U-GAGE™ QT50U Series Sensor — Discrete Output

---

## Principles of Operation

Ultrasonic sensors emit one or multiple pulses of ultrasonic energy, which travel through the air at the speed of sound. A portion of this energy reflects off the target and travels back to the sensor. The sensor measures the total time required for the energy to reach the target and return to the sensor. The distance to the object is then calculated using the following formula:

$$D = \frac{ct}{2}$$

- D** = distance from the sensor to the target
- c** = speed of sound in air
- t** = transit time for the ultrasonic pulse

To improve accuracy, an ultrasonic sensor may average the results of several pulses before outputting a new value.

## Temperature Effects

The speed of sound is dependent upon the composition, pressure and temperature of the gas in which it is traveling. For most ultrasonic applications, the composition and pressure of the gas are relatively fixed, while the temperature may fluctuate.

In air, the speed of sound varies with temperature according to the following approximation:

$$C_{m/s} = 20 \sqrt{273 + T_C}$$

- C<sub>m/s</sub>** = speed of sound in meters per second
- T<sub>C</sub>** = temperature in °C

Or, in English units:

$$C_{ft/s} = 49 \sqrt{460 + T_F}$$

- C<sub>ft/s</sub>** = speed of sound in feet per second
- T<sub>F</sub>** = temperature in °F

The speed of sound changes roughly 1% per 6° C (10° F). QT50U series ultrasonic sensors have temperature compensation available, via the 8-pin DIP switch. Temperature compensation will reduce the error due to temperature by about 90%.

NOTE: If the sensor is measuring across a temperature gradient, the compensation will be less effective.

# U-GAGE™ QT50U Series Sensor — Discrete Output

## Sensor Programming

Three TEACH methods may be used to program the sensor:

- Teach individual minimum and maximum limits,
- Use Auto-Window feature to center a sensing window around the taught position, or
- Simultaneously use Auto-Window and position a threshold for background suppression at the taught position.

The sensor may be programmed either via its two push buttons, or via a remote switch. Remote programming also may be used to disable the push buttons, preventing unauthorized personnel from adjusting the programming settings. To access this feature, connect the gray wire of the sensor to 0 - 2V dc, with a remote programming switch between the sensor and the voltage.

NOTE: The impedance of the Remote Teach input is 12 kΩ.

Programming is accomplished by following the sequence of input pulses (see programming procedures starting on page 5). The duration of each pulse (corresponding to a push button “click”), and the period between multiple pulses, are defined as “T”:

$$0.04 \text{ seconds} < T < 0.8 \text{ seconds}$$

## Configuration

The QT50U features an 8-pin DIP switch bank for user setup. The DIP switches are located behind the access cover on the back of the sensor as shown in Figure 2. A spanner tool is included with each sensor for removing the cover.

