# QS18U Ultrasonic Sensor

## Features

Miniature ultrasonic sensors with TEACH-mode programming



- 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 M12 or 4-pin M8 QD connectors (either integral or with 150 mm pigtail)
- Wide operating range of –20 °C to +60 °C (–4 °F to +140 °F)
- Temperature compensation
- Configurable for normally open or normally closed operation
- Fast response time (15 milliseconds)

**WARNING:**
- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.

## Models

| Model | TEACH Option | Output |
|---|---|---|
| QS18UNA | Integral push button or remote TEACH (IP67, NEMA 6P) | NPN |
| QS18UPA | | PNP |
| QS18UNAE | Remote TEACH (epoxy-encapsulated, IP68, NEMA 6P) | NPN |
| QS18UPAE | | PNP |

The standard 4-wire 2 m (6.5 ft) cable with shield models are listed. To order the 9 m (30 ft) shielded cable models, add the suffix "W/30" to the model number (e.g., QS18UNA W/30).

A model with a QD connector requires a mating cordset. For QD models:
- To order the 4-pin integral M12 QD model, add the suffix **Q8** (for example, **QS18UNAQ8**).
- To order the 150 mm (6 in) cable with a 4-pin M12 QD model, add the suffix **Q5** (for example, **QS18UNAQ5**).
- To order the 4-pin integral M8 QD model, add the suffix **Q7** (for example, **QS18UNAQ7**).
- To order the 150 mm (6 in) cable with a 4-pin M8 QD model, add the suffix **Q** (for example, **QS18UNAQ**).

The following models are no longer available for order but are still covered by the information in this document.

- QS18UNAEQ7
- QS18UPAE W/30
- QS18UPAEQ7

## 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 = 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

Original Instructions
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119287
p/n: 119287 Rev. M

ПРОМЭЛЕКТРОНИКА/ sales@prom-elec.com

## Temperature Compensation

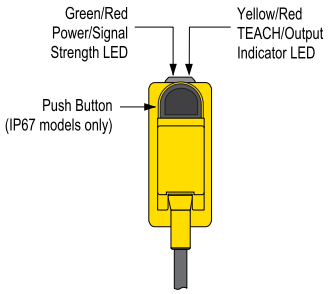
Changes in air temperature affect the speed of sound, which in turn affects the distance reading measured by the sensor. An increase in air temperature shifts both sensing window limits closer to the sensor. Conversely, a decrease in air temperature shifts both limits farther away from the sensor. This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

The Q18U 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

*Sensor Features*

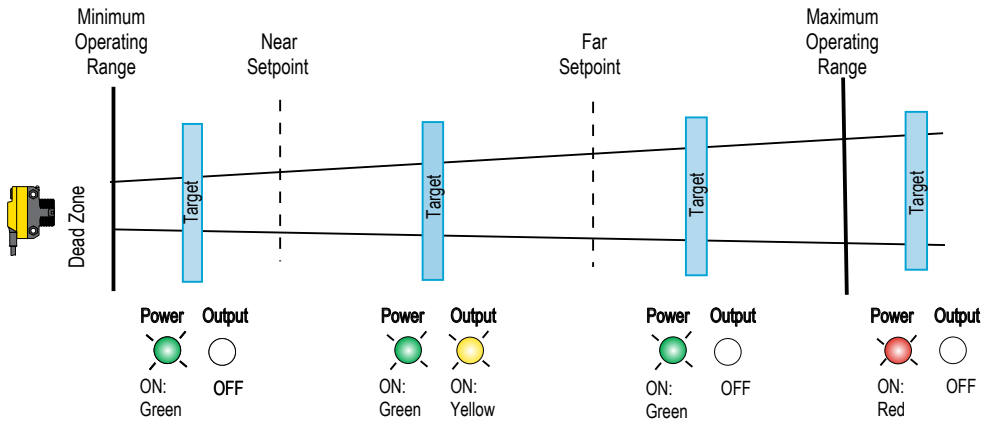



Two TEACH methods may be used to program the sensor:
- Teach individual minimum and maximum limits, or
- Use Auto-Window feature to center a sensing window around the taught position

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 0 V DC, with a remote programming switch between the sensor and the voltage.

