XL-MaxSonar® - WR/WRC™ Series
High Performance, IP67 Weather Resistant, Ultrasonic Range Finder
MB7051, MB7052, MB7053, MB7060, MB7062, MB7066, MB7067, MB7068, MB7070, MB7072, MB7076, MB7077, MB7078, MB7092

The XL-MaxSonar-WR and XL-MaxSonar-WRC sensor series provide users with robust range information in air. These sensors also feature high-power acoustic output along with real-time auto calibration for changing conditions (supply voltage sag, acoustic noise, or electrical noise), operation with supply voltage from 3V to 5.5V, object detection from 0-cm to 765-cm (select models) or 1068-cm (select models), and sonar range information from 20-cm out to 765-cm (select models) or 1068-cm (select models) with 1-cm resolution. Objects from 0-cm to 20-cm range as 20-cm of closer. The sensor is housed in a robust PVC housing, designed to meet the IP67 water intrusion standard, and matches standard electrical/water ¾” PVC pipe fittings. The user interface formats included are pulse-width (select models), real-time analog-voltage envelope (select models), analog voltage output, and serial output.

Features
- Real-time auto calibration and noise rejection
- High acoustic power output
- Precise narrow beam
- Object detection includes zero range objects
- 3V to 5.5V supply with very low average current draw
- Free run operation can continually measure and output range information
- 10Hz refresh rate (MB7060, MB7062, MB7066, MB7070, MB7072, MB7076, MB7092)
- 6.6Hz refresh rate (MB7052)
- 5.1Hz refresh rate (MB7051, MB7053)
- Triggered operation provides the range reading as desired
- All interfaces are active simultaneously
- RS232 Serial, 0 to Vcc, 9600 Baud, 81N
- Analog, (Vcc/1024) / cm for standard models
- Analog, (Vcc/1024) / 2cm for 10-meter models (MB7051, MB7066, MB7076)
- Sensor operates at 42KHz

Benefits
- Acoustic and electrical noise resistance
- Reliable and stable range data
- Robust, low cost IP67 standard sensor
- Narrow beam characteristics
- Very low power excellent for battery based systems
- Ranging can be triggered externally or internally
- Sensor reports the range reading directly, frees up user processor
- Easy hole mounting or mating with standard electrical fittings
- Filtering allows very reliable operation in most environments

Applications and Uses
- Tank level measurement
- Bin level measurement
- Proximity zone detection
- Environments with acoustic and electrical noise
- Distance measuring
- Long range object detection
- Super high sensitivity for long range small object detection (MB7051 & MB7053)
- Industrial sensor -40°C to +65°C (limited operation to +85°C)

Notes:
1 Minimum distance is 25cm for the MB7052, MB7092 Pipe and Compact, also including MB7051, MB7053 horned part.
2 Please reference page 23 for part number key

Close Range Operation
Applications requiring 100% reading-to-reading reliability should not use MaxSonar sensors at a distance closer than 20cm. Although most users find MaxSonar sensors to work reliably from 0 to 20cm for detecting objects in many applications, MaxBotix® Inc. does not guarantee operational reliability for objects closer than the minimum reported distance. Because of ultrasonic physics, these sensors are unable to achieve 100% reliability at close distances.

Warning: Personal Safety Applications
We do not recommend or endorse this product be used as a component in any personal safety applications. This product is not designed, intended or authorized for such use. These sensors and controls do not include the self-checking redundant circuitry needed for such use. Such unauthorized use may create a failure of the MaxBotix® Inc. product which may result in personal injury or death. MaxBotix® Inc. will not be held liable for unauthorized use of this component.
XL-MaxSonar-WR/WRC Pin Out

**Pin 1-** Leave open (or high) for serial output on the Pin 5 output. When Pin 1 is held low the Pin 5 output sends a pulse (instead of serial data), suitable for low noise chaining.

**Pin 2-** This pin outputs a pulse-width representation of range. To calculate the distance, use a scale factor of 58uS per cm. (MB7051, MB7052, MB7053, MB7060, MB7062, MB7066, MB7067, MB7068)

This pin outputs the analog voltage envelope of the acoustic waveform. For the MB7070 series and MB7092 sensors, this is a real-time always-active output (MB7070, MB7072, MB7076, MB7077, MB7078, MB7092)

**Pin 3-** AN-This pin outputs analog voltage with a scaling factor of (Vcc/1024) per cm. A supply of 5V yields ~4.9mV/cm, and 3.3V yields ~3.2mV/cm. Hardware limits the maximum reported range on this output to ~700 cm at 5V and ~600 cm at 3.3V. The output is buffered and corresponds to the most recent range data.

For the 10-meter sensors (MB7051, MB7053, MB7066, MB7076) Pin 3 outputs an analog voltage with a scaling of (Vcc/1024) per 2cm. A supply of 5V yields ~4.9mV/2cm, and 3.3V yields ~3.2mV/2cm. This Analog Voltage output steps in 2cm increments.

**Pin 4-** RX- This pin is internally pulled high. If Pin-4 is left unconnected or held high, the sensor will continually measure the range. If Pin-4 is held low the sensor will stop ranging. Bring high 20uS or more to command a range reading.

**Pin 5-** TX- When Pin 1 is open or held high, the Pin 5 output delivers asynchronous serial data in an RS232 format, except the voltages are 0-Vcc. The output is an ASCII capital “R”, followed by ASCII character digits representing the range in centimeters up to a maximum of 765 (select models) or 1068 (select models), followed by a carriage return (ASCII 13). The baud rate is 9600, 8 bits, no parity, with one stop bit. Although the voltages of 0V to Vcc are outside the RS232 standard, most RS232 devices have sufficient margin to read the 0V to Vcc serial data. If standard voltage level RS232 is desired, invert, and connect an RS232 converter such as a MAX232. When Pin 1 is held low, the Pin 5 output sends a single pulse, suitable for low noise chaining (no serial data).