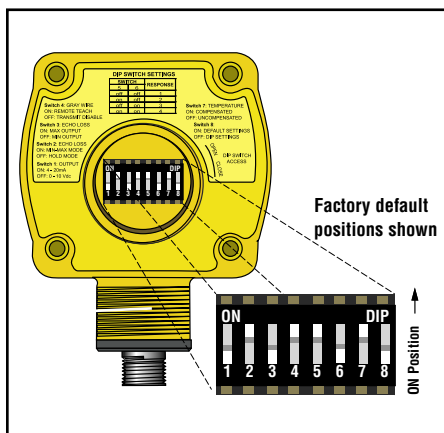


Figure 2. DIP switch location

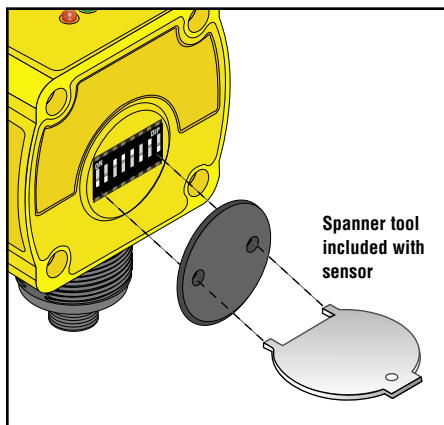


Figure 3. Removing the access cover

Switch	Function	Settings	
1	PNP or NPN Select	ON = Both outputs set for PNP OFF* = Both outputs set for NPN	
2	Window/Fill Level	ON = High/Low (fill level control) OFF* = ON/OFF (window)	
3	Output Operation	<b>Window selected on Switch 2:</b> ON* = Normally open OFF = Normally closed <b>Fill Level selected on Switch 2:</b> ON = Pump-in OFF = Pump-out	
4	Teach/Disable Control	ON* = Configured for remote teach OFF = Configured for transmit disable	
5 and 6	Response (100 ms/cycle) 1 cycle 4 cycles* 8 cycles 16 cycles	Switch 5	Switch 6
		OFF ON*	OFF OFF* ON ON
7	Temperature Compensation	ON* = Enabled OFF = Disabled	
8	Factory Calibration	ON = For factory calibration only; switch should be set to OFF for use OFF* = DIP-switch settings in control	

\* Factory default settings

# U-GAGE™ QT50U Series Sensor — Discrete Output

## DIP-Switch-Selectable Functions

### Switch 1: Output Mode Select

ON = Both outputs set to PNP (current sourcing)

OFF = Both outputs set to NPN (current sinking)

This switch configures the sensor internally to use either the PNP or NPN output configuration.

### Switch 2: High/Low Level Control

ON = High/Low (fill level control)

OFF = ON/OFF (window)

This switch determines whether the sensor is in fill level control mode or normal ON/OFF mode. The fill level control is shown in Figure 3. When switch 2 is ON, the switch 3 setting will determine whether the sensor is set up for pump-in or pump-out operation.

In ON/OFF mode, the sensor is either ON or OFF when the target is within the window limits and opposite when outside of the window limit.

### Switch 3: ON/OFF Mode

ON = normally open (output is energized when the target is within window)

OFF = normally closed (output is energized when the target is outside window)

### Switch 4: Teach/Transmit Enable Control

ON = Gray (or yellow) wire configured for remote teach

OFF = Gray (or yellow) wire configured for transmit disable

**High (5 to 30V dc or open):** Transmit Enabled (Power LED solid Green)

**Low (0 to 2V dc):** Transmit Disabled (Power LED flashes at 2 Hz)

When switch 4 is ON, the gray or yellow wire is used to teach the sensor's window limits. When switch 4 is OFF, the gray or yellow wire is used to enable and disable the sensor's transmit burst. This function may be used when multiple sensors are operating in close proximity and may be vulnerable to cross-talk interference. A PLC can be used to enable the sensors one at a time to avoid cross-talk.

When disabled, the sensor outputs will react as if no target is being sensed.

### Switches 5-6: Response Speed Adjustment

The speed of the output response is set using DIP-switch positions 5 and 6 (see table on page 3). There are four values for response speed, which relate to the number of sensing cycles over which the output value is averaged.

### Switch 7: Temperature Compensation

ON = Temperature compensation is enabled

OFF = Temperature compensation is disabled

Changes in air temperature affect the speed of sound, which in turn affects the distance reading measured by the sensor. An increase in air temperature shifts both sensing window limits closer to the sensor. Conversely, a decrease in air temperature shifts both limits farther away from the sensor. This shift is approximately 3.5% of the limit distance for a 20° C change in temperature. With temperature compensation enabled (Switch 7 ON), the sensor will maintain the window limits to within 1.8% over the -20° to +70° C range.



### CAUTION . . .

To avoid damage to the sensor caused by static discharge (ESD), observe proper ESD precautions (grounding) while adjusting the DIP switches.