Programming is accomplished by following the sequence of input pulses (see programming procedures). 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**.

*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 | The target is weak or outside the sensing range | | Yellow | Target is within window limits (normally open operation) |
| ON Green | The sensor is operating normally, good target | | ON Red (solid) | In TEACH Mode, waiting for the first limit |
| | | | ON Red (flashing) | In TEACH Mode, waiting for the second limit |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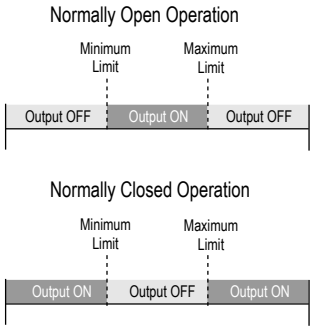
## Teaching Minimum and Maximum Limits

**General Notes on Programming**

- The sensor returns to Run mode if the first TEACH condition is not registered within 120 seconds.
- After the first limit is taught, the sensor remains in Program mode until the TEACH sequence is finished.
- To exit Program mode without saving any changes, press and hold the programming push button for more than 2 seconds (before teaching the second limit). The sensor reverts to the last saved limits.

*Teaching independent minimum and maximum limits*




| | Procedure | | Result |
|---|---|---|---|
| | **Push Button (0.04 sec ≤ Click ≤ 0.8 sec)** | **Remote Line (0.04 sec < T < 0.8 sec)** | |
| Programming Mode | Press and hold push button | No action required; sensor is ready for 1st limit teach | Output LED: ON Red<br>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**<br>Output LED: Flashing Red<br><br>**Teach Unacceptable**<br>Output LED: ON Red |
| Teach Second 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**<br>Output LED: Yellow or OFF<br><br>**Teach Unacceptable**<br>Output LED: Flashing Red |

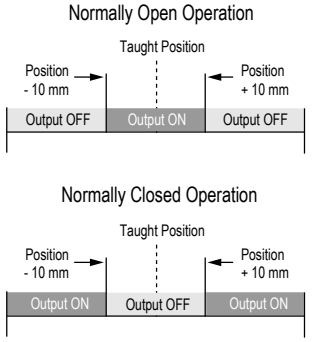
## Teaching Limits Using the Auto-Window Feature

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

**General Notes on Programming**

- The sensor returns to Run mode if the first TEACH condition is not registered within 120 seconds.
- After the first limit is taught, the sensor remains in Program mode until the TEACH sequence is finished.
- To exit Program mode without saving any changes, press and hold the programming push button for more than 2 seconds (before teaching the second limit). The sensor reverts to the last saved program.

*Using the Auto-Window feature for programming each output*




| | Procedure | | Result |
|---|---|---|---|
| | **Push Button (0.04 sec ≤ Click ≤ 0.8 sec)** | **Remote Line (0.04 sec < T < 0.8 sec)** | |
| Programming Mode | Press and hold push button | No action required; sensor is ready for 1st limit teach | Output LED: ON Red<br>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 center of the window | Power LED: Must be ON Green |
| | Click the push button | Single-pulse the remote line | **Teach Accepted**<br>Output LED: Flashing Red<br><br>**Teach Unacceptable**<br>Output LED: ON Red |

Continued on page 4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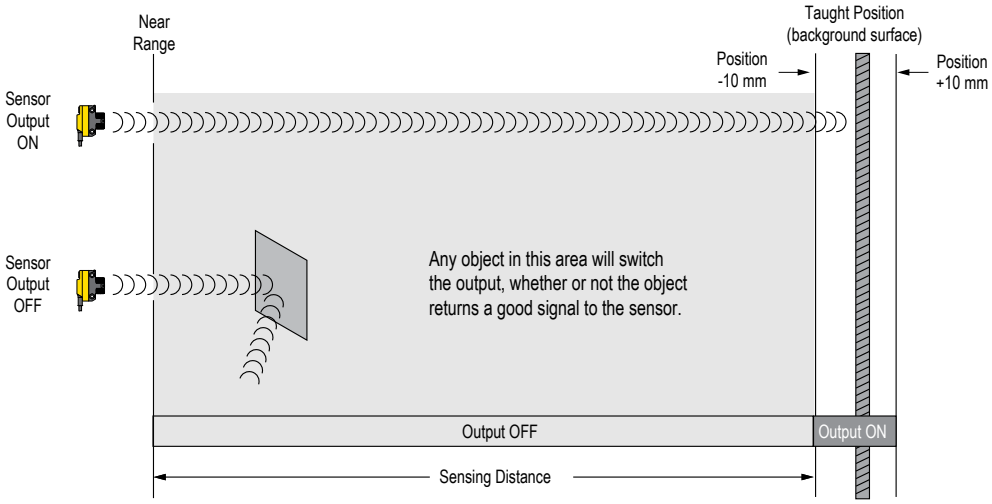
Continued from page 3

