

# SCXL-MaxSonar® - WR/WRC™ Series



## Self-Cleaning, High Resolution, IP67 Weather Resistant, Ultrasonic Sensor

MB7560, MB7563, MB7566, MB7567, MB7568, MB7569,  
MB7580, MB7583, MB7586, MB7587, MB7588, MB7589<sup>10</sup>

The SCXL-MaxSonar-WR/WRC sensor line includes an effective self-cleaning capability designed to reduce the impact of condensation in closed or high-moisture (dew, frost, etc.) environments. This sensor is a cost-effective solution for applications where precision range-finding, low-voltage operation, space saving, low-cost, self-cleaning, and IP67 weather resistance rating is needed. This sensor component module allows users of other, more costly precision rangefinders to lower the cost of their systems without sacrificing performance.

The SCXL-MaxSonar-WR/WRC self-cleaning sensor line provides high accuracy and high resolution ultrasonic proximity detection and ranging in air, with an IP67 weather resistant rating. This sensor line features 1-mm resolution, target-size and operating-voltage compensation for improved accuracy, superior rejection of outside noise sources, internal speed-of-sound temperature compensation and optional external speed-of-sound temperature compensation. The SCXL-MaxSonar-WR/WRC self-cleaning models are available in 5-meter or 10-meter models. This ultrasonic sensor ranges to objects from 30-cm\* to maximum range. Objects closer than 30-cm\* are typically reported as 30-cm\*. The interface output formats are pulse width, analog voltage, and digital serial in either RS232 (MB7560 series) or TTL (MB7580 series). Factory calibration is standard. \*For select sensors this distance is 50-cm, refer to page 5.

### Precision Ultrasonic Range Sensing

- Self-cleaning algorithm
- Reading-to-reading stability of 1-mm at 1-meter is typical<sup>1</sup>
- Factory matched accuracy, typical accuracy of 1% or better<sup>1,2</sup>
- Target size and operating voltage compensation
- Internal temperature compensation
- Optional external temperature compensation
- Determines range to largest object (MB7568, MB7569, MB7588, MB7589)
- Determines range to first detectable object (MB7560, MB7563, MB7566, MB7567, MB7580, MB7583, MB7586, MB7587)
- Excellent clutter rejection
- Added chemical resistance available<sup>7</sup>

### Easy to use Component Module

- Easy to use interface with distance provided in a variety of outputs
- Sensor automatically handles

- acoustic noise<sup>2,4</sup>
- Small and easy to mount
- Calibrated sensor eliminates most sensor to sensor variations

### Range Outputs

- Pulse width, 1uS/mm resolution
- Analog Voltage, 5-mm or 10mm resolution<sup>8</sup>
- Serial, 1-mm resolution (RS232 or TTL)

### General Characteristics

- Low cost ultrasonic rangefinder
- 5-meters or 10-meter detection range
- Resolution of 1-mm
- Distance sensor from 30-cm to 5-meters or 50-cm to 10-meters based on model
- Excellent<sup>2</sup> MTBF<sup>7</sup>
- Free run operation with superior noise rejection<sup>3</sup>
- Operating temperature range from -40°C to +65°C<sup>9</sup>

- Operating voltage from 2.7V to 5.5V
- Current draw of ~68mA at 5V
- IP67 Rated
- Sensor should remain on and be allowed to free run for self-clean feature to operate.

### Applications & Uses

- Tank level measurement<sup>5</sup>
- Bin level measurement
- Long range object detection
- Height monitors
- Auto sizing
- Automated factory systems

### Notes:

- <sup>1</sup> Refer to section that compares WR to WRC on page 5
- <sup>2</sup> Users are encouraged to evaluate the sensor performance in their application
- <sup>3</sup> Reference pages 10-11 for part specific timing information
- <sup>4</sup> by design
- <sup>5</sup> MB7569 or MB7589 is the recommended sensor
- <sup>6</sup> See page 9 for multi-sensor operation
- <sup>7</sup> F-Option provides additional protection from hazardous chemical environments
- <sup>8</sup> refer to Pin 3 description on page 2
- <sup>9</sup> Please reference page 12 & 13 for minimum operating voltage verses temperature information
- <sup>10</sup> Please reference page 19 for part number key.

## Close Range Operation

Applications requiring 100% reading-to-reading reliability should not use MaxSonar sensors at a distance closer than 50cm. Although most users find MaxSonar sensors to work reliably from 0 to 50cm 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.

## SCXL-MaxSonar-WR Pin Out

**Pin 1- Temperature Sensor Connection:** Leave this pin unconnected if an external temperature sensor is not used. For best accuracy, this pin is optionally connected to the HR-MaxTemp temperature sensor. Some additional information for the temperature sensor can be found on page 9 of the datasheet.

**Pin 2- Pulse Width Output:** This pin outputs a pulse width representation of the distance with a scale factor of 1uS per mm. The pulse width output is sent with a value within 0.5% of the serial output.

**Pin 3- Analog Voltage Output:** This pin outputs a single ended analog voltage scaled representation of the distance. This output is referenced to the sensor ground and Vcc. After the ~50mS power up initialization, the voltage on this pin is set to a low voltage. Once the sensor has completed a range reading the voltage on this pin is set to the voltage corresponding to the latest measured distance.

The 5-meter sensors (MB7560, MB7567, MB7569, MB7580, MB7587, and MB7589) use a scale factor of (Vcc/5120) per 1-mm. The distance is output with a 5-mm resolution. The analog voltage output is typically within ±5-mm of the serial output.

The 10-meter sensors (MB7563, MB7566, MB7568, MB7583, MB7586, and MB7588) use a scale factor of (Vcc/10240) per 1-mm. The distance is output with a 10-mm resolution. The analog voltage output is typically within ±10-mm of the serial output.

Using a 10-bit analog to digital converter with the 5-meter sensors, one can read the analog voltage counts (i.e. 0 to 1023) directly and just multiply the number of counts in the value by 5 to yield the range in mm. For example, a converted value of 60 corresponds to 300-mm (where  $60 \times 5 = 300$ ), and 1000 counts corresponds to 5,000-mm (where  $1000 \times 5 = 5,000$ -mm).

Using a 10-bit analog to digital converter with the 10-meter sensors, one can read the analog voltage counts (i.e. 0 to 1023) directly and just multiply the number of counts in the value by 10 to yield the range in mm. For example, 30 counts corresponds to 300-mm (where  $30 \times 10 = 300$ ), and 1000 counts corresponds to 10,000-mm (where  $1000 \times 10 = 10,000$ -mm).