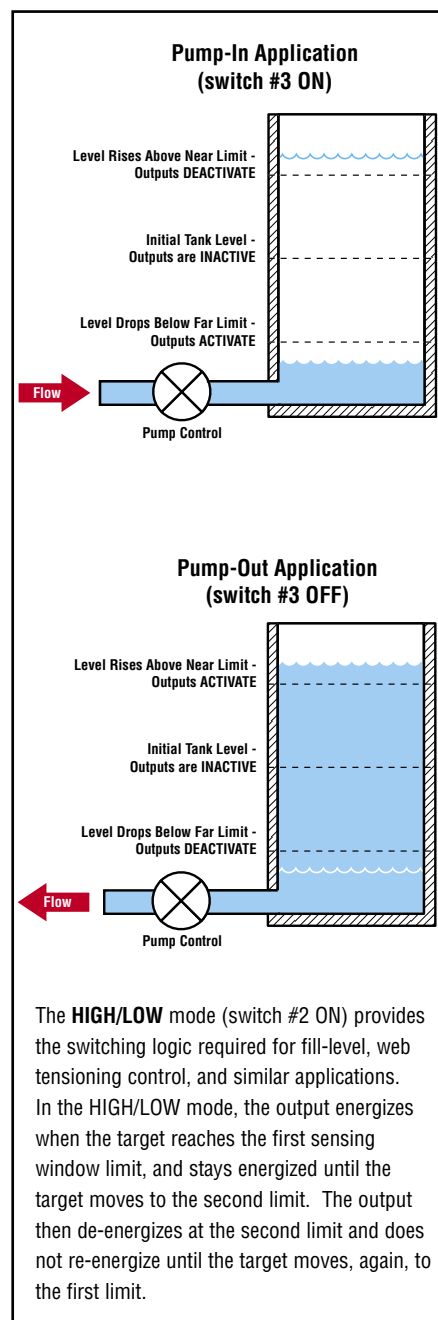


Figure 3. High/Low Level Control (switch #2 ON)

# U-GAGE™ QT50U Series Sensor — Discrete Output

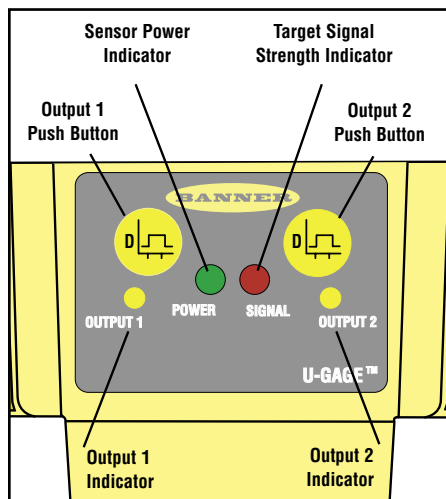


Figure 4. Sensor features

## NOTES:

- If temperature compensation is enabled, exposure to direct sunlight can affect the sensor's ability to accurately compensate for changes in temperature.
- With temperature compensation enabled, the temperature warmup drift upon power-up is less than 0.8% of the sensing distance. After 15 minutes, the apparent switchpoint will be within 0.5% of the actual position. After 30 minutes, the apparent switchpoint will be within 0.3% of the actual position.

## Switch 8: Factory Calibration

- ON = Factory calibration only
- OFF = Normal operation

## Status Indicators

**Signal LED (Red)** – indicates the strength and condition of the sensor's incoming signal.

Signal LED Status	Indicates
ON Bright	Good signal
ON Dim	Marginal signal strength
OFF	<ul style="list-style-type: none"> <li>• No signal is received*, or</li> <li>• Target is beyond the sensor's range limitations</li> </ul>

\*If no signal is received, the output will react as if the target is beyond the far limit. In normally open mode, the outputs will be OFF. In normally closed mode, the outputs will be ON.

**Output LEDs (Yellow or Red)** – indicate the position of the target, relative to the window limits.

Output/Teach LED	Indicates
ON Red (Solid)	In Teach mode; waiting for first limit to be taught
ON Red (Flashing)	In Teach mode; waiting for second limit to be taught
ON Yellow	Target is within window limits (normally open mode)
OFF	Target is outside window limits (normally open mode)

**Power ON/OFF LED (Green)** – indicates the operating status of the sensor.

Power ON/OFF LED	Indicates
OFF	Power is OFF
ON Solid	Sensor is operating normally
Flashing @ 4 Hz	Output is overloaded (RUN mode)
Flashing @ 2 Hz	Transmit disabled (see page 4)

# U-GAGE™ QT50U Series Sensor — Discrete Output

## Teaching Minimum and Maximum Limits

The outputs are independent. To readjust minimum or maximum limits for either output, follow the teach procedure for that output only.

