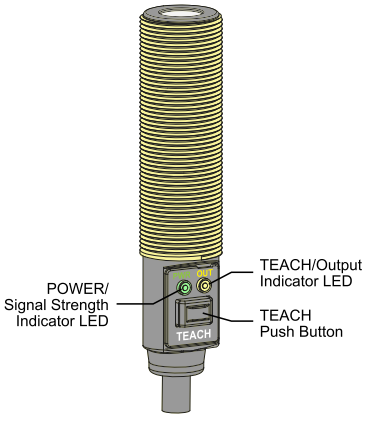
# U-GAGE™ S18U Series Sensors with Discrete Output

## Datasheet

*18 mm Ultrasonic Sensors with TEACH-mode programming*




- Fast, easy-to-use TEACH-Mode programming; no potentiometer adjustments
- Short dead zone
- One NPN and one PNP output
- Two bi-colored status LEDs
- Rugged encapsulated design for harsh environments
- Choose 2-meter or 9-meter unterminated cable, or 5-pin M12 quick-disconnect connector
- Wide operating range of –20 °C to +60 °C (–4 °F to +140 °F)
- Choose either straight or right-angle housing
- Temperature compensation
- Configurable for normally open or normally closed operation
- Fast response time (5 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 Number | Sensing Range | Cable[1] | Supply Voltage | Output | Housing Configuration |
|---|---|---|---|---|---|
| **S18UBA** | 30 mm to 300 mm (1.2 in to 11.8 in) | 5-wire, 2 m (6.5 ft) cable | 10 V DC to 30 V DC | Bipolar NPN/PNP | Straight |
| **S18UBAQ** | | 5-pin M12 quick-disconnect connector | | | |
| **S18UBAR** | | 5-wire, 2 m (6.5 ft) cable | | | Right-Angle |
| **S18UBARQ** | | 5-pin M12 quick-disconnect connector | | | |

**NOTE:** Information about discrete models is available at http://www.bannerengineering.com.

## Configuration Instructions

### Status Indicators

| Power On/Off LED State | Indicates |
|---|---|
| Off | The power is off |
| On red | The target is weak or is outside of the sensing range |
| On green | The sensor is operating normally, target is good |

| Output/Teach LED State | Indicates |
|---|---|
| Off | The target is outside of the window limits (normally open operation) |
| On yellow | The target is within the window limits (normally open operation) |
| On red | The sensor is in TEACH mode and is waiting for the first limit |
| Flashing red | The sensor is in TEACH mode and is waiting for the second limit |

(1)

- 9 m cables are available by adding suffix "**W/30**" to the model number of any cabled sensor (for example, **S18UBA W/30**).
- A model with a quick-disconnect connector requires a mating cable.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# Sensor Programming

Use one of two TEACH methods to program the sensor:

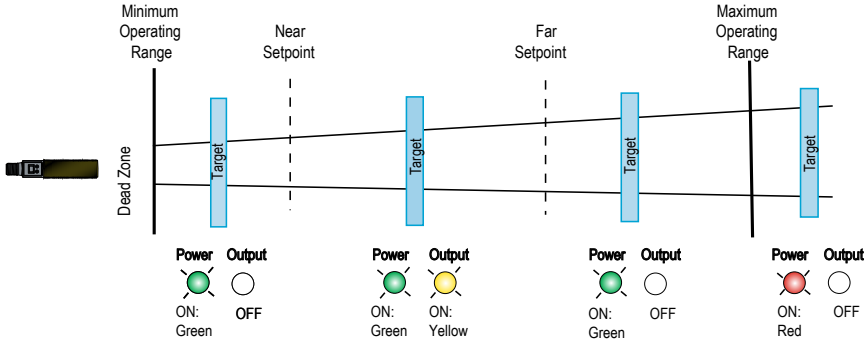
- Teach individual minimum and maximum limits
- Use Auto-Window feature to center a sensing window around the taught position

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 gray wire of the sensor to 0 V DC to 2 V 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. 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*

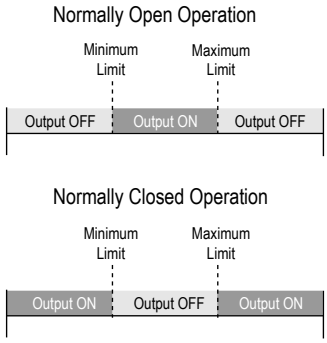



## Teach Minimum and Maximum Limits

**NOTE:**

- 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 > 2 seconds (before teaching the second limit). The sensor reverts to the last saved limits

