

WORLD-BEAM QS18U Ultrasonic Sensors



Miniature Ultrasonic Sensors with TEACH-Mode Programming



Features

- Fast, easy-to-use TEACH-Mode programming; no potentiometer adjustments
- Ultra-compact housing
- One discrete output: NPN or PNP, depending on model
- Two bi-colored status LEDs
- Rugged encapsulated version for harsh environments
- Choose 2 meter or 9 meter unterminated cable, 4-pin Euro-style or 4-pin Pico-style QD connectors (either integral or with 150 mm pigtail)
- Wide operating range of -20° to +60° C (-13° to +140° F)
- Temperature compensation
- Configurable for normally open or normally closed operation
- Fast response time (15 milliseconds)

Models

Models	Sensing Range	TEACH Option	Cable*	Supply Voltage	Output
QS18UNA	50 mm to 500 mm (2 in to 20 in)	Integral push button or remote TEACH (IP67, NEMA 6P)	4-wire, 2 m (6.5 ft) cable with shield	12-30V dc	NPN
QS18UPA					PNP
QS18UNAE		Remote TEACH (epoxy-encapsulated, IP68, NEMA 6P)			NPN
QS18UPAE					PNP

Overview

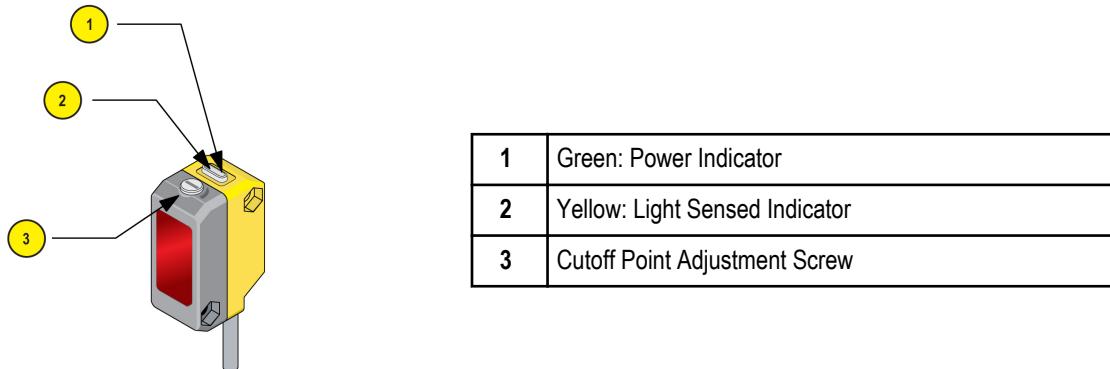


Figure 1. Sensor features

Sensor Installation

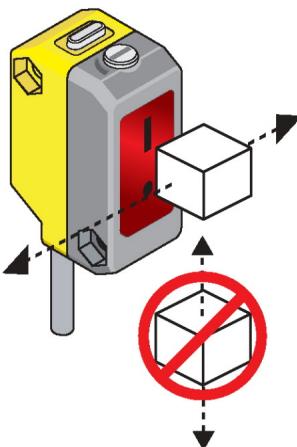


Figure 2. Required Orientation of Object to Sensor

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:

In metric units: $C_{m/s} = 20 \sqrt{273 + T_C}$

$C_{m/s}$ = speed of sound in meters per second

T_C = temperature in °C

In English units: $C_{ft/s} = 49 \sqrt{460 + T_F}$

$C_{ft/s}$ = speed of sound in feet per second

T_F = temperature in °F

Temperature Compensation

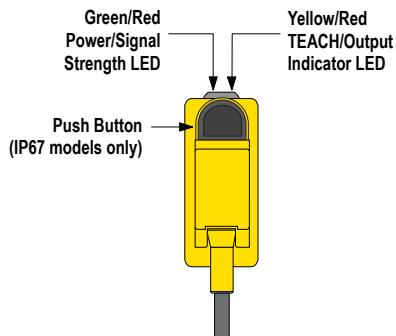
Changes in air temperature affect the speed of sound, which in turn affects the distance reading measured by the sensor. An increase in air temperature shifts both sensing window limits closer to the sensor. Conversely, a decrease in air temperature shifts both limits farther away from the sensor. This shift is approximately 3.5% of the limit distance for a 20° C change in temperature.