Repeat the teach procedure for the other output, if used.

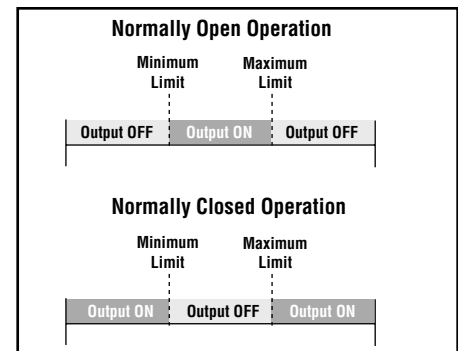


Figure 4. Teaching independent minimum and maximum limits

	Procedure		Result		
	Push Button	Remote Wire 0.04 sec. < T < 0.8 sec.			
<b>Programming Mode</b>	<ul style="list-style-type: none"> <li>Push and hold push button for selected output</li> </ul>	<p>No action required</p>	<ul style="list-style-type: none"> <li>Corresponding output LED turns ON Red</li> <li>Sensor waits for first limit</li> </ul>		
<b>Teach First Limit</b>	<ul style="list-style-type: none"> <li>Position the target for the first limit</li> <li>“Click” the same push button</li> </ul>	<ul style="list-style-type: none"> <li>Position the target for the first limit</li> </ul> <table border="1"> <tr> <td> <b>Output 1</b> <ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul> </td> <td> <b>Output 2</b> <ul style="list-style-type: none"> <li>Double-pulse the remote line</li> </ul> </td> </tr> </table>	<b>Output 1</b> <ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul>	<b>Output 2</b> <ul style="list-style-type: none"> <li>Double-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Sensor learns the first limit position</li> <li>LED for selected output changes to Flashing Red</li> </ul>
<b>Output 1</b> <ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul>	<b>Output 2</b> <ul style="list-style-type: none"> <li>Double-pulse the remote line</li> </ul>				
<b>Teach Second Limit</b>	<ul style="list-style-type: none"> <li>Position the target for the second limit</li> <li>“Click” the same push button</li> </ul>	<ul style="list-style-type: none"> <li>Position the target for the second limit</li> <li>Single-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Sensor stores both limits</li> <li>LED for selected output turns ON Yellow</li> </ul>		

# U-GAGE™ QT50U Series Sensor — Discrete Output

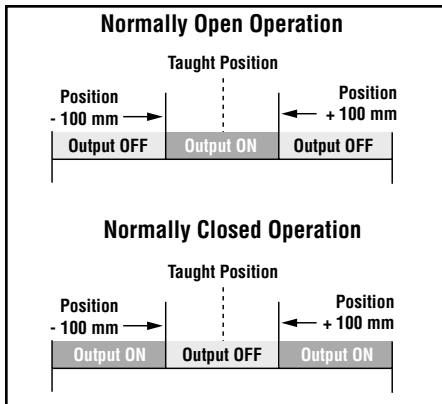


Figure 5. Using the Auto-Window feature for programming each output

## Teaching Limits Using the Auto-Window Feature

Teaching the same limit twice for the same output automatically centers a 200 mm window on the taught position.

The outputs are independent. To readjust a midpoint for either output, follow the teach procedure for that output only. Repeat the teach procedure for the other output, if used.