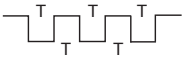
| | Procedure | | Result |
|---|---|---|---|
| | Push Button (0.04 sec ≤ Click ≤ 0.8 sec) | Remote Line (0.04 sec < T < 0.8 sec) | |
| Re-Teach Limit | Without moving the target, click the push button again  | Without moving the target, single-pulse the remote line again   | Teach Accepted<br>Output LED: Yellow or OFF<br><br>Teach Unacceptable<br>Output LED: Flashing Red |

*An application for the Auto-Window feature (retroreflective mode)*




## Normally Open/Normally Closed Operation Select

Configure the sensor for either normally open or normally closed operation using the remote teach wire (white). A series of three pulses on the line toggles between normally open (NO) and normally closed (NC) 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 "Teaching Minimum and Maximum Limits" on page 3 and "Teaching Limits Using the Auto-Window Feature" on page 3.)

| | Procedure | | Result |
|---|---|---|---|
| | Push Button (0.04 sec ≤ Click ≤ 0.8 sec) | Remote Line (0.04 sec < T < 0.8 sec) | |
| Toggle between NO/ NC Operation | Not available via push button | Triple-pulse the remote line   | Selects either Normally Open or Normally Closed operation depending on the 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 sec ≤ Click ≤ 0.8 sec) | Remote Line (0.04 sec < T < 0.8 sec) | |
| Push Button Lockout | Not available via push button | Four-pulse the remote line   | Push buttons are either enabled or disabled, depending on condition. |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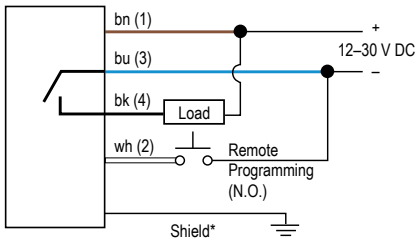
## Wiring Diagrams

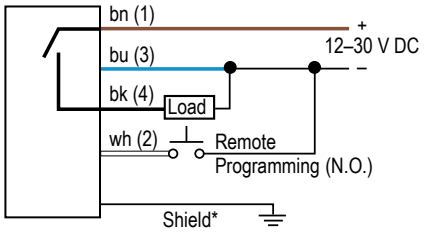
Banner recommends connecting the shield wire to earth ground. Shielded cordsets are recommended for all QD models.

*NPN (Sinking) Output Models*



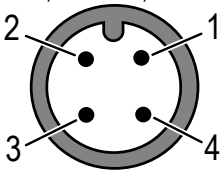

* It is recommended that the shield wire be connected to either earth ground or DC common.

*PNP (Sourcing) Output Models*

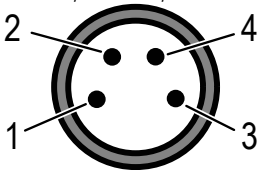



* It is recommended that the shield wire be connected to either earth ground or DC common.