**Pin 4- RX:** This pin is internally pulled high. If this pin is left unconnected or held high, the sensor will continually measure and output the range data. If held low, the SCXL-MaxSonar-WR will stop ranging. Bring high for 20uS or longer to command a range reading.

**Pin 5-Serial Output:** The MB756X sensors have a serial RS232 data format (with 0V to Vcc levels) and the MB758X sensors have TTL outputs. The output is an ASCII capital "R", followed by four ASCII character digits representing the range in millimeters, followed by a carriage return (ASCII 13). The maximum range reported is 4999 mm (5-meter models) or 9998 mm (10-meter models). A range value of 5000 or 9999 corresponds to no target being detected in the field of view.

The serial data format is 9600 baud, 8 data bits, no parity, with one stop bit (9600-8-N-1).

Because the data is presented in a binary data format, the serial output is most accurate.

**V+ Pin 6 - Positive Power, Vcc:** The sensor operates on voltages from 2.7V - 5.5V DC. The SCXL-MaxSonar-WR self-cleaning sensors have a current draw of ~34mA at 3.3V and ~68mA at 5V. For best operation, the sensor requires that the DC power be free from electrical noise. (For installations with known dirty electrical power, a 100uF capacitor placed at the sensor pins between V+ and GND will typically correct the electrical noise.) Please reference page 12 & 13 for minimum operating voltage verses temperature information.

**GND Pin 7 – Sensor ground pin:** DC return, and circuit common ground.

## Self-Cleaning Description

The SCXL-MaxSonar-WR sensors feature a self-cleaning protocol which gently heats the face of the transducer, and atomizes any moisture/condensation on the sensor's transducer face. This feature allows the sensor to be used in a wide variety of applications that may experience condensation issues. Self-cleaning is needed for many such applications due to detection performance limitations resulting from condensation, including only reporting the minimum or maximum reported distance.

Condensation is frequently an issue in tanks because the sensor is typically mounted at the top of the tank, above a warmer liquid. On clear nights or cold nights, this causes the sensor hardware to be colder than its surrounding environment, causing condensation to build up on the surface of the exposed sensor hardware. This can also occur in some buildings, depending on climate control.

The reason that condensation is problematic to sensors is fairly straightforward. Sensors determine distance to targets, even if that target is on the surface of the transducer. Targets (condensation, solid particles, etc.) on the surface of the transducer impede sensor operation. These targets (on the surface of the transducer) will either be detected or cause a reduction in the sensitivity of the sensor. The self-cleaning operation is designed to prevent buildup and remove buildup of moisture from the surface of the transducer. For proper self-cleaning, the sensor must remain on, and continue normal ranging operation.

The self-cleaning feature is only designed for moisture, not removal of dust or other solid particles. Multiple sensor operation is not possible without running in triggered mode.

## Single-sensor operation

The self-cleaning protocol runs with the RX pin is set to 'High'. It does not run with the RX pin is set to 'Low'. We recommend running this protocol when condensation is expected. This will occur at different times depending on your specific application environment. Sensor wiring for single sensor operation is shown on page 9 of this datasheet.

## Multiple-sensor operation

Running more than one sensor in a given environment is only possible by running in triggered operation mode.

Below are several different strategies for setting up multiple sensors in triggered mode (arranged in order for use in lower-moisture to higher-moisture environments).

- 1.) (Note: this low-power strategy maximizes sensor availability while allowing self-cleaning cycle to run – for lower-moisture environments, or where maximum data is needed):
  - a. Run each sensor for seven (7) seconds in sequence. Take a range reading from each sensor sequentially.
- 2.) (Note: This strategy is designed for high-moisture environments, saves battery when condensation is not expected. For example, during the portion of the night when the temperature is dropping):
  - a. Run all sensors continually when condensation is expected.
  - b. Only run a sensor when range information is needed. At this time, shut down (by holding the RX pin LOW) all the other sensors and cycle the desired sensor for seven (7) seconds.
  - c. Timing of sensor cycles should be based on other data (i.e. time of day/year, temperature, etc.)
- 3.) (Note: This strategy maximizes self-cleaning cycles over time - for high-moisture environments):
  - a. Run all sensors continually while ignoring range output (keeps sensors condensation-free but no range readings during this time – maximizes self-cleaning cycles over time)
  - b. When a reading is desired, shut down the sensors, trigger each individual sensor one at a time for seven (7) seconds and take a range reading for each sensor
  - c. Go back to step 1 (keep all sensors running).

MaxBotix recommends choosing an SCXL-MaxSonar-WR product for applications that are in high-moisture environments, or which are vulnerable to occasional condensation. These sensors are IP67 rated.

## Base sensor (MB7560 and MB7580)

The MB7560 and MB7580 are the base model of the SCXL-MaxSonar-WR self-cleaning sensor line. These sensors are recommended for users unsure of which sensor to use in their application. All other sensors in this series are based off of these sensor models. The additional features are mentioned in their respective sections below.

## SCXL-MaxSonar-WRLS (MB7563 and MB7583)

The SCXL-MaxSonar-WRLS self-cleaning sensors are 10-meter sensors with high sensitivity. These sensors are recommended for applications in which objects that do not reflect enough ultrasonic sound, such as people, need to be detected. Users are encouraged to test the sensor in their application to verify usability.

## SCXL-MaxSonar-WRL (MB7566, MB7586)

The SCXL-MaxSonar-WRL self-cleaning sensors are the 10-meter version of the SCXL-MaxSonar-WR sensors.

## SCXL-MaxSonar-WRML (MB7568, MB7588)

The SCXL-MaxSonar-WRML sensors are equipped with filtering firmware which allows the sensor to ignore smaller targets and noise, and still report the target that gives the largest acoustic return with a 10-meter maximum range. (The sensor will also reject periodic noise, even noise that has a higher amplitude than the acoustic return from the target.) This provides the flexibility to consistently range larger targets in the presence of clutter and noise. If the largest target is removed, the SCXL-MaxSonar-WRML will switch to the target with the next largest detectable return.

The SCXL-MaxSonar-WRML sensors were designed for applications where users were concerned with ranging the distance to large flat targets (such as in a water tank). This stands in contrast to other SCXL-MaxSonar-WR sensors which will report the distance to the first detectable target.