The QS18U series ultrasonic sensors are temperature compensated. This reduces the error due to temperature by about 90%. The sensor will maintain its window limits to within 1.8% over the -20° to +60° C (-4° to +140° F) range.

**NOTE:**

- Exposure to direct sunlight can affect the sensor's ability to accurately compensate for changes in temperature.
- If the sensor is measuring across a temperature gradient, the compensation will be less effective.
- The temperature warmup drift upon power-up is less than 7% of the sensing distance. After 5 minutes, the apparent switchpoint will be within 0.6% of the actual position. After 25 minutes, the sensing position will be stable.

Sensor Programming



Two TEACH methods may be used to program the sensor:

- Teach individual minimum and maximum limits, or
- Use Auto-Window feature to center a sensing window around the taught position

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

Figure 3. Sensor Features

Programming is accomplished by following the sequence of input pulses (see programming procedures starting on page 4). The duration of each pulse (corresponding to a push button "click"), and the period between multiple pulses, are defined as "T":

0.04 seconds < T < 0.8 seconds

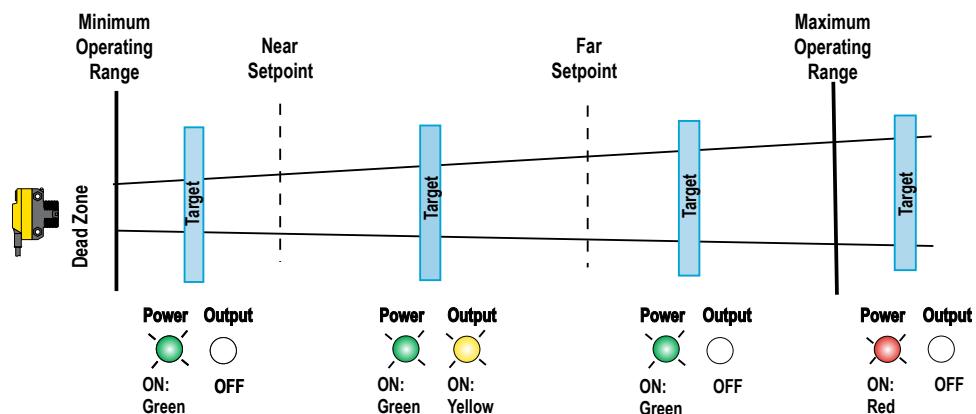


Figure 4. TEACH Interface

Status Indicators

Power ON/OFF LED	Indicates	Output/Teach LED	Indicates
OFF	Power is OFF	OFF	Target is outside window limits (normally open operation).
ON Red	Target is weak or outside sensing range.	Yellow	Target is within window limits (normally open operation).

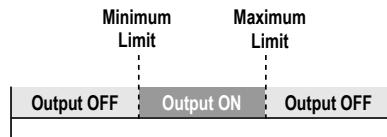
Power ON/OFF LED	Indicates	Output/Teach LED	Indicates
ON Green	Sensor is operating normally, good target.	ON Red (solid)	In Teach Mode, waiting for first limit.
		ON Red (flashing)	In Teach Mode, waiting for second limit.

Teaching Minimum and Maximum Limits

General Notes on Programming

- The sensor will return to RUN mode if the first TEACH condition is not registered within 120 seconds.
- After the first limit is taught, the sensor will remain in PROGRAM mode until the TEACH sequence is finished.
- To exit PROGRAM mode without saving any changes, press and hold the programming push button > 2 seconds (before teaching the second limit). The sensor will revert to the last saved limits.