*4-pin M12 male pinout*




*4-pin M8 male pinout*




## Specifications

**Sensing Range**

50 to 500 mm (2 to 20 inches)

**Supply Voltage**

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

**Ultrasonic Frequency**

300 kHz, rep. rate 7.5 ms

**Supply Protection Circuitry**

Protected against reverse polarity and transient voltages

**Repeatability**

0.7 mm

**Minimum Window Size**

5 mm

**Hysteresis**

1.4 mm

**Adjustments**

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

**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.

**Output Protection**

Protected against short-circuit conditions

**Certifications**

Banner Engineering BV
Park Lane, Culliganlaan 2F bus 3
1831 Diegem, BELGIUM

Turck Banner LTD Blenheim House
Blenheim Court
Wickford, Essex SS11 8YT
GREAT BRITAIN

**Output Rating**

Rating: 100 mA maximum load; see Application Note 1

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

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

**Output Response**

15 milliseconds

**Delay at Power Up**

300 milliseconds

**Indicators**

**Range Indicator (Red/Green) and Teh/Output Indicator (Amber/Red)**

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

Teh/Output Indicator: Amber - Target is within taught limits; OFF - Target is outside taught window limits; Red - Sensor is in TEH mode

**Construction**

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

**Connections**

2 m (6.5 ft) or 9 m (30 ft) 4-conductor PVC jacketed attached cable, or 4-pin M12 integral quick-disconnect (Q8), or 4-pin M8 integral quick-disconnect (Q7), or 4-pin M12 150 mm (6 in) cable quick-disconnect (Q5), or 4-pin M8 150 mm (6 in) cable quick-disconnect(Q)

**Temperature Warmup Drift**

See "Temperature Compensation" on page 2

**Temperature Effect**

Non-encapsulated models: ± 0.05% per °C from –20 to 50 °C, ± 0.1% per °C from 50 to 60 °C

Encapsulated models: ± 0.05% per °C from 0 to 60 °C, ± 0.1% per °C from –20 to 0 °C

**Application Notes**

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

NPN off-state leakage current is < 200 µA for load resistances > 3 kΩ 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.

**Environmental Rating**

Leakproof design, rated NEMA 6P; IEC IP67 or IP68 depending on model; UL Type 1

**Operating Conditions**

−20 °C to 60 °C (−4 °F to 140 °F)

100% relative humidity (non-condensing)

**Vibration and Mechanical Shock**

All models meet MIL-STD-202F, Method 201A (Vibration: 10 Hz to 60 Hz maximum, 0.06 inch (1.52 mm) double amplitude, 10G maximum acceleration) requirements. Also meets IEC 60947-5-2 (Shock: 30G 11 ms duration, half sine wave) requirements.

**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 (A) | Supply Wiring (AWG) | Required Overcurrent Protection (A) |
|---|---|---|---|
| 20 | 5.0 | 26 | 1.0 |
| 22 | 3.0 | 28 | 0.8 |
| 24 | 2.0 | 30 | 0.5 |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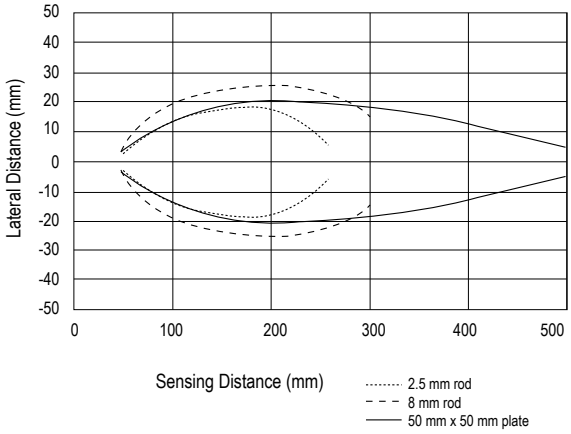
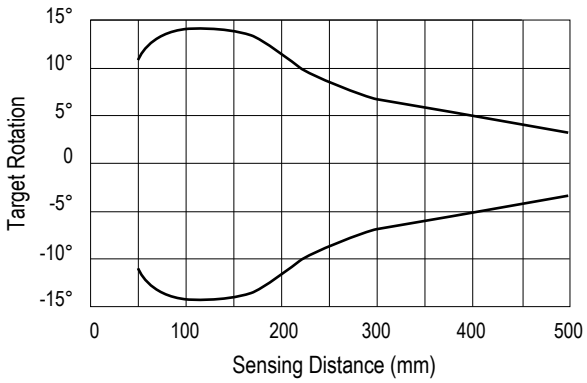
*QS18U Effective Beam Pattern (Typical)*