	Procedure		Result				
	Push Button	Remote Wire 0.04 sec. < T < 0.8 sec.					
<b>Programming Mode</b>	<ul style="list-style-type: none"> <li>Push and hold the push button for the selected output</li> </ul>	No action required	<ul style="list-style-type: none"> <li>LED for the selected output turns ON Red</li> <li>Sensor waits for the first limit</li> </ul>				
<b>Teach Limit</b>	<ul style="list-style-type: none"> <li>Position the sensor for the midpoint of the sensing window</li> <li>“Click” the same push button</li> </ul>	<ul style="list-style-type: none"> <li>Position the target for the midpoint of the sensing window</li> </ul> <table border="1" style="width: 100%;"> <tr> <td style="text-align: center;"><b>Output 1</b></td> <td style="text-align: center;"><b>Output 2</b></td> </tr> <tr> <td> <ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul> </td> <td> <ul style="list-style-type: none"> <li>Double-pulse the remote line</li> </ul> </td> </tr> </table>	<b>Output 1</b>	<b>Output 2</b>	<ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Double-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>LED for the selected output flashes Red</li> </ul>
<b>Output 1</b>	<b>Output 2</b>						
<ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Double-pulse the remote line</li> </ul>						
<b>Re-Teach Limit</b>	<ul style="list-style-type: none"> <li>Without moving the target, “click” the button again</li> </ul>	<ul style="list-style-type: none"> <li>Without moving the target, single-pulse the remote line again</li> </ul>	<ul style="list-style-type: none"> <li>LED for the selected output turns ON Yellow</li> <li>Sensor stores sensing window for the selected output</li> <li>Sensor returns to RUN mode</li> </ul>				

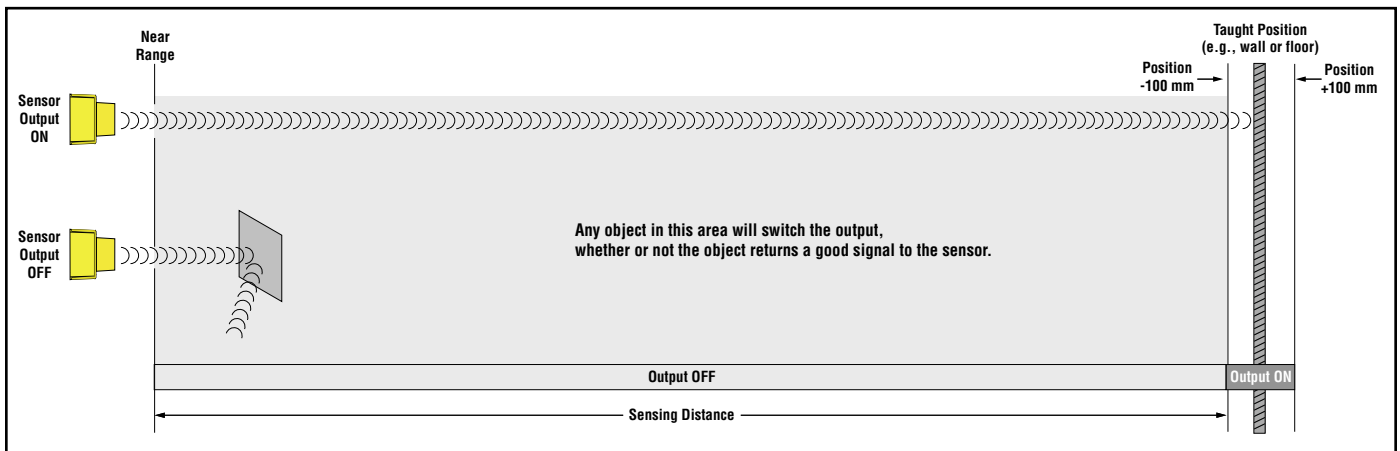


Figure 6. An application for Auto-Window feature (retroreflective mode)

# U-GAGE™ QT50U Series Sensor — Discrete Output

## Simultaneous Auto-Window/Background Suppression

**Output 1:** Auto-Window (automatically centers a 200 mm window on taught position)

**Output 2:** Background Suppression (sensor ignores objects beyond the taught position)

Taught position is identical for both outputs.

To adjust the Background Suppression limit (different from the limit for Output 1), teach a new limit to Output 2 using the Auto-Window procedure (page 7). Output 2 will remain in Background Suppression mode until it is taught new min/max limits (page 6).