In general, the SCXL-MaxSonar-WRML will select the largest target from its field of view and report its range. Even so, objects up close may provide significantly greater returns over distant objects. Users are encouraged to test the sensor in their application to verify usability.

When targets are of similar amplitude reflections, preference is given to the closest target.

## SCXL-MaxSonar-WRM (MB7569 and MB7589)

The SCXL-MaxSonar-WRM sensors are the 5-meter version of the SCXL-MaxSonar-WRML sensors.

## About Package Types

The SCXL-MaxSonar-WR sensors are available in a variety of packages for applications with specific mounting requirements. The full horn package provides peak accuracy and sensitivity in this sensor line. It is recommended that testing is completed to ensure that the selected sensor will operate as desired in your application.

Package Types Currently Available
Full Horn – 3/4" NPT straight; back mounted thread ( <b>best performance</b> )
Compact – 3/4" NPT straight; back mounted thread
1"NPS – External thread over full sensor body (1"NPS)
1"BSPP – External thread over full sensor body (1"BSPP)
30mm1.5 – External thread over full sensor body (30mm1.5)
<b>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.</b>



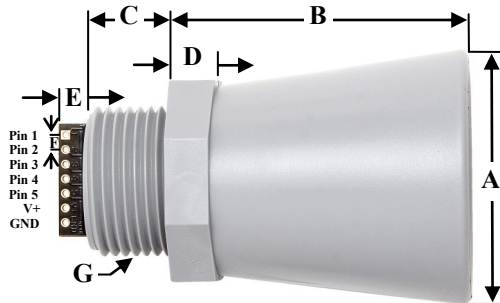
## Performance Changes when Selecting a Non-Full Horn Package

When selecting a SCXL-MaxSonar-WR sensor 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 be less accurate by an additional +/- 0.5%.
- The sensor may have a dead zone from 0mm-500mm.
- 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.

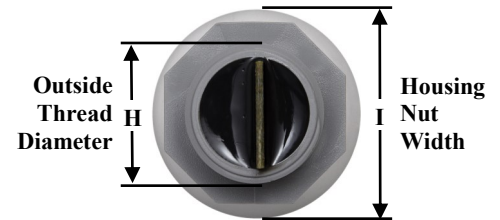
## Mechanical Dimensions

### Full Horn

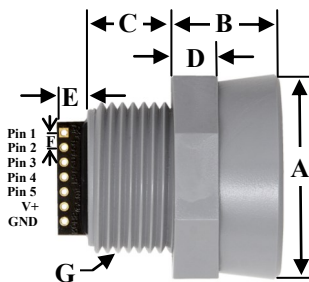


A	1.72" dia.	43.8 mm dia.
B	2.00"	50.7 mm
C	0.58"	14.4 mm
D	0.31"	7.9 mm
E	0.23"	5.8 mm
F	0.1"	2.54 mm
G	3/4"-14 NPS	
H	1.032" dia.	26.2 mm dia.
I	1.37"	34.8 mm
Weight, 1.76 oz., 50 grams		

Values Are Nominal

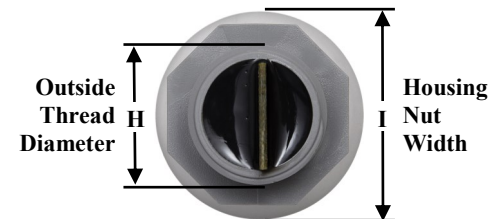


### Compact Housing

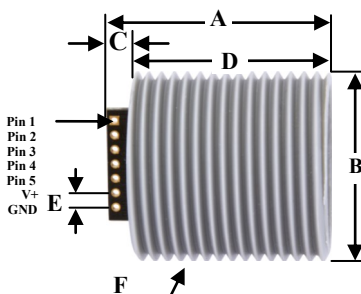


A	1.37" dia.	34.7 mm dia.
B	0.70"	17.9 mm
C	0.57"	14.4 mm
D	0.31"	7.9 mm
E	0.23"	5.8 mm
F	0.1"	2.54 mm
G	3/4"-14 NPS	
H	1.032" dia.	26.2 mm dia.
I	1.37"	34.8 mm
Weight, 1.23 oz., 32 grams		

Values Are Nominal

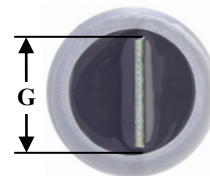


### 1" NPS Pipe Threading



A	1.52"	38.5 mm
B	1.29" dia.	33.0 mm dia.
C	0.22"	5.5 mm
D	1.30"	33.1 mm
E	0.10"	0.10"
F	1" - NPS	
G	0.78"	19.81 mm
Weight, 1.23 oz., 35 grams		

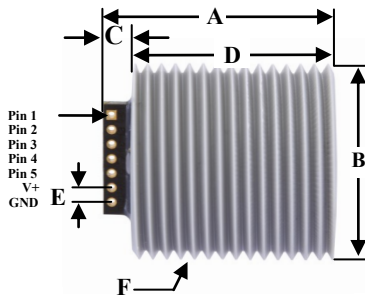
Values Are Nominal





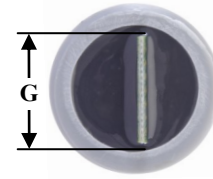
## Mechanical Dimensions Continued

### 1" BSPP Pipe Threading

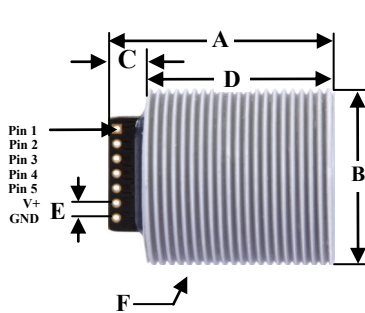


A	1.52"	38.5 mm
B	1.29" dia.	33.0 mm dia.
C	0.22"	5.5 mm
D	1.30"	33.1 mm
E	0.10"	0.10"
F	1" — BSPP	
G	0.78"	19.81 mm
Weight, 1.21 oz., 34.3 grams		

Values Are Nominal

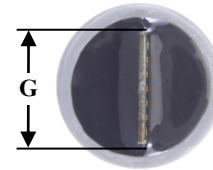


### 30mm1.5 Pipe Threading



A	1.52"	38.5 mm
B	1.17" dia.	29.7 mm dia.
C	0.22"	5.5 mm
D	1.30"	33.1 mm
E	0.10"	0.10"
F	30mm 1.5	
G	0.78"	19.81 mm
Weight, 1.10 oz., 31.1 grams		