Normally Open Operation



Normally Closed Operation

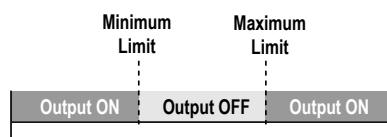
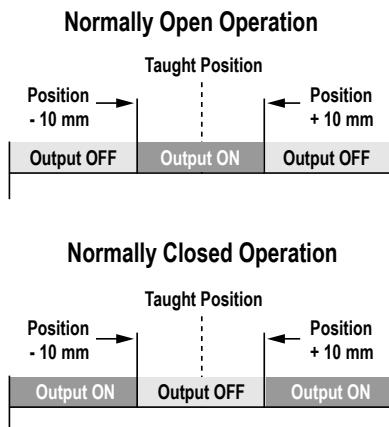


Figure 5. Teaching independent minimum and maximum limits

	Procedure		Result
	Push Button 0.04 seconds \leq "Click" \leq 0.8 seconds	Remote Line 0.04 sec $<$ T $<$ 0.8 sec	
Program- ming Mode	• Press and hold push button 	• No action required; sensor is ready for 1st limit teach	Output LED: ON Red Power LED: ON Green (good signal) or ON Red (no signal)
Teach First Limit	• Position the target for the first limit	• Position the target for the first limit	Power LED: Must be ON Green
	• "Click" the push button 	• Single-pulse the remote line 	Teach Accepted Output LED: Flashing Red Teach Unacceptable Output LED: ON Red
Teach Sec- ond Limit	• Position the target for the second limit	• Position the target for the second limit	Power LED: Must be ON Green
	• "Click" the push button 	• Single-pulse the remote line 	Teach Accepted Output LED: Yellow or OFF Teach Unacceptable Output LED: Flashing Red

Teaching Limits Using the Auto-Window Feature

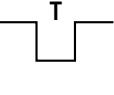
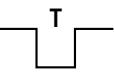


Teaching the same limit twice automatically centers a 20 mm window on the taught position.

General Notes on Programming

- The sensor will return to RUN mode if the first TEACH condition is not registered within 120 seconds.
- After the first limit is taught, the sensor will remain in PROGRAM mode until the TEACH sequence is finished.
- To exit PROGRAM mode without saving any changes, press and hold the programming push button > 2 seconds (before teaching the second limit). The sensor will revert to the last saved program.

Figure 6. Using the Auto-Window feature for programming each output

	Procedure		Result
	Push Button 0.04 seconds ≤ "Click" ≤ 0.8 seconds	Remote Line 0.04 sec < T < 0.8 sec	
Programming Mode	<ul style="list-style-type: none"> Press and hold push button 	<ul style="list-style-type: none"> No action required; sensor is ready for 1st limit teach 	Output LED: ON Red Power LED: ON Green (good signal) or ON Red (no signal)
Teach First Limit	<ul style="list-style-type: none"> Position the target for the first limit 	<ul style="list-style-type: none"> Position the target for the center of the window 	Power LED: Must be ON Green
	<ul style="list-style-type: none"> "Click" the push button 	<ul style="list-style-type: none"> Single-pulse the remote line 	Teach Accepted Output LED: Flashing Red Teach Unacceptable Output LED: ON Red
Re-Teach Limit	<ul style="list-style-type: none"> Without moving the target, "click" the push button again 	<ul style="list-style-type: none"> Without moving the target, single-pulse the remote line again 	Teach Accepted Output LED: Yellow or OFF Teach Unacceptable Output LED: Flashing Red