V+ Operates on 3V - 5.5V. The average (and peak) current draw for 3.3V operation is 2.1mA (50mA peak) and 5V operation is 3.4mA (100mA peak) respectively. Peak current is used during sonar pulse transmit. Please reference page 14 for minimum operating voltage verses temperature information.

**GND-** Return for the DC power supply. GND (& V+) must be ripple and noise free for best operation.

About Ultrasonic Sensors

Our ultrasonic sensors are desired for use in air, non-contact object detection and ranging sensors that detect objects within a defined area. These sensors are not affected by the color or other visual characteristics of the detected object. Ultrasonic sensors use high frequency sound to detect and localize objects in a variety of environments. Ultrasonic sensors measure the time of flight for sound that has been transmitted to and reflected back from nearby objects. Based upon the time of flight, the sensor then outputs a range reading.

Auto Calibration

Each time before the XL-MaxSonar-WR takes a range reading it auto calibrates. The sensor then uses this data to range objects. If the temperature, humidity, or applied voltage changes during sensor operation, the sensor will continue to function normally. (The sensors do not apply compensation for the speed of sound change verses temperature to any range readings.) If the application requires temperature compensation please look at the HRXL-MaxSonar-WR sensor line.

Supply Voltage Compensation

During power up, the XL-MaxSonar-WR sensor line will calibrate itself for the supply voltage. Additionally, the sensor will compensate if the supplied voltage gradually changes.

If the average voltage applied to the sensor changes faster than 0.5V per second, it is best to remove and reapply power to the sensor. For best operation, the sensor requires noise free power. If the sensor is used with noise on the supplied power or ground, the accuracy of the readings may be affected. Typically, adding a 100uF capacitor at the sensor between the V+ and GND pins will correct most power related electrical noise issues.
Real-time Auto Calibration

The XL-MaxSonar-WR automatically calibrates prior to each range reading. The sensor then uses this data to range objects. If the temperature, humidity, or applied voltage changes during sensor operation, the sensor will continue to function normally. (The sensors do not apply compensation for the speed of sound change versus temperature to any range readings.) Detection has been characterized in the published sensor beam patterns.

Real-time Noise Rejection

While the XL-MaxSonar-WR is designed to operate in the presence of noise, best operation is obtained when noise strength is low and desired signal strength is high. Hence, the user is encouraged to mount the sensor in such a way that minimizes outside acoustic noise pickup. In addition, keep the DC power to the sensor free of noise. This will let the sensor deal with noise issues outside of the users direct control (Even so, in general, the sensor will still function well even if these things are ignored). Users are encouraged to test the sensor in their application to verify usability.

Sensor Minimum Distance

The XL-MaxSonar-WR sensors have a minimum reported distance of 20-cm\(^1\) (7.87 inches). However, the XL-MaxSonar-WR will range and report targets to the front sensor face. Large targets closer than 20-cm\(^1\) will typically range as 20-cm\(^1\). For the alternative housings, objects between 4-cm and 20-cm will typically range as 20-cm.

*Note 1: 25cm for the MB7052, MB7092 Pipe and Compact, also including MB7051, MB7053 horned part.*

WR Exposed Materials

The exposed materials of a properly mounted MaxSonar WR standard sensor are: Aluminum (oxidized surface), PVC, & silicone rubber (VMQ).

Additional Options for Purchase

Please contact MaxBotix for any additional information regarding the options listed below at info@maxbotix.com.

F-Option

In addition to the standard MaxSonar WR, MaxBotix Inc. has developed the F-Option for additional protection necessary in a few hazardous chemical environments. Extremely corrosive gases or liquids can degrade or compromise the operation of the sensing unit. As a result, we offer a more chemically inert seal which allows our sensors to operate in all but the harshest of chemical environments. In addition to the chemical resistance the sensor has improved performance in wet or dust environments.

Please Note: Our sensors are designed for operation in normal atmosphere (air). Please be aware that the speed of sound and atmospheric attenuation may change as a result of the transmission properties of different chemical/air mediums. Users are strongly encouraged to characterize and test the operation of the sensor in the new medium to verify operation, and properly scale the outputted range information.

The exposed materials of a properly mounted MaxSonar WR sensor with the F-Option added are: Aluminum (oxidized surface), PVC, & Fluorosilicone (with an additional back up FEP Teflon® seal).

Shielded Cable Attach Option

For simple integration of our sensors into end-user applications, MaxBotix has developed the Shielded Cable Attach Option to create a completely IP67 rated MaxSonar-WR sensor. The standard Shielded Cable Attach Option uses 3 feet of the MaxSonar MB7954 Shielded Cable (MB7984 when attached by MaxBotix) with an epoxy filled cap to fully protect the pin-out of the MaxSonar sensor. Additional cable length can be specified and purchased using part number MB7984.

P-Option

The P-Option is a Parylene coating applied to the surface of the aluminum transducer. This helps to improve the corrosion resistance of the aluminum transducer. The exposed materials of a properly mounted MaxSonar WR sensor with the P-Option added are: Parylene, PVC, & silicone rubber (VMQ). The F-Option can be purchased with the P-Option.
Sensor Descriptions

**Base Sensor (MB7060 and MB7070)**
The MB7060 and MB7070 are the base models of the XL-MaxSonar-WR sensor line. These sensors are recommended for general purpose usage. All other sensors in this series are based off these sensor models. The additional features are mentioned in their respective sections below.