Values Are Nominal



## Sensor minimum distance - No sensor dead zone

(MB7560, MB7567, MB7569, MB7580, MB7587, and MB7589)

The 5 meter sensors have a minimum reported distance of 30-cm (11.8 inches). However, the SCXL-MaxSonar-WR self-cleaning sensors will report targets up to the sensor face (for the WR sensors)<sup>1</sup> and to within 1-mm of the front sensor face (for the WRC sensors)<sup>1</sup>. For the 5 meter SCXL-MaxSonar-WR sensors, targets closer than 300-mm will typically range as 300-mm. Notes: <sup>1</sup> refers to section that compares WR to WRC on page 4

## Sensor minimum distance - No sensor dead zone

(MB7563, MB7566, MB7568, MB7583, MB7586, and MB7588)

The SCXL-MaxSonar-WRL self-cleaning sensor has a minimum reported distance of 50-cm (19.7 inches). However, this sensor will report targets up to the sensor face. For the SCXL-MaxSonar-WRL sensor, targets closer than 500-mm will typically range as 500-mm.

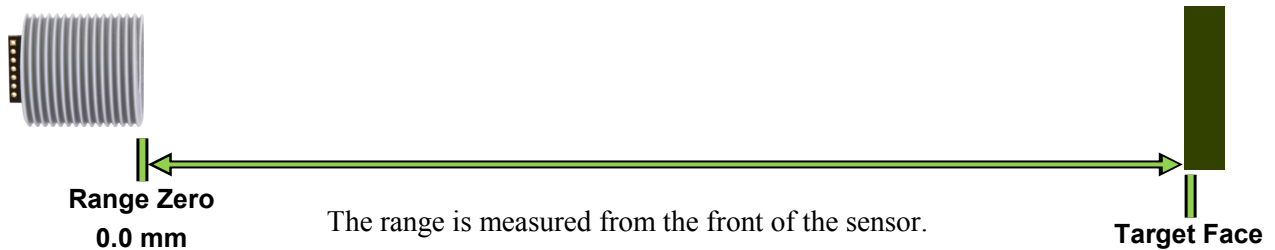
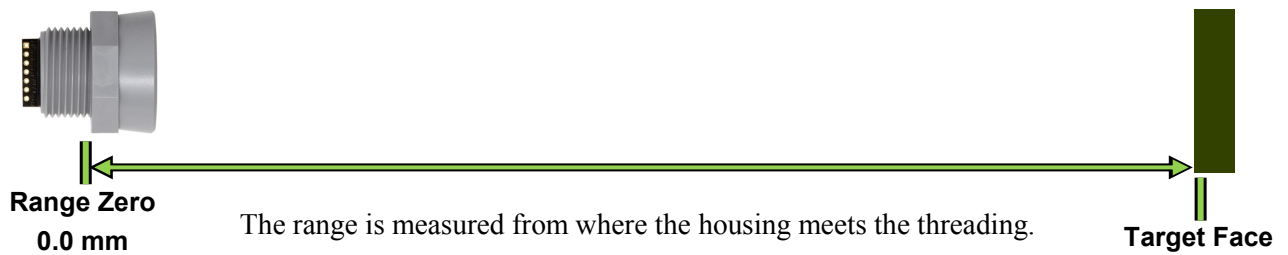
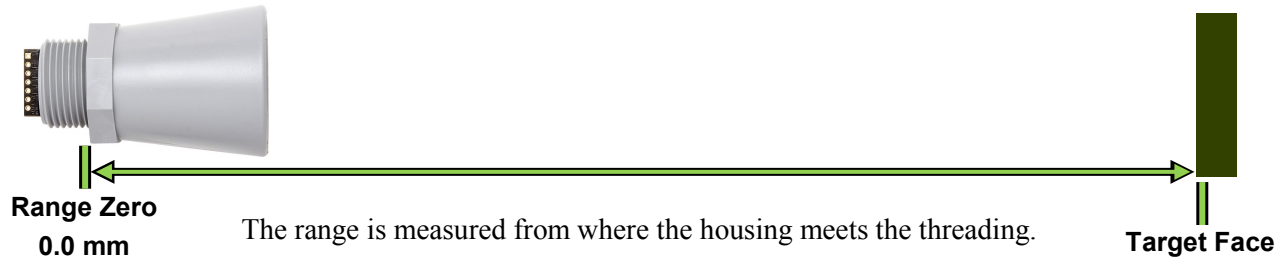
## Sensor operation from 30-cm to 50-cm

Because of acoustic effects in the near field, objects between 30-cm and 50-cm may experience acoustic phase cancellation of the returning wave, resulting in inaccuracies of up to 5-mm. These effects become less prevalent as the target distance increases, and have not been observed past 50-cm. For this reason, users that require the highest accuracy are encouraged to mount the SCXL-MaxSonar-WR self-cleaning sensors farther than 50-cm away from objects.

## Range “0” location

The SCXL-MaxSonar-WR self-cleaning sensors reports the range to distant targets from where the threading and nut meet on the sensor housing as shown in the diagram below.

In general, the SCXL-MaxSonar-WR units will report the range to the leading edge of the closest detectable object. Target detection has been characterized in the sensor beam patterns.



## About Ultrasonic Sensors

The SCXL-MaxSonar-WR self-cleaning ultrasonic sensors are in-air, non-contact object detection and ranging sensors that detect objects within an 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 outputs a range reading.

## Device Comparison

Part Number	Serial Interface	First Detectable target	Most Likely Filter	High Performance HR Filter <sup>1</sup>	Optimized for snow depth	Soft/Small Target Detection <sup>2</sup>	5 Meter Range	10 Meter Range	Self Cleaning
MB7560	RS232	Yes		Yes			Yes		Yes
MB7563	RS232	Yes		Yes		Yes		Yes	Yes
MB7566	RS232	Yes		Yes				Yes	Yes
MB7568	RS232		Yes	Yes				Yes	Yes
MB7569	RS232		Yes	Yes			Yes		Yes
MB7580	TTL	Yes		Yes			Yes		Yes
MB7583	TTL	Yes		Yes		Yes		Yes	Yes
MB7586	TTL	Yes		Yes				Yes	Yes
MB7588	TTL		Yes	Yes				Yes	Yes
MB7589	TTL		Yes	Yes			Yes		Yes

### Notes

<sup>1</sup> Exceeds the ability of the first generation XL-MaxSonar-WR models MB70##. Also includes target size compensation, internal temperature sensor, external temperature sensor, factory calibration, supply voltage droop compensation, continuous automatic calibration, and side lobe suppression.