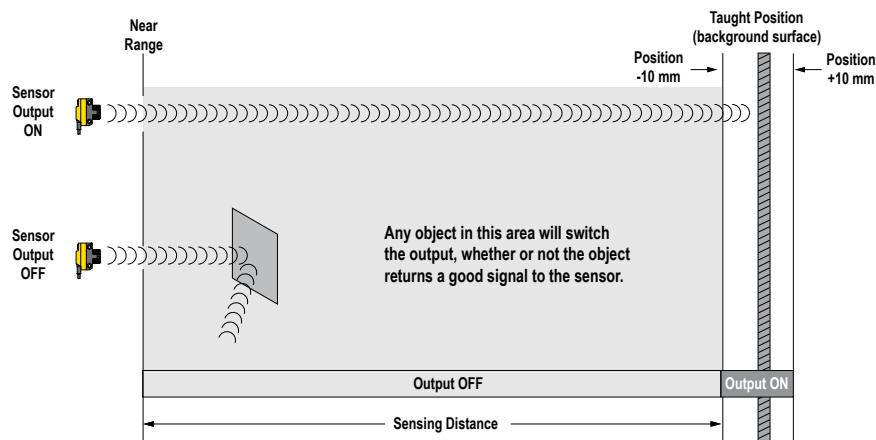


Figure 7. An application for the Auto-Window feature (retroflective mode)

Normally Open / Normally Closed Operation Select

The sensor can be configured for either normally open or normally closed operation via the remote teach wire (white). A series of three pulses on the line will toggle between normally open and normally closed operation. Normally open is defined as the output energizing when the target is present. Normally closed is defined as the output energizing when the target is absent. See Figures 5 and 6.

	Procedure		Result
	Push Button 0.04 seconds \leq "Click" \leq 0.8 seconds	Remote Line 0.04 sec $<$ T $<$ 0.8 sec	
Toggle be- tween N.O. / N.C. Operation	<ul style="list-style-type: none"> Not available via push button 	<ul style="list-style-type: none"> Triple-pulse the remote line 	Either Normally Open or Normally Closed operation is selected, depending on previous condition.

Push Button Lockout

Enables or disables the push button to prevent unauthorized personnel from adjusting the program settings.

	Procedure		Result
	Push Button 0.04 seconds \leq "Click" \leq 0.8 seconds	Remote Line 0.04 sec $<$ T $<$ 0.8 sec	
Push But- ton Lock- out	<ul style="list-style-type: none"> Not available via push button 	<ul style="list-style-type: none"> Four-pulse the remote line 	Push buttons are either enabled or disabled, depending on condition.

Specifications

Supply Voltage

12 - 30V dc (10% maximum ripple); 25 mA max (exclusive of load)

Supply Protection Circuitry

Protected against reverse polarity and transient voltages

Output Configuration

SPST solid-state switch conducts when target is sensed within sensing window; one NPN (current sinking) or one PNP (current sourcing), depending on model.

Rating: 100 mA maximum load; see Application Note 1

Off-state leakage current: less than 10 μ A (sourcing); less than 200 μ A (sinking); see Application Note 2

ON-state saturation voltage: NPN: less than 1.6V @ 100 mA; PNP: less than 3.0V @ 100 mA

Output Response

NOTE: 300 ms delay on power-up; output does not conduct during this time

15 milliseconds

Repeatability

0.7 mm

Indicators

Range Indicator (Red/Green) and Teach/Output Indicator (Yellow/Red)

Range Indicator: Green - Target is within sensing range; Red - Target is outside sensing range; OFF - Sensing Power is OFF

Teach/Output Indicator: Yellow - Target is within taught limits; OFF - Target is outside taught window limits; Red - Sensor is in TEACH mode

Adjustments

Sensing Window Limits: TEACH-mode programming of near and far window limits may be set using the push button or remotely via TEACH input

Construction

ABS housing, TPE Push Button, ABS Push Button housing, Polycarbonate lightpipes, leakproof design

Connections

2 m (6.5 ft) or 9 m (30 ft) 4-conductor PVC jacketed attached cable, or 4-pin Euro-style integral QD (Q8), or 4-pin Pico-style integral QD (Q7), or 4-pin Euro-style 150 mm (6 in) pigtail QD (Q5), or 4-pin Pico-style 150 mm (6 in) pigtail QD (Q)

Operating Conditions

Relative Humidity: 100% @ 55° C (non-condensing)

Temperature: - 20° to + 60° C (- 4° to + 140° F)

Application Notes

If supply voltage is > 24V dc, derate maximum output current 5 mA/°C above 50°C.