**XL-MaxSonar-WR1 (MB7062 and MB7072)**
The XL-MaxSonar-WR1 sensors feature a 3 reading stability filter that ranges to the first detectable target. Filtering is available on Pin3 (AN) and Pin 5 (TX). Filtering is not applied to the output on Pin 2 (PW). This filter requires that 3 consecutive range readings are within 1 cm of each other to be considered a valid range reading. If the range readings are outside 1 cm, the sensor discards the range reading set and reports the last valid range reading. This sensor does not view maximum range as a valid range, and will not report 765 when no target is detected. If this sensor does not detect a target for 1 hour, the sensor will go into fail-safe and report 000.

**XL-MaxSonar-WRL (MB7066 and MB7076)**
The XL-MaxSonar-WRL will report a maximum distance of 10 meters for large targets.

**XL-MaxSonar-WRM (MB7052 and MB7092)**
The MB7052 and MB7092 sensors prioritize large targets over both small targets and noise. These sensors report the target that gives the largest acoustic reflection. This stands in contrast to other units such as the MB7060 which are designed to report the distance to the first detectable target. If the largest target is removed from the field of view, the MB7052 and MB7092 will switch to the target that gives the next largest detectable return.

When targets are of similar amplitude reflections, preference is given to the closer target. The sensor expects to see a target by 7.56 meters. If no target is found, the sensor will increase in sensitivity until a target is found, or until no targets can be found.

In addition to the most-likely filtering, the MB7052 and MB7092 come equipped with a three-reading filter and reading hold which requires three consecutive range readings within 1 cm of the most recent reading to be considered a valid range reading. If readings are found to be outside 1 cm, or no target can be found by the sensor, then the sensor will report the last valid range reading. Upon power-up the sensor will default to reporting 7.65 meters unit a valid range reading is found.

The last reading hold is designed for users operating in environments with intermittent high noise who desire to poll the MB7052 or MB7092 at intermittent times. This allows the sensor to report the previously valid reading until the sensor’s environment improves. If no valid range reading is found for ~1.5 hours, the sensor will send a fail-safe output “000” on all interfaces.

**XL-MaxSonar-WRML (MB7051)**
The MB7051 includes all the features of the MB7052 with a maximum distance of 10 meters which provides a very robust long range sensing solution. The MB7051 is ideal for applications requiring small or soft target detection at longer ranges than our previously mentioned XL-MaxSonar-WR sensors.

The MB7051 has improved sensitivity to objects with the addition of a horn extension. This improvement results in the sensor detecting objects of similar size about 2.5 times further in comparison to the MB7066 sensor. The detection patterns of each are shown in the beam pattern section of the datasheet.

**XL-MaxSonar-WRML1 (MB7053)**
The MB7053 is based on the MB7051 but removes the three reading stability filter. This prevents the sensor from entering a fail-safe mode where it reports 000. It also allows the MB7053 to respond to large changes in range more quickly than the MB7051.
Sensor Comparison Chart

<table>
<thead>
<tr>
<th>Part Number</th>
<th>AN Voltage</th>
<th>Serial Data (0 to Vcc level)</th>
<th>Pulse Width</th>
<th>Analog Envelope</th>
<th>Stability Filter</th>
<th>Most Likely Filter</th>
<th>Refresh Rate</th>
<th>Other Packages Available¹</th>
<th>7 meter range</th>
<th>10 meter range</th>
</tr>
</thead>
<tbody>
<tr>
<td>MB7051</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>5.1Hz</td>
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<td></td>
</tr>
<tr>
<td>MB7052</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>6.6Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
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<td>MB7053</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>5.1Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MB7060</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>10Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MB7062</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>10Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MB7066</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Yes</td>
<td>10Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
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<td>MB7070</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Yes</td>
<td>10Hz</td>
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</tr>
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<td>MB7072</td>
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<td></td>
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<td>10Hz</td>
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<td></td>
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<td>MB7076</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td></td>
<td></td>
<td>Yes</td>
<td>10Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MB7092</td>
<td>Yes</td>
<td>RS232</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>10Hz</td>
<td>Yes</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:¹ Alternative package types have a maximum effective detection range of 645cm, the sensor will still report 765 as a “no detection” output if a target is not found.

About Package Types

<table>
<thead>
<tr>
<th>Package Types Currently Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Horn — 3/4” NPT straight; back mounted thread (best performance)</td>
</tr>
<tr>
<td>Compact — 3/4” NPT straight; back mounted thread</td>
</tr>
<tr>
<td>Ultra-Compact — PCB with 4 mounting holes</td>
</tr>
<tr>
<td>1”NPS — External thread over full sensor body (1”NPS)</td>
</tr>
<tr>
<td>1” BSPP — External thread over full sensor body (1”BSPP)</td>
</tr>
<tr>
<td>30mm1.5 — External thread over full sensor body (30mm1.5)</td>
</tr>
<tr>
<td>MB7051 &amp; MB7053— Full Horn with a horn extension (Not pictured)</td>
</tr>
</tbody>
</table>

All package types have exposed PCB on user end for easy connection. Users desiring a fully enclosed assembly may purchase the “Shielded Cable Option” along with their sensor.