*Teaching independent minimum and maximum limits*




1. Enter Programming mode.

| Method | Action | Result |
|---|---|---|
| **Push Button**(1) | Press and hold the TEACH button | Output LED: On red<br>Power LED: On green (good signal) or On red (no signal) |
| **Remote Input**(2) | No action required; the sensor is ready for the first limit | |

2. Present the target for the first limit. The Power LED must be On green.
3. Teach the first limit.

(1) 0.04 s < “click” < 0.8 s
(2) 0.04 s < T < 0.8 s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| Method | Action | Result |
|---|---|---|
| **Push Button** | Press the TEACH button one time. | **Teach Accepted**<br>Output LED: Flashes Red |
| **Remote Input** | Single-pulse the remote line. | **Teach Not Accepted**<br>Output LED: On Red |

4. Present the target for the second limit. The Power LED must be On green.
5. Teach the second limit.

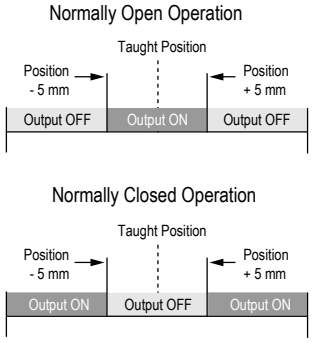
| Method | Action | Result |
|---|---|---|
| **Push Button** | Press the TEACH button one time. | **Teach Accepted**<br>Output LED: Yellow or OFF |
| **Remote Input** | Single-pulse the remote line. | **Teach Not Accepted**<br>Output LED: Flashes Red |

## Teaching Limits Using the Auto-Window Feature

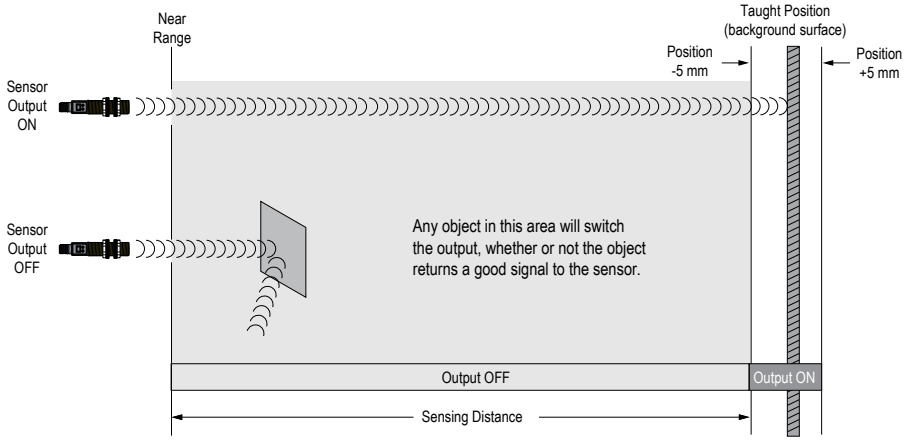
Teaching the same limit twice for the same output automatically centers a 10 mm window on the taught position.

**NOTE:**
- 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 > 2 seconds (before teaching the second limit). The sensor reverts to the last saved limits

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




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




1. Enter Programming mode.

| Method | Action | Result |
|---|---|---|
| **Push Button**[1] | Press and hold the TEACH button | Output LED: On red<br>Power LED: On green (good signal) or On red (no signal) |
| **Remote Input**[2] | No action required; the sensor is ready for the first limit | |

2. Position the target for the center of the window. The Power LED must be On green.
3. Teach the limit.

[1] 0.04 s < “click” < 0.8 s
[2] 0.04 s < T < 0.8 s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| Method | Action | Result |
|---|---|---|
| **Push Button** | Press the TEACH button one time. | **Teach Accepted**<br>Output LED: Flashing Red |
| **Remote Input** | Single-pulse the remote line. | **Teach Not Accepted**<br>Output LED: ON Red |

4. Teach the limit a second time.

| Method | Action | Result |
|---|---|---|
| **Push Button** | Without moving the target, press the TEACH button one time. | **Teach Accepted**<br>Output LED: Yellow or OFF |
| **Remote Input** | Without moving the target, single-pulse the remote line. | **Teach Not Accepted**<br>Output LED: Flashing Red |

### Normally Open/Normally Closed Operation Select

The sensor can be configured for either normally open or normally closed operation via the remote teach wire (gray). 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 "Figure: Teaching independent minimum and maximum limits" on page 2 and "Figure: Using the Auto-Window feature for programming each output" on page 3.