<sup>2</sup> Higher gain and other calibration allows better performance to soft targets such as grain.

## Auto Calibration

Each time a SCXL-MaxSonar-WR self-cleaning sensor series takes a range reading, it calibrates itself. 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 over the rated temperature range while applying compensation for changes caused by temperature and voltage.

## Target Size Compensation

Most low cost ultrasonic rangefinders will report the range to smaller size targets as farther than the actual distance. In addition, they may also report the range to larger size targets as closer than the actual distance.

The SCXL-MaxSonar-WR self-cleaning sensor line compensates for target size differences. This means that, provided an object is large enough to be detected, the sensor will report the same distance, typically within 1%<sup>1</sup>, regardless of target size<sup>1</sup>. Smaller targets can have additional detection noise that may limit this feature. In addition, targets with small or rounded surfaces may have an apparent distance that is slightly farther, where the distance reported may be a composite of the sensed object(s). Compensation for target size is applied to all range outputs: pulse width, analog voltage, and serial format output by the sensor.

## Supply Voltage Compensation

During power up, the SCXL-MaxSonar-WR self-cleaning sensor line will calibrate itself for changes in 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 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.

**Notes:** <sup>1</sup> Refer to section that compares WR to WRC on page 5



## SCXL-MaxSonar-WR Temperature Compensation On Board – Internal Temperature Compensation (Not recommended during sensor operation)

The speed of sound in air increases by about 0.6 meters per second, per degree centigrade. Because of this, each SCXL-MaxSonar-WR self-cleaning sensor is equipped with an internal temperature sensor which allows the sensor to apply compensation for speed of sound changes.

The actual air temperature of the path between the sensor and the target may not match the temperature measured at the sensor itself. Sensors can be mounted in vertical applications, or applications where the environment temperature gradient is severe. These users may experience a temperature measurement error which will affect the sensor accuracy. For example, buildings with a height of 3-meters can have floor to ceiling temperature variations of 5°C or more.

Because of these temperature effects, users desiring the highest accuracy output are encouraged to use a properly mounted external temperature sensor or to manually account for this measurement error.

Operating the sensor using the internal temperature sensor will result in range readings being increased by approximately 1% . This is because the self-cleaning function does result in a slight temperature increase at the transducer surface.

## HR-MaxTemp, an External Temperature Sensor (Required for accurate readings)

Although the SCXL-MaxSonar-WR self-cleaning sensor has an internal temperature sensor; for best accuracy, users are encouraged to use the optional external temperature sensor. On power-up, the SCXL-MaxSonar-WR will automatically detect an attached HR-MaxTemp temperature sensor and begin to apply temperature compensation using the external temperature sensor.

The external temperature sensor allows for the most accurate temperature compensation, by allowing temperature readings to be taken that better reflect the composite temperature of the acoustic ranging path. For best results, users are encouraged to connect the temperature sensor midway between the SCXL-MaxSonar-WR and the expected target.

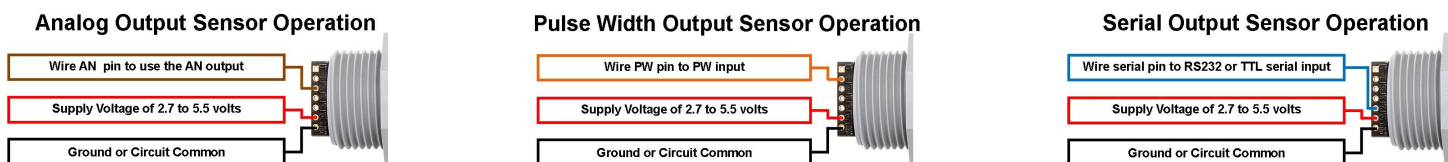
## Operating Modes

### Free-Run Operation

When operating in free run mode, the SCXL-MaxSonar-WR self-cleaning sensors are designed to be used in a variety of outdoor, industrial, or indoor situations. Many acoustic noise sources will have little to no effect on the reported range of the SCXL-MaxSonar-WR sensors. Most range readings are accurately reported. If the range readings are affected, the effect is typically less than 5-mm<sup>1</sup>.

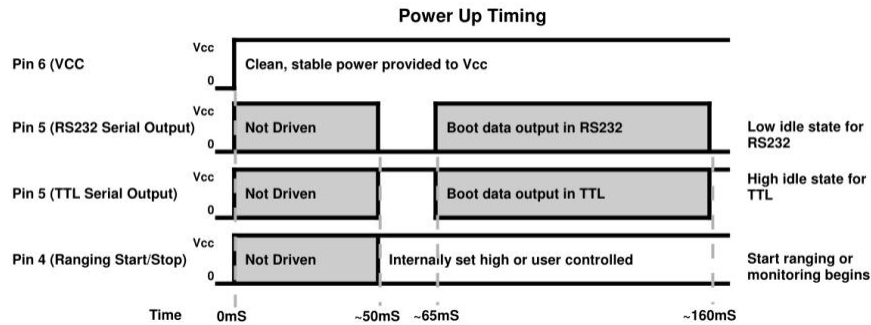
### Independent Sensor Operation

The SCXL-MaxSonar-WR self-cleaning sensors have the capability to operate independently when the user desires. When using the SCXL-MaxSonar-WR self-cleaning sensors in single or independent sensor operation, it is easiest to allow the sensor to free-run. Free-run is the default mode of operation for all of the MaxBotix Inc., sensors. The SCXL-MaxSonar-WR self-cleaning sensors have three separate outputs that update the range data simultaneously: Analog Voltage, Pulse Width, and Serial Data. Below are diagrams on how to connect the sensor for each of the three outputs for single or independent sensor operation.