Performance Changes when Selecting a Non-Full Horn Package

When selecting a XL-MaxSonar-WR without the full horn the sensor will experience the following performance changes:

- The sensor will have a wider beam shape for the first meter.
- The sensor may have a dead zone from 0-6cm.
- The sensor may be less accurate by an additional +/- 0.5%.
- The sensor may have worse performance to small or soft targets.
- The sensor may experience decreased noise immunity when ranging to small, soft, angled, or distant targets.
- The maximum effective detection range is to 645cm, the sensor will still report 765 as a “no detection” output if a target is not found.
Mechanical Dimensions

**Full Horn**

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.72” dia.</td>
<td>43.8 mm dia.</td>
</tr>
<tr>
<td>B</td>
<td>2.00”</td>
<td>50.7 mm</td>
</tr>
<tr>
<td>C</td>
<td>0.58”</td>
<td>14.4 mm</td>
</tr>
<tr>
<td>D</td>
<td>0.31”</td>
<td>7.9 mm</td>
</tr>
<tr>
<td>E</td>
<td>0.23”</td>
<td>5.8 mm</td>
</tr>
<tr>
<td>F</td>
<td>0.10”</td>
<td>2.54 mm</td>
</tr>
<tr>
<td>G</td>
<td>3/4”-14 NPS</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1.032” dia.</td>
<td>26.2 mm dia.</td>
</tr>
<tr>
<td>I</td>
<td>1.37”</td>
<td>34.8 mm</td>
</tr>
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Weight: 50 grams

Values Are Nominal

**Ultra-Compact**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>30.48 mm</td>
<td>1.20”</td>
</tr>
<tr>
<td>B</td>
<td>35.56 mm</td>
<td>1.40”</td>
</tr>
<tr>
<td>C</td>
<td>12.24 mm</td>
<td>0.60”</td>
</tr>
<tr>
<td>D</td>
<td>2.54 mm</td>
<td>0.10”</td>
</tr>
<tr>
<td>E</td>
<td>2.54 mm</td>
<td>0.10”</td>
</tr>
<tr>
<td>F</td>
<td>17.78 mm</td>
<td>0.70”</td>
</tr>
<tr>
<td>G</td>
<td>30.48 mm</td>
<td>1.20”</td>
</tr>
<tr>
<td>H</td>
<td>3.18 mm</td>
<td>0.13”</td>
</tr>
<tr>
<td>I</td>
<td>25.4 mm</td>
<td>1.00”</td>
</tr>
<tr>
<td>J</td>
<td>25.27 mm</td>
<td>1.00”</td>
</tr>
<tr>
<td>K</td>
<td>10.4 mm</td>
<td>0.41”</td>
</tr>
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</table>

All values are nominal

**Compact Housing**

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<th>Value</th>
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<tbody>
<tr>
<td>A</td>
<td>1.37” dia.</td>
<td>34.7 mm dia.</td>
</tr>
<tr>
<td>B</td>
<td>0.70”</td>
<td>17.9 mm</td>
</tr>
<tr>
<td>C</td>
<td>0.57”</td>
<td>14.4 mm</td>
</tr>
<tr>
<td>D</td>
<td>0.31”</td>
<td>7.9 mm</td>
</tr>
<tr>
<td>E</td>
<td>0.23”</td>
<td>5.8 mm</td>
</tr>
<tr>
<td>F</td>
<td>0.10”</td>
<td>2.54 mm</td>
</tr>
<tr>
<td>G</td>
<td>3/4”-14 NPS</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>1.032” dia.</td>
<td>26.2 mm dia.</td>
</tr>
<tr>
<td>I</td>
<td>1.37”</td>
<td>34.8 mm</td>
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Weight: 32 grams

Values Are Nominal
Mechanical Dimensions Continued

1” NPS Pipe Threading

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<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.29” dia.</td>
<td>38.2 mm dia.</td>
<td>1.30”</td>
<td>33.1 mm</td>
<td>0.20”</td>
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Values Are Nominal

1” BSPP Pipe Threading

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<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.29” dia.</td>
<td>38.2 mm dia.</td>
<td>1.30”</td>
<td>33.1 mm</td>
<td>0.20”</td>
<td>5.2 mm</td>
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Values Are Nominal

30mm1.5 Pipe Threading

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<th>B</th>
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<th>Weight</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>1.17” dia.</td>
<td>29.7 mm dia.</td>
<td>1.30”</td>
<td>33.1 mm</td>
<td>0.20”</td>
<td>5.2 mm</td>
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Values Are Nominal

MB7051 & MB7053

<table>
<thead>
<tr>
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<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.039” dia.</td>
<td>77.2 mm dia.</td>
<td>8.327”</td>
<td>211.5 mm</td>
<td>4.827”</td>
<td>122.6 mm</td>
<td>0.636”</td>
<td>16.2 mm</td>
<td>0.580”</td>
<td>14.7 mm</td>
<td>1.198”</td>
<td>30.4 mm</td>
<td>0.315”</td>
<td>7.9 mm</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>F</td>
<td>G</td>
<td>H</td>
<td>I</td>
<td>J</td>
<td>L</td>
<td>M</td>
<td>K</td>
<td>3/4”-14 NPS</td>
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</tbody>
</table>

Values Are Nominal
Range “0” Location

The XL-MaxSonar-WR sensors report the range to distant targets starting from the front of the sensor as shown in the diagrams below.