To toggle between normally open or normally closed operation, triple-pulse the remote line. Either Normally Open or Normally Closed operation is selected, depending on previous condition.

### Set the Response Speed

The default sensor response speed is 5 ms. Change the sensor response speed to slow (10 ms) with the following procedures.

Slow response speed improves immunity to the presence of strong ultrasonic targets positioned just beyond the operating range of the sensor. The slow response speed allows the sensor to ignore these unexpected targets.

#### Fast (5 ms) Response Speed

| Method | Action | Result |
|---|---|---|
| **Push Button** | Press the TEACH button five times. | The response speed is set at Fast (5 ms). |
| **Remote Input** | Five-pulse the remote line. | |

#### Slow (10 ms) Response Speed

| Method | Action | Result |
|---|---|---|
| **Push Button** | Press the TEACH button six times. | The response speed is set at Slow (10 ms). |
| **Remote Input** | Six-pulse the remote line. | |

### Lock the Buttons

Enable or disable the buttons to prevent unauthorized adjustment of the program settings.

To lock or unlock the buttons, four-pulse the remote line. The buttons are enabled or disabled, depending on the previous condition.

# Installation

## 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:


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| | | | |
|---|---|---|---|
| In metric units: | $C_{m/s} = 20 \sqrt{273 + T_C}$ | In English units: | $C_{ft/s} = 49 \sqrt{460 + T_F}$ |
| **$C_{m/s}$** = speed of sound in meters per second | | **$C_{ft/s}$** = speed of sound in feet per second | |
| **$T_C$** = temperature in °C | | **$T_F$** = temperature in °F | |

## Temperature Compensation

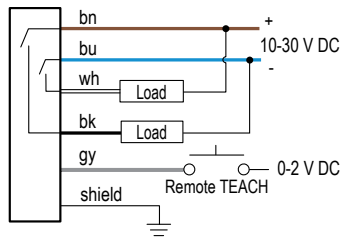
Changes in air temperature affect the speed of sound, which in turn affects the distance reading measured by the sensor. An increase in air temperature shifts both sensing window limits closer to the sensor. Conversely, a decrease in air temperature shifts both limits farther away from the sensor. This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

The S18U 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.

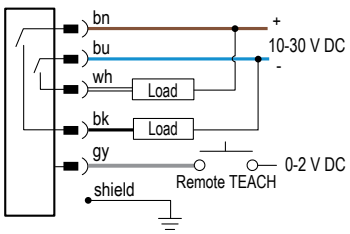
**NOTE:**
- Exposure to direct sunlight can affect the sensor's ability to accurately compensate for changes in temperature.
- If the sensor is measuring across a temperature gradient, the compensation will be less effective.
- The temperature warmup drift upon power-up is less than 1.7% of the sensing distance.After 10 minutes, the apparent distance will be within 0.3% of the actual position. After 25 minutes, the sensing position will be stable.

# Wiring Diagrams

*Cabled Models*




*QD Models*




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

# S18U Specifications

**Sensing Range**
30 to 300 mm (1.2 in to 11.8 in)

**Supply Voltage**
10 V DC to 30 V DC (10% maximum ripple); 20 mA max. (exclusive of load), 40 mA typical @ 25V input

**Ultrasonic Frequency**
300 kHz, rep. rate 2.5 ms

**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) and one PNP (current sourcing) output in each model.

**Output Protection**
Protected against short circuit conditions

**Delay at Power-Up**
300 milliseconds

**Temperature Effect**
0.02% of distance/ °C

**Connections**
2 m (6.5 ft) or 9 m (30 ft) shielded 5-conductor (with drain) PVC jacketed attached cable or 5-pin M12 quick-disconnect connector

**Output Ratings**
100 mA maximum
**OFF-state leakage current:** < 5 microamps
**NPN saturation:** < 200 mV @ 10 mA and < 600 mV @ 100 mA
**PNP saturation:** < 1.2 V @ 10 mA and < 1.6 V @ 100 mA

**Operating Conditions**
**Temperature:** –20 °C to +60 °C (–4 °F to +140 °F)

**Temperature Warmup Drift**
Less than 1.7% of sensing distance upon power-up (see Temperature Compensation)

**Environmental Rating**
Leakproof design is rated IP67; NEMA 6P

**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.

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

**Certifications**

**Remote TEACH Input**
**Impedance:** 12 kΩ

**Construction**
**Threaded Barrel:** Thermoplastic polyester
**Push Button:** Santoprene
**Push Button Housing:** ABS/PC
**Lightpipes:** Acrylic