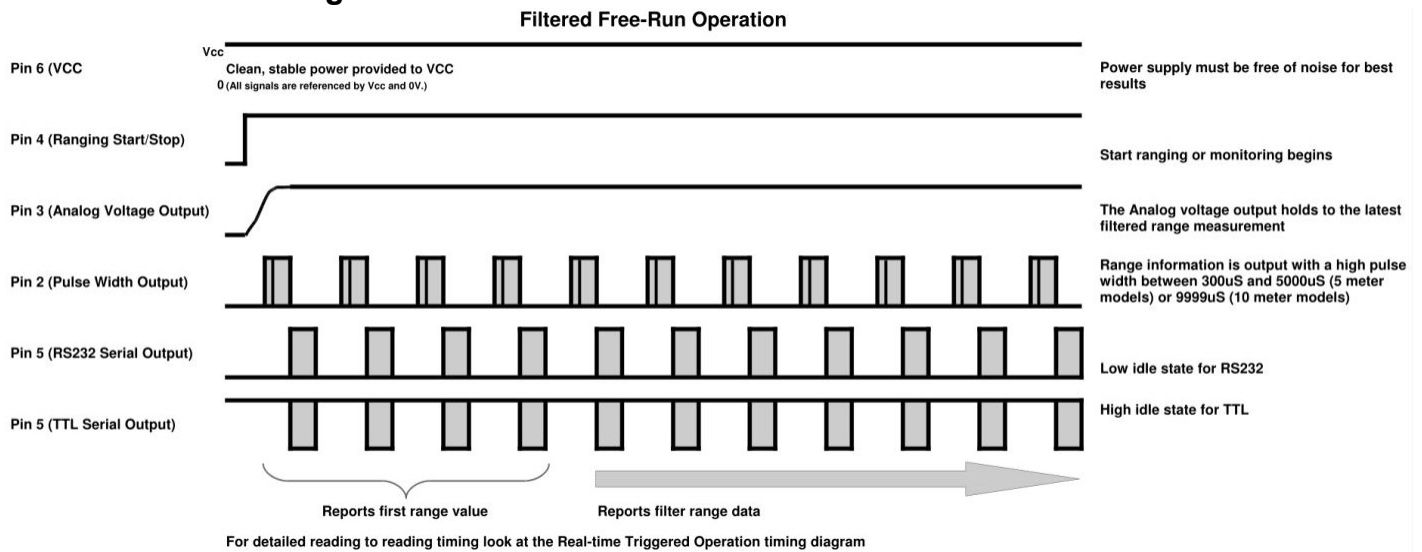


## Sensor Timing Diagrams

### Power Up Timing



### Sensor Free-Run Timing



Product	Maximum Refresh Rate	Free Run Filter	Pulse Width Reported	Serial Data Reported	Pin 4 Brought Low	End of Self Cleaning Cycle	End of range cycle
MB7560, MB7567, MB7580, MB7587	0.555 Hz	0.111 Hz	~118mS	~124mS	~132mS	~1802mS	~1803mS
MB7569 and MB7589	0.550 Hz	0.110 Hz	~133mS	~139mS	~147mS	~1817mS	~1818mS
MB7563, MB7566, MB7583, MB7586	0.541 Hz	0.108 Hz	~147mS	~158mS	~166mS	~1849mS	~1850mS
MB7568 and MB7588	0.537 Hz	0.107 Hz	~161mS	~171mS	~179mS	~1862mS	~1863mS

When operating in free run mode, the SCXL-MaxSonar-WR self-cleaning sensors are designed to be used in a variety of outdoor, industrial, or indoor environments. Many acoustic noise sources will have little to no effect on the reported range of the SCXL-MaxSonar-WR self-cleaning sensors<sup>1</sup>. Most range readings are accurately reported<sup>1</sup>. If the range readings are affected, the effect is typically less than 5-mm<sup>1</sup>.

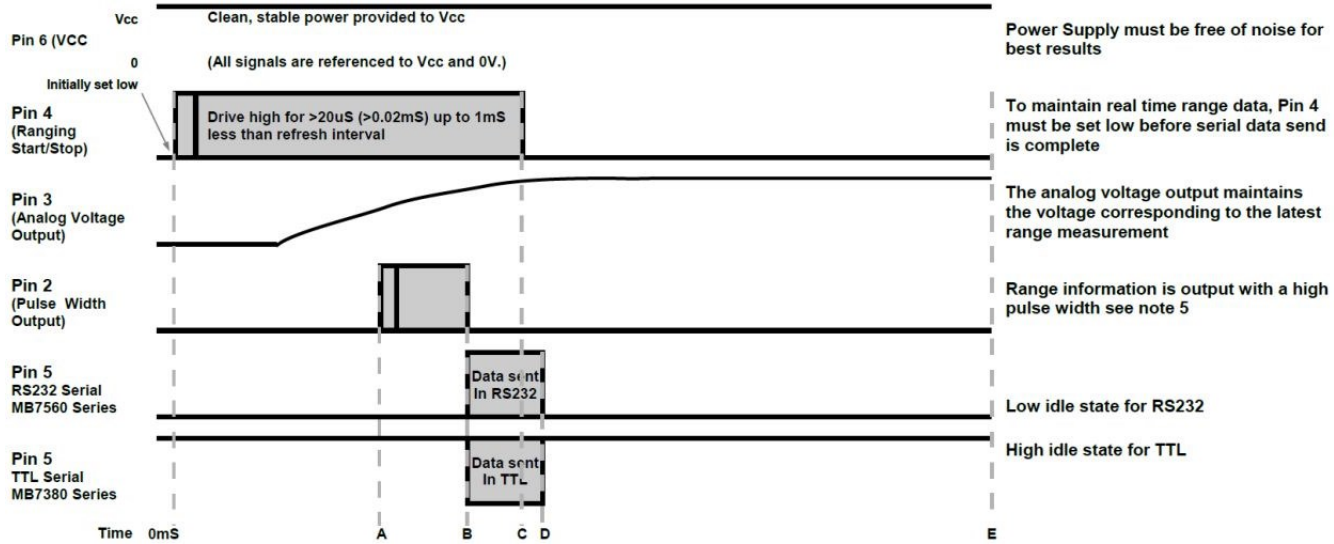
The SCXL-MaxSonar-WR self-cleaning sensors use an internal filter to process range data. This filter improves the sensor's performance for accuracy, noise rejection, and reading to reading stability.

On the SCXL-MaxSonar-WR self-cleaning sensors, when pin 4 is left high, the sensor will continue to range, the data output includes a filter for increased accuracy in environments with acoustic noise. The SCXL-MaxSonar-WR self-cleaning sensors will output the range based on recent range information. The filter does not affect the speed at which data is made available to the user but instead allows for more consistent range information to be presented.