The XL-MaxSonar-WR will report the range to the closest detectable object. Target detection has been characterized in the sensor beam patterns.
The range is measured from the front of the transducer to the target.
Typical Performance to Target

All sensor models

Typical Performance in Clutter

MB7060, MB7062, MB7076, MB7070, MB7072, MB7076

Typical Performance in Clutter

MB7051, MB7052, MB7053, MB7092
XL-MaxSonar-WR Sensor Operating Modes

Independent Sensor Operation

The XL-MaxSonar-WR sensors are designed to operate in a single sensor environment. Free-run is the default mode of operation for all of the MaxBotix Inc., sensors. The XL-MaxSonar-WR sensors have three separate outputs that update the range data simultaneously: Analog Voltage, Pulse Width, and RS232 Serial. Below are diagrams on how to connect the sensor for each of the three outputs. Note 1 - select models output an Analog Envelope for end user processing (MB707X sensors and MB7092)

Using Multiple Sensors in a Single System

When using multiple ultrasonic sensors in a single system, there can be interference (cross-talk) from the other sensors. MaxBotix Inc., has engineered a solution to this problem for the XL-MaxSonar-WR sensors. The solution is referred to as chaining. We have 3 methods of chaining that work well to avoid the issue of cross-talk.

The first method is AN Output Commanded Loop. The first sensor will range, then trigger the next sensor to range and so on for all the sensors in the array. Once the last sensor has ranged, the array stops until the first sensor is triggered to range again. Below is a diagram on how to set this up.

The next method is AN Output Constantly Looping. The first sensor will range, then trigger the next sensor to range and so on for all the sensors in the array. Once the last sensor has ranged, the array stops until the first sensor is triggered to range again. Below is a diagram on how to set this up.

The final method is AN Output Simultaneous Operation. This method does not work in all applications and is sensitive to how the other sensors in the array are physically positioned in comparison to each other. Testing is recommended to verify this method will work for your application. All the sensors RX pins are connected together and triggered at the same time.
causing all the sensor to take a range reading at the same time. Once the range reading is complete, the sensors stop ranging until triggered next time. Below is a diagram on how to set this up.

Power supply must be noise free for best results

The analog voltage output mains the voltage corresponding to the latest range measurement

Range information is output with a high pulse width that is at least 1.16mS

Low idle state for RS232

<table>
<thead>
<tr>
<th>Product</th>
<th>Maximum Refresh Rate</th>
<th>Pulse Width Reported</th>
<th>Max Pulse Width End</th>
<th>Serial Data Reported</th>
<th>End of Range Cycle</th>
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</thead>
<tbody>
<tr>
<td>MB7051, MB7053</td>
<td>5.1 Hz</td>
<td>~135mS</td>
<td>~195.9mS</td>
<td>~124mS</td>
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<td>MB7052</td>
<td>6.6 Hz</td>
<td>~82.3mS</td>
<td>~126.7mS</td>
<td>~144.3mS</td>
<td>~149mS</td>
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<td>MB7060, MB7062,</td>
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<td>~32.3mS</td>
<td>~76.7mS</td>
<td>~94.3mS</td>
<td>~99mS</td>
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<tr>
<td>MB7066</td>
<td>10 Hz</td>
<td>NA</td>
<td>~94.2mS</td>
<td>~94.3mS</td>
<td>~99mS</td>
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<tr>
<td>MB7070, MB7072, MB7076, MB7092</td>
<td>10 Hz</td>
<td>NA</td>
<td>NA</td>
<td>~94.3mS</td>
<td>~99mS</td>
</tr>
</tbody>
</table>
Sensor Timing Diagrams

Power-Up Timing

Free-Run Operation

Vcc

Pin 6 (Vcc)
Clean, stable power provided to VCC
Power supply must be free of noise for best results

0 (All signals are referenced by Vcc and 0V.)

Pin 4 (Ranging Start/Stop)
Start ranging or monitoring begins

Pin 3 (Analog Voltage Output)
The Analog voltage output holds to the latest range measurement

Pin 2 (Pulse Width Output)
Range information is output with a high pulse width between 1.16mS and 44.4mS (7.65 meter models) or 62mS (10.68 meter models)

Pin 5 (RS232 Serial Output)
Low idle state for RS232

Sensor Free-Run Timing
Sensor Timing Diagrams Continued

Real-Time Operation

Timing Description

175mS after power-up, the XL-MaxSonar-WR is ready to begin ranging. If Pin-4 is left open or held high (20uS or greater), the sensor will take a range reading. The XL-MaxSonar-WR checks Pin-4 at the end of every cycle. Range data can be acquired once every period. Each period starts by Pin-4 being high or open, after which the XL-MaxSonar-WR calibrates and calculates for 20.5mS, and after which, the 42KHz waves are sent. The sensor then determines the range to the target. Next the analog voltage is set. The sensors with a pulse width (PW), Pin 2 is set high for a length of time \(^1\). Then serial data is sent \(^1\). The most accurate range output on the XL-MaxSonar-WR sensors is the PW output.

Note 1: Reference the timing specifications on the previous page for the exact times.

Sensors with the analog envelope output (MB7070 series and MB7092), Pin-2 will show the real-time signal return information of the Analog Waveform.

People Sensing:

For users that desire to detect people, the detection area to the 1-inch diameter dowel, in general, represents the area that the sensor will reliably detect people.
MB7051-MB7053 XL-MaxSonar®-WRML/WRML1™ Beam Pattern and Uses
The XL-MaxSonar-WRML/WRML1 provide a super sensitive robust long range sensing solution. The MB7051-MB7053 are ideal for applications requiring small or soft target detection ranges out to 10 meters. The sensors are great for applications such as people detection, 10 meter bin and tank level measurement, and soft target detection.