**Minimum Window Size**
5 mm

**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

**Indicators**
**Range Indicator (Red/Green)**
Green—Target is within sensing range
Red—Target is outside sensing range
OFF—Sensing power is OFF
**Teach/Output Indicator (Amber/Red)**
Yellow—Target is within taught limits
OFF—Target is outside taught window limits
Red—Sensor is in TEACH mode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**Repeatability**

0.5 mm

**Output Response Time**

5 milliseconds

**Hysteresis**

0.7 mm

**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.

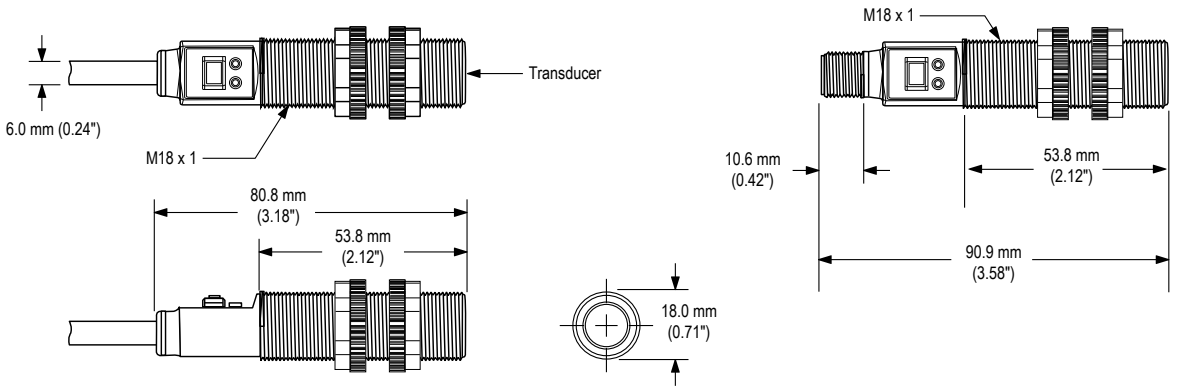
Supply wiring leads < 24 AWG shall not be spliced.

For additional product support, go to www.bannerengineering.com.

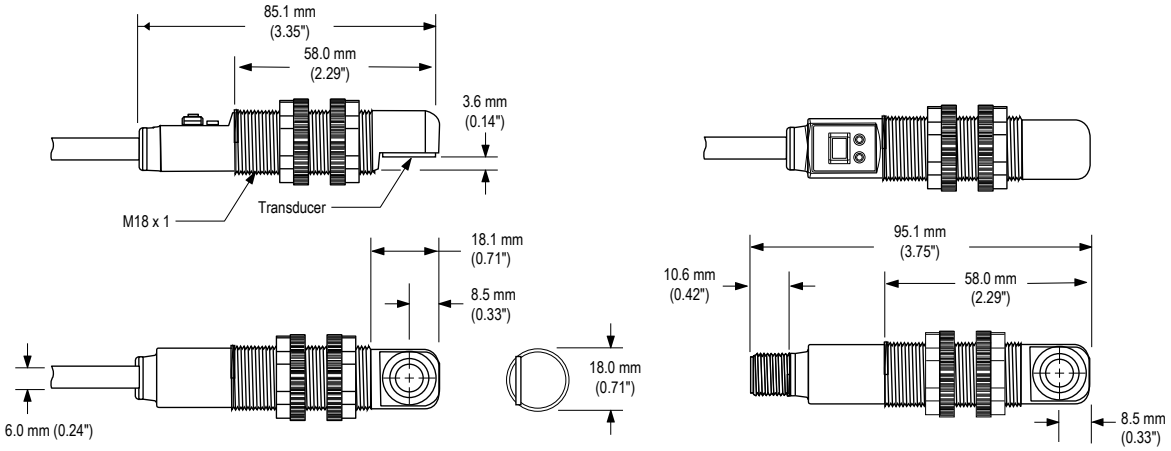
| Supply Wiring (AWG) | Required Overcurrent Protection (A) | Supply Wiring (AWG) | Required Overcurrent Protection (A) |
|---|---|---|---|
| 20 | 5.0 | 26 | 1.0 |
| 22 | 3.0 | 28 | 0.8 |
| 24 | 1.0 | 30 | 0.5 |