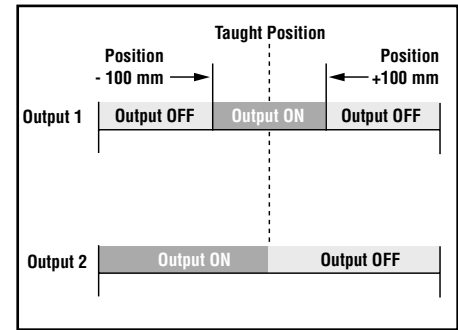


Figure 7. Using simultaneous Auto-Window/background suppression (normally open illustrated)

	Procedure		Result
	Push Button	Remote Wire 0.04 sec. < T < 0.8 sec.	
Programming Mode	<ul style="list-style-type: none"> <li>Push and hold <b>Output 1</b> push button</li> </ul>	No action required	<ul style="list-style-type: none"> <li>Output 1 LED turns ON Red</li> </ul>
	<ul style="list-style-type: none"> <li>“Click” <b>Output 2</b> push button</li> </ul>	No action required	<ul style="list-style-type: none"> <li>Output 2 LED turns ON Red (both Output LEDs should be ON Red)</li> </ul>
Teach Limits to Both Outputs Simultaneously	<ul style="list-style-type: none"> <li>Position the target at the sensing window midpoint/suppression limit</li> <li>“Click” either push button</li> </ul>	<ul style="list-style-type: none"> <li>Position the target at the sensing window midpoint/suppression limit</li> <li>Triple-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Both output LEDs Flash Red</li> </ul>
	<ul style="list-style-type: none"> <li>“Click” either push button again</li> </ul>	<ul style="list-style-type: none"> <li>Single-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Both output LEDs turn ON Yellow</li> <li>Sensor stores sensing window on Output 1 and suppression limit on Output 2</li> <li>Sensor returns to RUN mode</li> </ul>

## Push Button Lockout


Enables or disables the keypad to prevent unauthorized personnel from adjusting the programming settings.

	Push Button		Remote Line	
	Procedure	Result	Procedure 0.04 sec. < T < 0.8 sec.	Result
Push Button Lockout	<ul style="list-style-type: none"> <li>Not available via push button</li> </ul>	<ul style="list-style-type: none"> <li>Not applicable</li> </ul>	<ul style="list-style-type: none"> <li>Four-pulse the remote line</li> </ul>	<ul style="list-style-type: none"> <li>Push buttons are either enabled or disabled, depending on previous condition.</li> </ul>



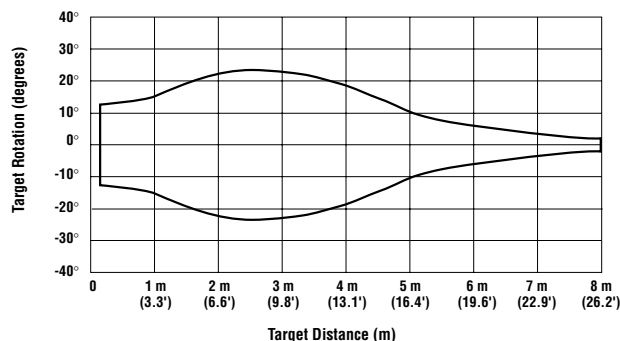
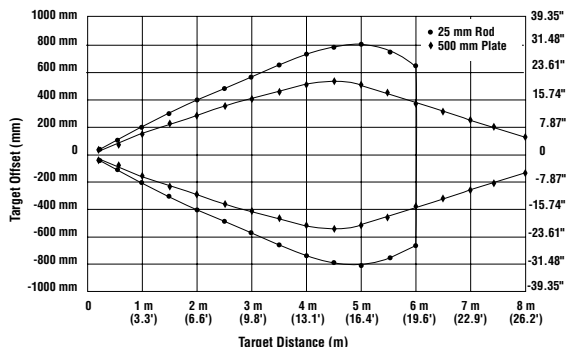
# U-GAGE™ QT50U Series Sensor — Discrete Output