MB7051-8XX MB7053-8XX
XL-MaxSonar® -WRML/WRML1™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for various targets. Targets are placed in front of the sensor. The target shapes shown below are not drawn to scale.
A 0.1-mm (0.025-inch) diameter dowel 4 ft length
B 2.54-cm (1-inch) diameter dowel 4 ft length
C 8.88-cm (3.5-inch) diameter dowel 4 ft length
D 11-inch wide board 4 ft length moved left to right with the board parallel to the front of the sensor face. This shows the sensor’s range capability.
E 2” x 2” corner reflector 4 ft long.

5.0 V
3.3 V

MB7051-MB7053 Features and Benefits
• Pencil beam applications >10°
• Super high sensitivity to small and soft targets. About 2.5 times further compared to the MB7052.
• Extremely narrow beam which is great for cluttered environments.
• 10 meter maximum distance.
• Clutter rejection provides range to the largest amplitude reflection within the field of view
• Real-time calibration, noise rejection and additional filtering provides stable range information
• Excellent for ranging to large objects in the presence of cluttered or noisy environments

MB7051-MB7053 Applications and Uses
• Pencil beam applications >10°
• Environments with acoustic and electrical noise
• People Detection
• Soft Targets
• Bin Level Measurement
• Tank Level Measurement
**MB7052-MB7092 XL-MaxSonar®-WRM1/WRMA1™ Beam Pattern and Uses**

The XL-MaxSonar-WRM1/WRMA1 ignores smaller targets and only reports the range to the largest acoustic return. The filtering in the MB7052 and MB7092 also rejects moving target clutter such as rain or snow, electrical noise, and outside acoustic noise.

**MB7052-1XX MB7092-1XX**

**XL-MaxSonar®-WRM/WRM1™ Beam Pattern**

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor:
- A: 6.1-mm (0.25-inch) diameter dowel
- B: 2.54-cm (1-inch) diameter dowel
- C: 8.89-cm (3.5-inch) diameter dowel
- D: 11-inch wide board moved left to right with the board parallel to the front sensor face. This shows the sensor’s range capability.

**Note:** For people detection the pattern typically falls between charts A and B.

**Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.**

**MB7052-MB7092 Features and Benefits**

- Clutter rejection provides range to the largest amplitude reflection within the field of view
- Real-time calibration, noise rejection and additional filtering provides stable range information
- Excellent for ranging to large objects in the presence of cluttered or noisy environments
- Excellent for applications that require consistently accurate outputs
- Impressive acoustic and electrical noise resistance
- 10Hz refresh rate for the MB7092
- 6.6Hz refresh rate on the MB7052

**MB7052-MB7092 Applications and Uses**

- Autonomous Navigation
- Environments with acoustic and electrical noise
- Bin Level Measurement
- Tank Level Measurement
MB7060-MB7070 XL-MaxSonar®-WR/WRA1™ Beam Pattern and Uses

The XL-MaxSonar-WR/WRA1 reports the range to the first detectable target. The MB7060 and MB7070 sensors are the most recommended XL-MaxSonar-WR sensor. This is a good starting place when unsure of which XL-MaxSonar-WR to use.

MB7060-1XX MB7070-1XX

XL-MaxSonar®-WR/WRA1™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor.

A 6.1-mm (0.25-inch) diameter dowel
B 2.54-cm (1-inch) diameter dowel
C 8.89-cm (3.5-inch) diameter dowel
D 11-inch wide board moved left to right with the board parallel to the front sensor face.

This shows the sensor’s range capability.

Note: For people detection the pattern typically falls between charts A and B.

MB7060-MB7070

Features and Benefits

• Real-time calibration, and noise rejection for every ranging cycle
• Readings can occur up to every 100mS (10Hz)
• Analog voltage (Vcc/1024) / cm
• Precise narrow beam
• Continuously variable gain

MB7060-MB7070

Applications and Uses

• Applications where a stability filter is not needed or desired
• Multi-Sensor Arrays
• Distance Measuring
• People Detection
MB7062-MB7072 XL-MaxSonar®-WR/WRA™ Beam Pattern and Uses

The XL-MaxSonar-WR/WRA sensors have a 3 reading stability filter in the firmware. This sensor is well suited for applications requiring stable, accurate range readings. This sensor ranges to the first detectable target.

MB7062-MB7072 Features and Benefits
- 1 hour fail-safe built into sensor
- Real-time calibration, noise rejection and additional filtering provides stable range information
- Excellent for ranging to large objects in the presence of cluttered or noisy environments
- Excellent for applications that require consistently accurate outputs
- Advanced acoustic and electrical noise filtered output

MB7062-MB7072 Applications and Uses
- Long range object detection
- Industrial sensor
- Drop in upgrade for MB7060 and MB7070

MB7062-1XX MB7072-1XX
XL-MaxSonar®-WR™ Beam Pattern

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor:
- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel
- D 11-inch wide board moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.

Note: For people detection the pattern typically falls between charts A and B.

Beam Patterns drawn to a 1:95 scale for easy comparison to our other products.
MB7066-1XX MB7076-1XX

MB7066-MB7076 XL-MaxSonar®-WR/WRL/WRLA1™ Beam Pattern and Uses

The XL-MaxSonar-WRL/WRLA1 ranges objects from 0-cm to 1068-cm (35 feet) and provides range information from 20-cm to 1068-cm with a 1-cm resolution. This sensor is designed for applications where large object detection is needed to 10 meters.