# Dimensions

*Straight Housing*




*Right-Angle Housing*



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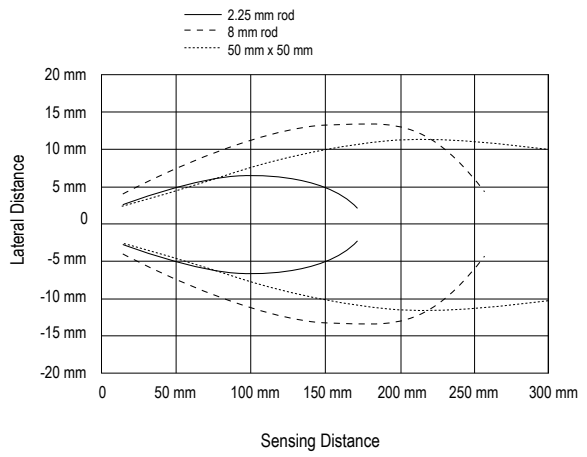
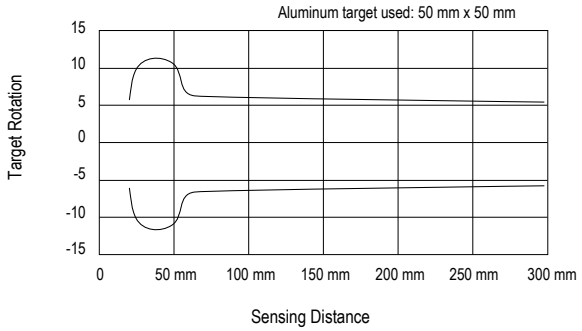
## Response Curves

*Effective Beam Pattern (Typical)*

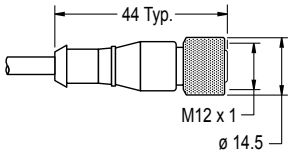
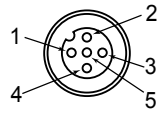
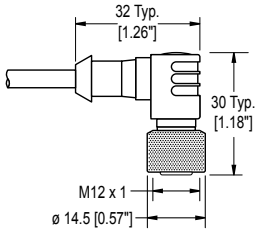



*Maximum Target Rotation Angle*




# Accessories

## Quick-Disconnect Cables

| 5-Pin Threaded M12 Cordsets with Shield—Single Ended | | | | |
|---|---|---|---|---|
| **Model** | **Length** | **Style** | **Dimensions** | **Pinout (Female)** |
| **MQDEC2-506** | 2 m (6.56 ft) | Straight |   |   1 = Brown 2 = White 3 = Blue 4 = Black 5 = Gray |
| **MQDEC2-515** | 5 m (16.4 ft) | | | |
| **MQDEC2-530** | 9 m (29.5 ft) | | | |
| **MQDEC2-550** | 15 m (49.2 ft) | | | |
| **MQDEC2-575** | 23 m (75.44 ft) | | | |
| **MQDEC2-5100** | 30.5 m (100 ft) | | | |
| **MQDEC2-506RA** | 2 m (6.56 ft) | Right-Angle |   | |
| **MQDEC2-515RA** | 5 m (16.4 ft) | | | |
| **MQDEC2-530RA** | 9 m (29.5 ft) | | | |
| **MQDEC2-550RA** | 15 m (49.2 ft) | | | |
| **MQDEC2-575RA** | 23 m (75.44 ft) | | | |
| **MQDEC2-5100RA** | 31 m (101.68 ft) | | | |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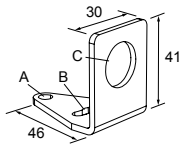
## Brackets

**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

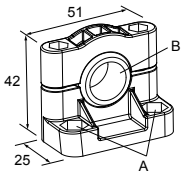
**Hole center spacing:** A to B = 24.2
**Hole size:** A = ø 4.6, B = 17.0 × 4.6, C = ø 18.5




**SMB18SF**

- 18 mm swivel bracket with M18 × 1 internal thread
- Black thermoplastic polyester
- Stainless steel swivel locking hardware included

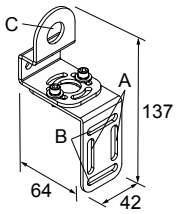
**Hole center spacing:** A = 36.0
**Hole size:** A = ø 5.3, B = ø 18.0




**SMB18UR**

- 2-piece universal swivel bracket
- 300 series stainless steel
- Stainless steel swivel locking hardware included
- Mounting hole for 18 mm sensor

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

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