NPN off-state leakage current is < 200 μ A for load resistances > 3 k Ω or optically isolated loads. For load current of 100 mA, leakage is < 1% of load current.

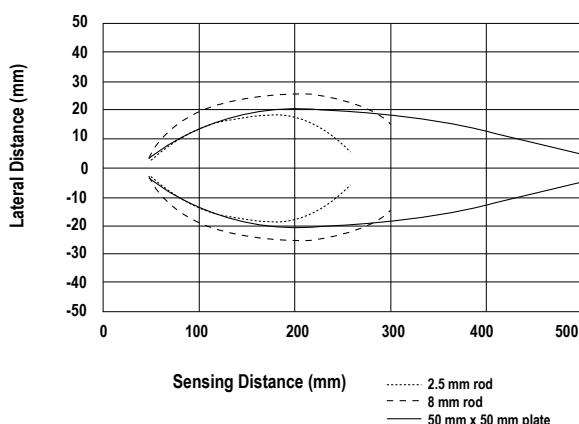
Objects passing inside the specified near limit may produce a false response.

Certifications

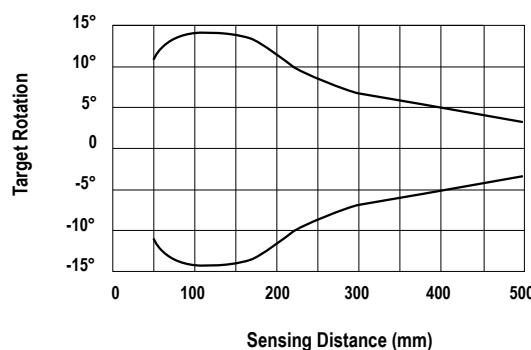


Sensor Response Curves

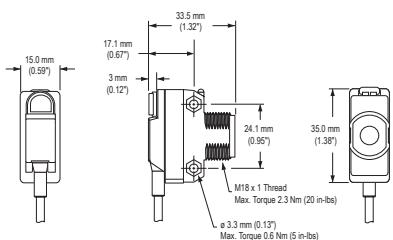
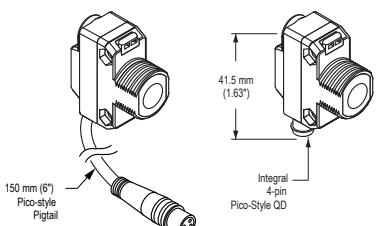
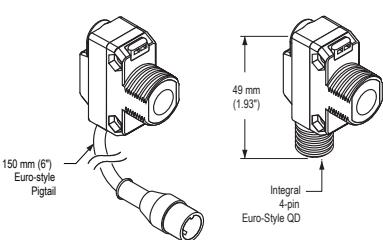
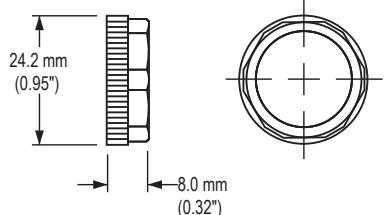
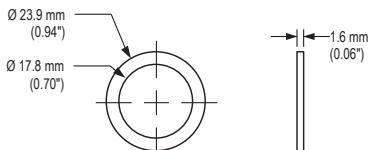
QS18U Effective Beam Pattern (Typical)



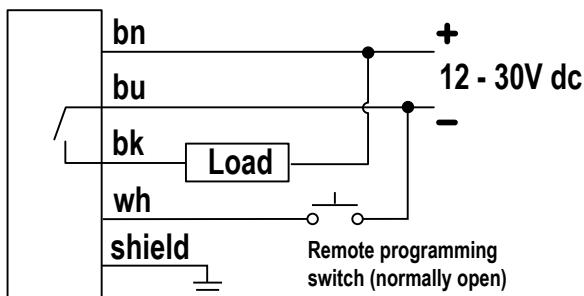
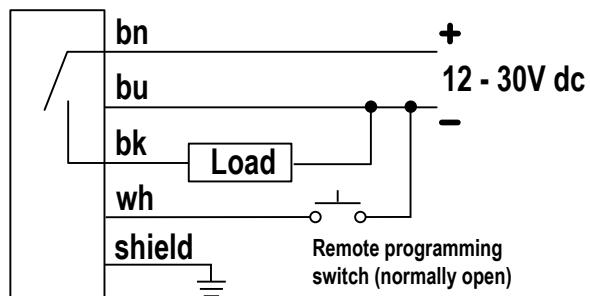
QS18U Maximum Target Rotation Angle