**MB7066-MB7076 Features and Benefits**
- Extended 10 meter range detection and outputs
- High acoustic power output
- Readings can occur up to every 100ms, 10-Hz rate
- Triggered operation provides the range reading as desired
- Fast measurement cycle
- Quality narrow beam characteristics
- Low cost, long range IP67 sensor

**MB7066-MB7076 Applications and Uses**
- Robot ranging sensor
- Autonomous navigation
- Distance measuring
- Long range object detection
- Industrial sensor
MB706X-MB707X XL-MaxSonar-WRC Beam Pattern and Uses

The XL-MaxSonar-WR product line is available in alternative housings that include a WRC housing, 1” NPS pipe threading, 1” BSPP pipe threading, and 30mm 1.5 pipe threading.

**MB706X-MB707X**

**Features and Benefits**
- Can be flush mounted in an application
- Same resolution as the full horn equivalent
- Available in both metric and imperial housing sizes

**MB706X-MB707X**

**Applications and Uses**
- UAV blimps
- Bin level measurement
- Proximity zone detection
- Robot ranging sensor
- Tank level measurement
- Auto sizing

---

**XL-MaxSonar® - Beam Pattern**

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor.

- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel
- D 11-inch wide board moved left to right with the board parallel to the front sensor face.

*Note:* For people detection the pattern typically falls between charts A and B.

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.
MB706X-MB707X XL-MaxSonar-WR UltraCompact Beam Pattern and Uses

The XL-MaxSonar-WR product line is available in an UltraCompact alternative housing. The UltraCompact housing is designed for users that are creating a custom horn mount. The recommended horn can be downloaded from http://www.maxbotix.com/Ultrasonic_Sensors/Outdoor_Sensors.htm under the “Documents” Tab.

**MB7052-300 MB7052-320 MB7070-300 MB7070-320**
**MB7060-300 MB7060-320 MB7072-300 MB7072-320**
**MB7062-300 MB7062-320 MB7092-300 MB7092-320**

**XL-MaxSonar®- Beam Pattern**

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor.

- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel
- D 11-inch wide board moved left to right with the board parallel to the front sensor face.

This shows the sensor’s range capability. Note: For people detection the pattern typically falls between charts A and B.

**Beam Characteristics are Approximate**

Beam Pattern drawn to a 1:95 scale for easy comparison to our other products.

**MB706X-MB707X Features and Benefits**

- Can be flush mounted in an application
- Same resolution as the full horn equivalent
- Gives the ability to create custom mounts

**Note 1:** The “full horn” reference means that the sensor is mounted in a horn like the image to the right.

**Applications and Uses**

- UAV blimps
- Bin level measurement
- Proximity zone detection
- Robot ranging sensor
- Tank level measurement
- Auto sizing
MB706X-MB707X XL-MaxSonar-WR UltraCompact Beam Pattern and Uses

The XL-MaxSonar-WR product line is available in an UltraCompact alternative housing. The UltraCompact housing is designed for users that want to create a custom mount. The recommended designs can be downloaded from http://www.maxbotix.com/Ultrasonic_Sensors/Outdoor_Sensors.htm under the “Documents” Tab.

### MB7052-400  MB7052-420  MB7070-400  MB7070-420  MB7072-400  MB7072-420
### MB7060-400  MB7060-420  MB7062-400  MB7062-420  MB7092-400  MB7092-420

**XL-MaxSonar - Beam Pattern**

Sample results for measured beam pattern are shown on a 30-cm grid. The detection pattern is shown for dowels of varying diameters that are placed in front of the sensor

- **A**: 6.1-mm (0.25-inch) diameter dowel
- **B**: 2.54-cm (1-inch) diameter dowel
- **C**: 8.89-cm (3.5-inch) diameter dowel
- **D**: 11-inch wide board moved left to right with the board parallel to the front sensor face

This shows the sensor’s range capability.

**Note:** For people detection the pattern typically falls between charts A and B.

### Features and Benefits
- Can be flush mounted in an application
- Same resolution as the full horn equivalent
- Allows for custom mounts to be designed.

### Applications and Uses
- UAV blimps
- Bin level measurement
- Proximity zone detection
- Robot ranging sensor
- Tank level measurement
- Auto sizing

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MaxBotix Inc., products are engineered and assembled in the USA

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Patent 7,679,996

Web: www.maxbotix.com

PD11838q
**Part Numbers**

All part numbers are a combination of a six-character base followed by a dash and a three-digit product code. Please review the following table for more information on the three-digit product code.

Note: Active part numbers listed on page 24 and 25.

The following tables display all of the active and valid part numbers for these products.

### Active Part Numbers for MB7051

<table>
<thead>
<tr>
<th>Base</th>
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<th>Wire</th>
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### Active Part Numbers for MB7052

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### Active Part Numbers for MB7053

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<td>MB7053-810</td>
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The following tables display all of the active and valid part numbers for these products.

### Active Part Numbers for MB7060

| MB7060-100 | MB7060-101 | MB7060-110 | MB7060-111 | MB7060-120 | MB7060-121 | MB7060-130 | MB7060-131 |
| MB7060-200 | MB7060-201 | MB7060-210 | MB7060-211 | MB7060-220 | MB7060-221 | MB7060-230 | MB7060-231 |
| MB7060-300 | MB7060-320 | MB7060-400 | MB7060-420 | MB7060-500 | MB7060-501 | MB7060-510 | MB7060-511 |
| MB7060-520 | MB7060-521 | MB7060-530 | MB7060-531 | MB7060-600 | MB7060-601 | MB7060-610 | MB7060-611 |
| MB7060-620 | MB7060-621 | MB7060-630 | MB7060-631 | MB7060-700 | MB7060-701 | MB7060-710 | MB7060-711 |
| MB7060-720 | MB7060-721 | MB7060-730 | MB7060-731 |