*QS18U Maximum Target Rotation Angle*




## FCC Part 15 Class A for Unintentional Radiators

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

(Part 15.21) Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

## Industry Canada ICES-003(A)

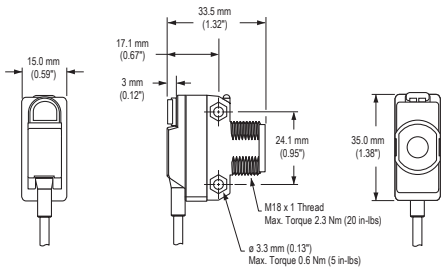
This device complies with CAN ICES-3 (A)/NMB-3(A). Operation is subject to the following two conditions: 1) This device may not cause harmful interference; and 2) This device must accept any interference received, including interference that may cause undesired operation.

Cet appareil est conforme à la norme NMB-3(A). Le fonctionnement est soumis aux deux conditions suivantes : (1) ce dispositif ne peut pas occasionner d'interférences, et (2) il doit tolérer toute interférence, y compris celles susceptibles de provoquer un fonctionnement non souhaité du dispositif.

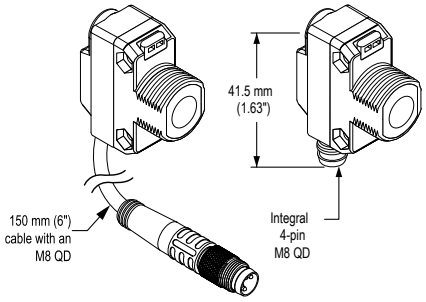
## Dimensions

All measurements are listed in millimeters, unless noted otherwise. The measurements provided are subject to change.

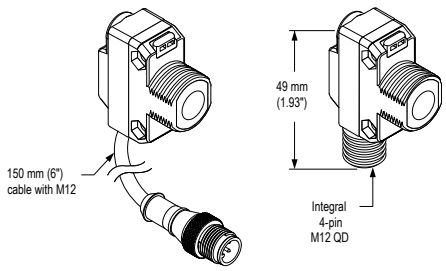
*Cabled models*



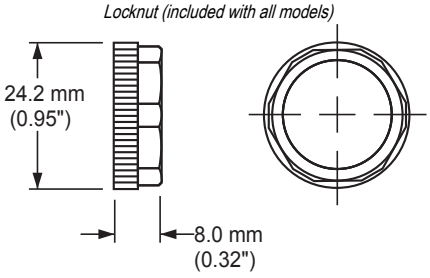

*M8 QD models*



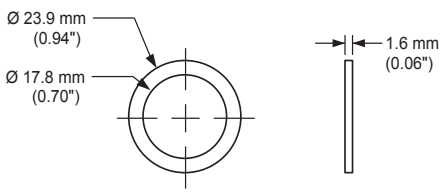

*M12 QD models*




*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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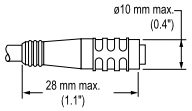
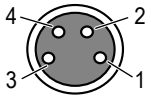
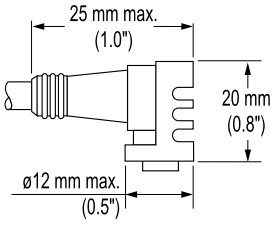
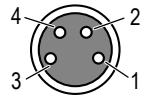
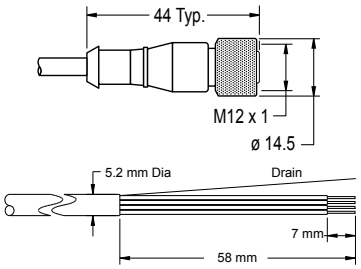
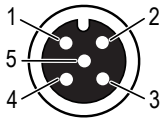
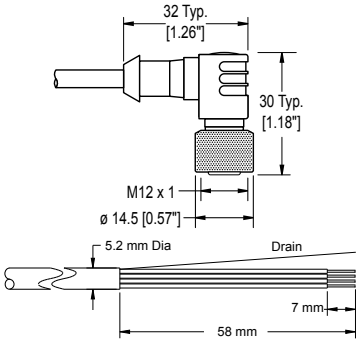
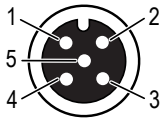
# Accessories