**Notes:** <sup>1</sup> Refer to section that compares WR to WRC on page 5

## Sensor Timing Diagrams Cont.

### Real-time Triggered Operation



Product	Maximum Refresh Rate <sup>1</sup>	Pulse Width sent (A)	Serial Data sent (B)	RX Pin set low (C)	Begin Self Cleaning Cycle (D)	End of Self Cleaning Cycle	End of range cycle (E)
MB7560, MB7567, MB7580, MB7587	0.555 Hz	~118mS	~124mS	~131mS	~132mS	~1.802 seconds	~1.803 seconds
MB7569 and MB7589	0.550 Hz	~133mS	~139mS	~146mS	~147mS	~1.817 seconds	~1.818 seconds
MB7563, MB7566, MB7583, MB7586	0.541 Hz	~147mS	~158mS	~165mS	~166mS	~1.849 seconds	~1.850 seconds
MB7568 and MB7588	0.537 Hz	~161mS	~171mS	~178mS	~179mS	~1.862 seconds	~1.863 seconds

### Triggered—Real-time Operation Timing

Users can enter and remain in the real-time or triggered operation by making sure that before the end each range cycle, the voltage level on Pin 4 is set low. After the sensor has completed the last reading, Pin 4 is brought high. When Pin 4 is brought high, a new range cycle starts and the SCXL-MaxSonar-WR outputs the most recent range data without filtering.

Readings during triggered operation are less accurate than the filtered operation by approximately ±5-mm. Because the range readings are not filtered, noise tolerance can be greatly reduced. Care should be taken to make sure that only one self-cleaning sensor is sampling range at a time.

**Pulse Width data sent (Column A)** - Column A shows the approximate time that the sensor starts to output the pulse width data. The Pulse Width output time can be as short as 300uS (minimum reported distance). For 5 meter sensors, the pulse width can take as long as 5000uS (maximum reported distance) to be sent. For 10 meter sensors the Pulse Width can take as long as 9999uS (maximum reported distance) to be sent.

**Serial data sent (Column B)** - Column B shows the approximate time during each range cycle when the serial data is output for the sensor. Range data takes ~8mS to be reported from the serial data output.

**RX Pin set low (Column C)** - When operating the SCXL-MaxSonar-WR self-cleaning sensor in Triggered Operation, Pin 4 is must be brought high for a time frame greater than 20uS (0.02mS) and less than the time in Column C in the chart above. If Pin 4 remains high for a period of time greater than the value in Column C, the sensor will switch into free-run filter operation.

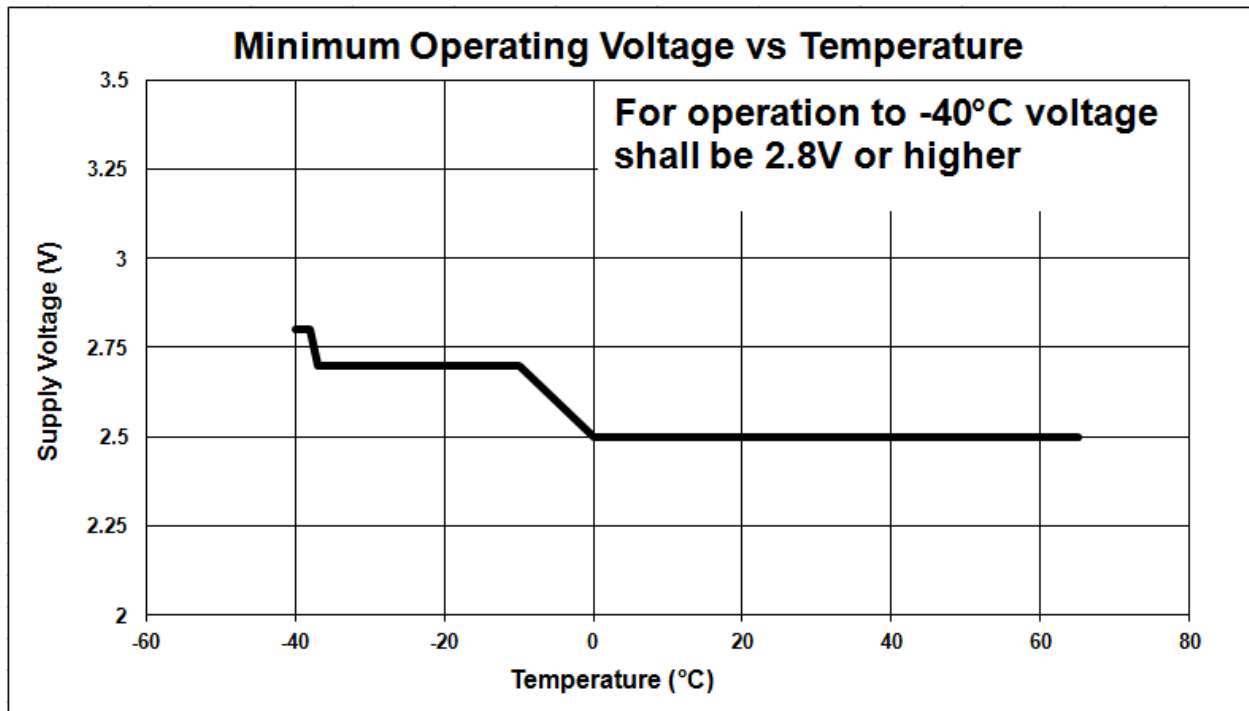
**Self-Cleaning Cycle (Column D)** - Approximately 1mS after the serial data is output from the sensor, the SCXL-MaxSonar-WR self-cleaning sensor enters a self-cleaning mode that lasts approximately 1.562 seconds. This mode has been measured to increase sensor temperature by at least 5C during free-run operation that lasts 15 minutes.

## Voltage vs Temperature

The graphs below show minimum operating voltage of the sensor verses temperature.