### Active Part Numbers for MB7062

| MB7062-100 | MB7062-101 | MB7062-110 | MB7062-111 | MB7062-120 | MB7062-121 | MB7062-130 | MB7062-131 |
| MB7062-720 | MB7062-721 | MB7062-730 | MB7062-731 |

### Active Part Numbers for MB7066

| MB7066-100 | MB7066-101 | MB7066-110 | MB7066-111 | MB7066-120 | MB7066-121 | MB7066-130 | MB7066-131 |

### Active Part Numbers for MB7070

| MB7070-100 | MB7070-101 | MB7070-110 | MB7070-111 | MB7070-120 | MB7070-121 | MB7070-130 | MB7070-131 |
| MB7070-520 | MB7070-521 | MB7070-530 | MB7070-531 | MB7070-600 | MB7070-601 | MB7070-610 | MB7070-611 |
| MB7070-720 | MB7070-721 | MB7070-730 | MB7070-731 |

### Active Part Numbers for MB7072

| MB7072-100 | MB7072-101 | MB7072-110 | MB7072-111 | MB7072-120 | MB7072-121 | MB7072-130 | MB7072-131 |
| MB7072-200 | MB7072-201 | MB7072-210 | MB7072-211 | MB7072-220 | MB7072-221 | MB7072-230 | MB7072-231 |
| MB7072-520 | MB7072-521 | MB7072-530 | MB7072-531 | MB7072-600 | MB7072-601 | MB7072-610 | MB7072-611 |
| MB7072-620 | MB7072-621 | MB7072-630 | MB7072-631 | MB7072-700 | MB7072-701 | MB7072-710 | MB7072-711 |
| MB7072-720 | MB7072-721 | MB7072-730 | MB7072-731 |

### Active Part Numbers for MB7076

| MB7076-100 | MB7076-101 | MB7076-110 | MB7076-111 | MB7076-120 | MB7076-121 | MB7076-130 | MB7076-131 |
Active Part Numbers for MB7092

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<th>Active Part Number</th>
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<td>MB7067 – Compact</td>
<td>MB7060 in 3/4&quot; NPS WRC Housing</td>
<td>MB7060-2XX</td>
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<tr>
<td>MB7260 – Ultra Compact</td>
<td>MB7060 in Ultra Compact</td>
<td>MB7060-3XX</td>
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<td>MB7267 – Ultra Compact Flush Mount</td>
<td>MB7060 in Ultra Compact Flush Mount</td>
<td>MB7060-4XX</td>
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<td>MB7060 in 1&quot; NPS Housing</td>
<td>MB7060-5XX</td>
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<td>MB7067 – 1&quot; BSPP</td>
<td>MB7060 in 1&quot; BSPP Housing</td>
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<td>MB7060 in 30mm 1.5 Housing</td>
<td>MB7060-7XX</td>
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<td>MB7062-2XX</td>
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<td>MB7262 – Ultra Compact</td>
<td>MB7062 in Ultra Compact</td>
<td>MB7062-3XX</td>
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<td>MB7068 – Ultra Compact Flush Mount</td>
<td>MB7062 in Ultra Compact Flush Mount</td>
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<td>MB7277 – Ultra Compact Flush Mount</td>
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<td>MB7072 in 1&quot; BSPP Housing</td>
<td>MB7072-6XX</td>
</tr>
<tr>
<td>MB7078 – 30mm 1.5</td>
<td>MB7072 in 30mm 1.5 Housing</td>
<td>MB7072-7XX</td>
</tr>
</tbody>
</table>

The legacy part numbers MB7067, MB7068, MB7260, MB7262, MB7267, MB7077, MB7078, MB7270, MB7277 and MB7278 are now contained within MB7060, MB7062, MB7070 and MB7072 which are the base for all housing options on these products. To select a product with a legacy part number, select the desired housing option on the product with the appropriate base. Please review the following table for more information.
After reviewing this datasheet, do you have any more questions?

We offer Technical Support on all of our products even if you purchased them through one of our many vendors worldwide.

You can fill out a Technical Support form for assistance on a sensor here --> Technical Support

Not sure which sensor you need for your application?

We offer Sensor Selection Assistance, click the link here to fill out a form for support --> Sensor Selection Help

Looking for tutorials to help you get started?

Frequently Asked Questions about Our Sensors

We receive many questions about our products and services. This resource offers answers to common inquiries we receive about our product lines and their application.

Fully Calibrated Beam Patterns

All of our sensors are factory calibrated to provide consistent beam patterns, detection zones, to fit into a wide variety of applications. In our product lines, each model number comes with a different beam pattern that reflects the sensitivity and the detection zone of how it sees a target. Additionally, we strive to maintain consistency between our finished products, and you will see little to no deviation between sensors of the same model. This allows you to have confidence in your final application when using multiple sensors.

Understanding Range Readings

The success of an application may hinge upon knowing the exact location of a target. However, a sensor may report one meter even if the target is not exactly one meter away from the sensor. Sensor specifications, such as resolution, precision, and accuracy, help you to understand sensor performance.

How to Use Multiple Ultrasonic Sensors

This guide covers three ways to run your sensors in a Multiple Sensor environment and issues you may face.

Contact us now with any questions at sales@maxbotix.com or call +1-218-454-0766.

Please call during our preferred business hours of 8:00 am – 4:30 pm EST on Monday through Thursday and 8:00 am – 2:00 pm EST on Friday, or you may leave us a voicemail anytime.