## Quick-Disconnect (QD) Cordsets

| 4-Pin Single-Ended Snap-On M8 Female Cordsets with Shield | | | | | |
|---|---|---|---|---|---|
| **Model** | **Length** | **Style** | **Dimensions** | **Pinout (Female)** | |
| **PKG4S-2** | 2 m (6.56 ft) | Straight |  |  | 1 = Brown<br>2 = White<br>3 = Blue<br>4 = Black |
| **PKW4ZS-2** | 2 m (6.56 ft) | Right Angle |  |  | |

| 4-pin Single-Ended M12 Female Shielded Cordsets (datasheet p/n 236187) | | | | |
|---|---|---|---|---|
| **Model** | **Length** | **Dimensions (mm)** | **Pinout (Female)** | |
| **BC-M12F4-22-1-SF** | 1 m (3.28 ft) |  |  | 1 = Brown<br>2 = White<br>3 = Blue<br>4 = Black<br>5 = Unused |
| **BC-M12F4-22-2-SF** | 2 m (6.56 ft) | | | |
| **BC-M12F4-22-5-SF** | 5 m (16.4 ft) | | | |
| **BC-M12F4-22-8-SF** | 8 m (26.25 ft) | | | |
| **BC-M12F4-22-10-SF** | 10 m (30.81 ft) | | | |
| **BC-M12F4-22-15-SF** | 15 m (49.2 ft) | | | |

| 4-pin Single-Ended M12 Female Right-Angle Shielded Cordsets (datasheet p/n 236187) | | | | |
|---|---|---|---|---|
| **Model** | **Length** | **Dimensions (mm)** | **Pinout (Female)** | |
| **BC-M12F4A-22-1-SF** | 1 m (3.28 ft) |  |  | 1 = Brown<br>2 = White<br>3 = Blue<br>4 = Black<br>5 = Unused |
| **BC-M12F4A-22-2-SF** | 2 m (6.56 ft) | | | |
| **BC-M12F4A-22-5-SF** | 5 m (16.4 ft) | | | |
| **BC-M12F4A-22-8-SF** | 8 m (26.25 ft) | | | |
| **BC-M12F4A-22-10-SF** | 10 m (30.81 ft) | | | |
| **BC-M12F4A-22-15-SF** | 15 m (49.2 ft) | | | |

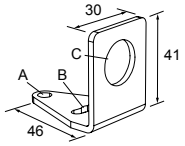
## Mounting Brackets

All measurements are listed in millimeters, unless noted otherwise. The measurements provided are subject to change.

**SMB18A**

- 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
- CAD Files: DXF, PDF, IGS, STP

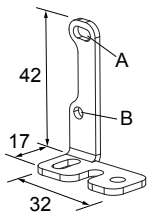
**Hole center spacing:** A to B = 24.2
**Hole size:** A = ø 4.6, B = 17.0 × 4.6, C = ø 18.5




**SMBQS18RA**

- Right-angle mounting bracket
- 14-ga. 304 stainless steel
- CAD Files: DXF, PDF, IGS, STP

**Hole center spacing:** A to B = 20.3
**Hole size:** A = 4.3 × 9.3, B = ø 4.3




Continued on page 8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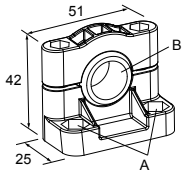
**SMB18SF**

- 18 mm swivel bracket with M18 × 1 internal thread
- Black thermoplastic polyester
- Stainless steel swivel locking hardware included
- CAD Files: DXF, PDF, IGS, STP

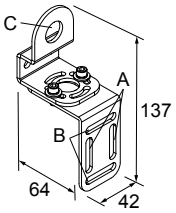
**Hole center spacing:** A = 36.0
**Hole size:** A = ø 5.3, B = ø 18.0




**SMB18UR**

- 2-piece universal swivel bracket
- 300 series stainless steel
- Stainless steel swivel locking hardware included
- Mounting hole for 18 mm sensor
- CAD Files: DXF, PDF, IGS, STP

**Hole center spacing:** A = 25.4, B = 46.7
**Hole size:** B = 6.9 × 32.0, C = ø 18.3

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