Dimensions

Cabled Models**Pico-Style QD Models****Euro-Style QD Models****Locknut** (included with all models)**Washer** (included with all models)**M3 Hardware Packet Contents:**

- 2 – M3 x 0.5 x 20 mm SS Screw
- 2 – M3 x 0.5 SS Hex Nut
- 2 – M3 SS Washer

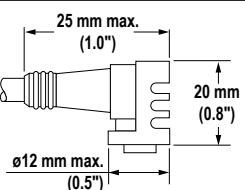
Wiring**NPN (Sinking) Output Models****PNP (Sourcing) Output Models**

Cable and QD hookups are functionally identical. It is recommended that the shield wire be connected to earth ground. Shielded cordsets are recommended for all QD models.

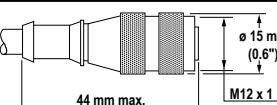
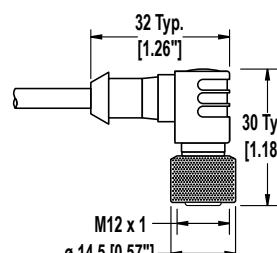
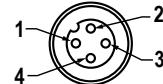
Quick-Disconnect (QD) Cordsets**4-Pin Snap-On M8/Pico-Style Cordsets with Shield**

Model	Length	Style	Dimensions	Pinout
PKG4S-2	2.00 m (6.56 ft)	Straight	 1 = Brown 2 = White 3 = Blue 4 = Black	 1 = Brown 2 = White 3 = Blue 4 = Black

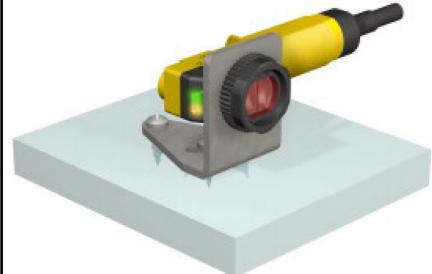
4-Pin Snap-On M8/Pico-Style Cordsets with Shield

Model	Length	Style	Dimensions	Pinout
PKW4ZS-2	2.00 m (6.56 ft)	Right Angle		

4-Pin Threaded M12/Euro-Style Cordsets with Shield

Model	Length	Style	Dimensions	Pinout
MQDEC2-406	1.83 m (6 ft)	Straight		
MQDEC2-415	4.57 m (15 ft)			
MQDEC2-430	9.14 m (30 ft)			
MQDEC2-406RA	1.83 m (6 ft)	Right-Angle		 1 = Brown 2 = White 3 = Blue 4 = Black
MQDEC2-415RA	4.57 m (15 ft)			
MQDEC2-430RA	9.14 m (30 ft)			

Mounting Brackets

SMB18A	<ul style="list-style-type: none"> Right-angle mounting bracket with a curved slot for versatile orientation 12-ga. stainless steel 18 mm sensor mounting hole Clearance for M4 (#8) hardware 	
SMBQS18RA	<ul style="list-style-type: none"> Right-angle mounting bracket 14-ga. 304 stainless steel 	
SMB18SF	<ul style="list-style-type: none"> 18 mm swivel bracket with M18 x 1 internal thread Black thermoplastic polyester Stainless steel swivel locking hardware included 	
SMB18UR	<ul style="list-style-type: none"> 2-piece universal swivel bracket 300 series stainless steel 	

- Stainless steel swivel locking hardware included
- Mounting hole for 18 mm sensor

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