## Specifications

<b>Sensing Range</b>	200 mm to 8 m (8" to 26')
<b>Supply Voltage</b>	10 to 30V dc (10% maximum ripple); 100 mA max at 10V, 40 mA max at 30V (exclusive of load)
<b>Ultrasonic Frequency</b>	75 kHz burst, rep. rate 96 ms
<b>Supply Protection Circuitry</b>	Protected against reverse polarity and transient overvoltages
<b>Output Protection</b>	Protected against short circuit conditions
<b>Delay at Power-up</b>	1.5 seconds
<b>Discrete Output Configuration</b>	PNP or NPN, selectable via DIP switch
<b>Output Ratings</b>	150 mA maximum <b>Off-state leakage current:</b> < 5 $\mu$ A <b>Output Saturation NPN:</b> < 200 mV @ 10 mA and < 650 mV @ 150 mA <b>Output Saturation PNP:</b> < 1.2V @ 10 mA and < 1.65V @ 150 mA
<b>Output Response Time</b>	100 ms to 1600 ms. See "Switches 5 and 6" in the table on page 3.
<b>Temperature Effect</b>	<b>Uncompensated:</b> 0.2% of distance/ $^{\circ}$ C <b>Compensated:</b> 0.02% of distance/ $^{\circ}$ C
<b>Hysteresis</b>	5 mm
<b>Repeatability</b>	1.0 mm
<b>Minimum Window Size</b>	20 mm
<b>Adjustments</b>	<b>Sensing window limits:</b> TEACH-Mode programming of near and far window limits may be set using the push buttons or remotely via TEACH input (see page 6).
<b>Indicators</b>	<b>Green Power On LED:</b> Indicates power is ON (see page 5) <b>Red Signal LED:</b> Indicates target is within sensing range, and the condition of the received signal (see page 5) <b>Teach/Output indicator (bicolor Yellow/Red):</b> Yellow – Target is within taught limits OFF – Target is outside taught window limits Red – Sensor is in TEACH mode
<b>Remote TEACH</b>	<b>To Teach:</b> Connect gray or yellow wire to 0 to +2V dc; impedance 12k $\Omega$ (See page 4 for transmit disable function)
<b>Construction</b>	<b>Transducer:</b> Ceramic/Epoxy composite <b>Housing:</b> ABS/Polycarbonate <b>Membrane Switch:</b> Polyester <b>Lightpipes:</b> Acrylic
<b>Operating Conditions</b>	<b>Temperature:</b> -20 $^{\circ}$ to +70 $^{\circ}$ C (-4 $^{\circ}$ to +158 $^{\circ}$ F) <b>Maximum relative humidity:</b> 100%
<b>Connections</b>	2 m (6.5') or 9 m (30') shielded 5-conductor (with drain) PVC jacketed attached cable or 5-pin Euro-style quick-disconnect or 5-pin Mini-style quick-disconnect
<b>Environmental Rating</b>	Leakproof design is rated IEC IP67; NEMA 6P
<b>Vibration and Mechanical Shock</b>	All models meet Mil Std. 202F requirements. Method 201A (vibration: 10 to 60Hz max., double amplitude 0.06", maximum acceleration 10G). Also meets IEC 947-5-2 requirements: 30G 11 ms duration, half sine wave
<b>Temperature Warmup Drift</b>	Less than 0.8% of sensing distance upon power-up with Temperature Compensation enabled (see Temperature Compensation, pages 4 and 5)
<b>Application Notes</b>	Objects passing inside the specified near limit (200 mm) may produce a false response.
<b>Certifications</b>	

# U-GAGE™ QT50U Series Sensor — Discrete Output

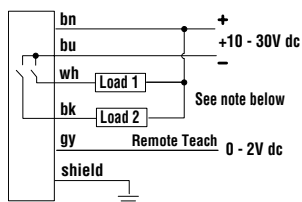
## Performance Curves



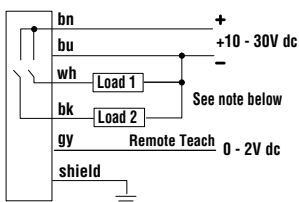
## Hookups

### Cabled Models

#### NPN Hookup

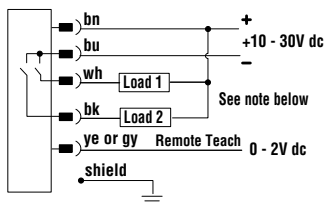


#### PNP Hookup

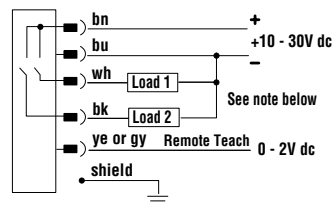


### QD Models

#### NPN Hookup



#### PNP Hookup

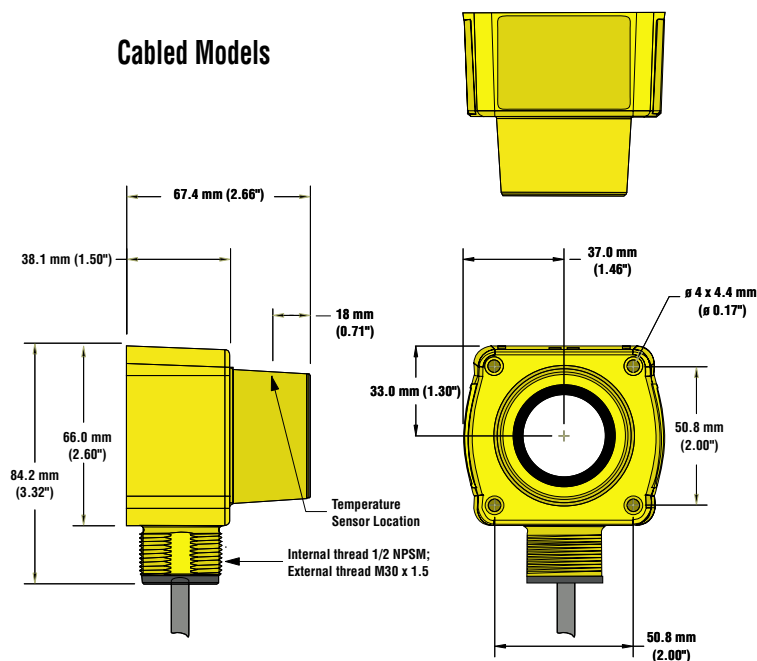


#### NOTES:

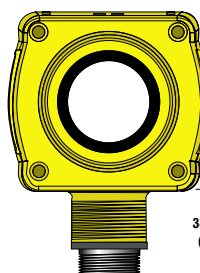
- NPN or PNP hookup must agree with DIP-switch settings (see pages 3 and 4).
- It is recommended that the shield wire be connected to earth ground or DC common.

## Dimensions

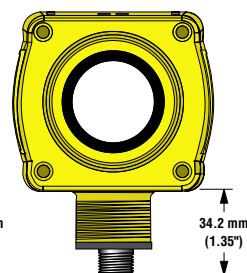
### Cabled Models



### Models with 5-Pin Mini-Style QD



### Models with 5-Pin Euro-Style QD




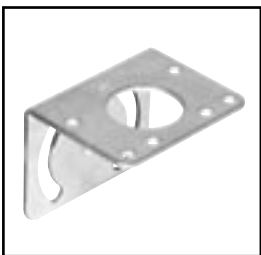
# U-GAGE™ QT50U Series Sensor — Discrete Output

## Accessories

### Quick-Disconnect (QD) Cable

Style	Model	Length	Connector	Pin-Outs
5-Pin Mini with shield	<b>MBCC2-506</b> <b>MBCC2-512</b> <b>MBCC2-530</b>	2 m (6.5') 4 m (12') 9 m (30')		
5-Pin Euro Straight with shield	<b>MQDEC2-506</b> <b>MQDEC2-515</b> <b>MQDEC2-530</b>	2 m (6.5') 5 m (15') 9 m (30')		
5-Pin Euro Right-angle with shield	<b>MQDEC2-506RA</b> <b>MQDEC2-515RA</b> <b>MQDEC2-530RA</b>	2 m (6.5') 5 m (15') 9 m (30')		

### Mounting Brackets

<b>SMB30SC</b>	<ul style="list-style-type: none"> <li>• 30 mm split clamp with swivel, black reinforced thermoplastic polyester</li> <li>• Stainless steel hardware included</li> </ul>	<b>SMB30MM</b>	<ul style="list-style-type: none"> <li>• 30 mm, 11-gauge, stainless steel bracket with curved mounting slots for versatility and orientation</li> <li>• Clearance for M6 (1/4") hardware</li> </ul>
			

# U-GAGE™ QT50U Series Sensor — Discrete Output

---



more sensors, more solutions

**WARRANTY:** Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.