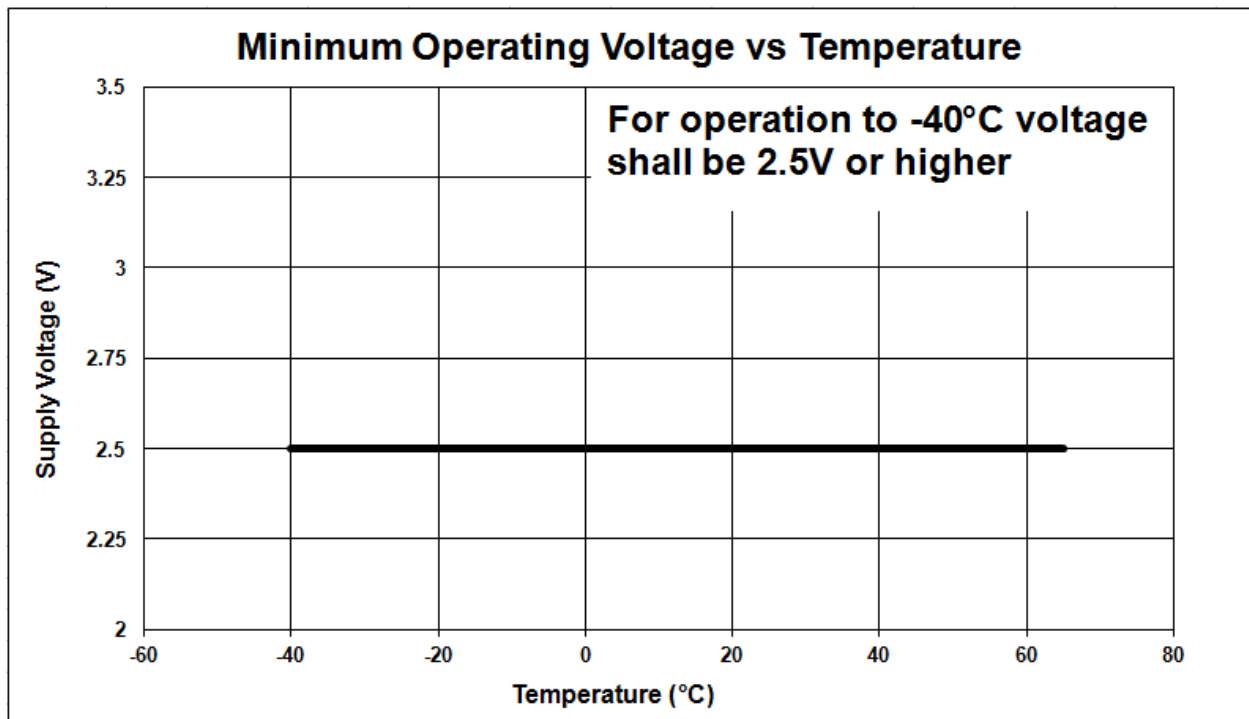
The graph pictured below is applicable to the following sensors:

**MB7560, MB7569, MB7580 & MB7589**



The graph pictured below is applicable to the following sensors:

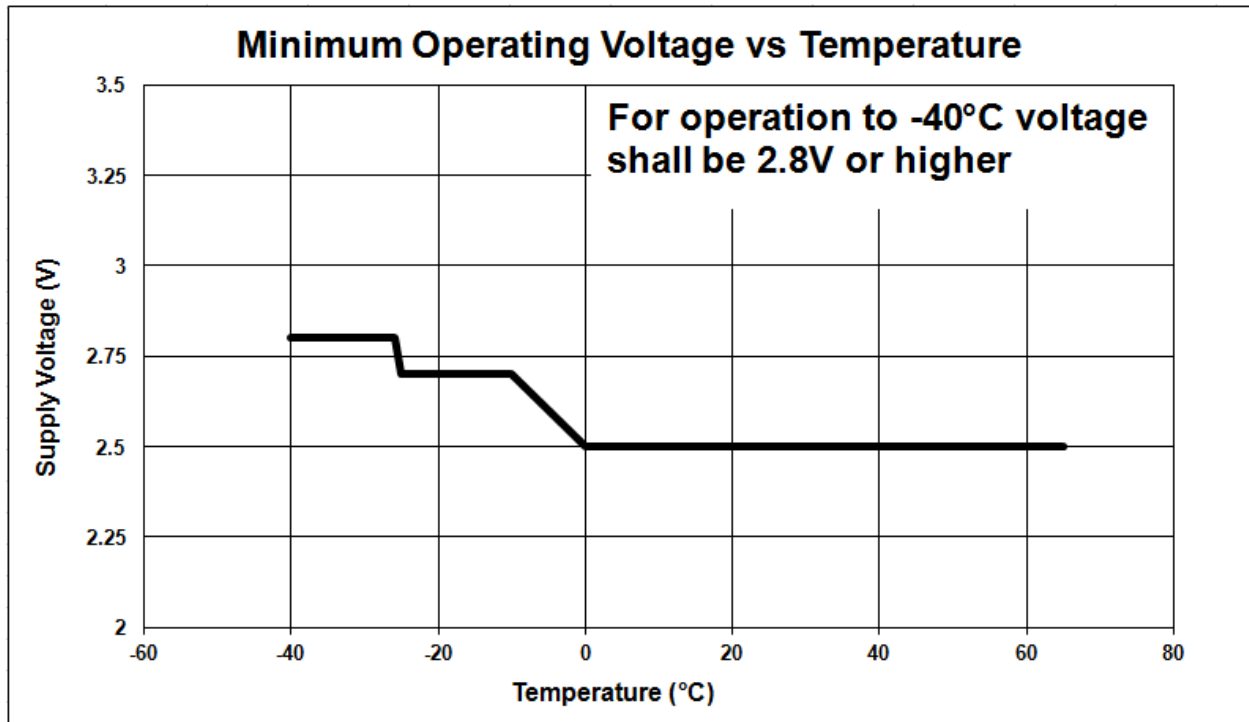
**MB7563, MB7566, MB7568, MB7583, MB7586, & MB7588**



## Voltage vs Temperature

The graph pictured below is applicable to the following sensors:

**MB7560-WRC, MB7560-1" NPS, MB7560-1" BSPP, MB7560-30mm1.5**  
**MB7569-WRC, MB7569-1" NPS, MB7569-1" BSPP, MB7569-30mm1.5**  
**MB7580-WRC, MB7580-1" NPS, MB7580-1" BSPP, MB7580-30mm1.5**  
**MB7589-WRC, MB7589-1" NPS, MB7589-1" BSPP, MB7589-30mm1.5**



## SCXL-MaxSonar®-WR™ Beam Patterns

### Background Information Regarding our Beam Patterns

Each SCXL-MaxSonar-WR self-cleaning sensor has a calibrated beam pattern. Each sensor is matched to provide the approximate detection pattern shown in this datasheet. This allows end users to select the part number that matches their given sensing application. Each part number has a consistent field of detection so additional units of the same part number will have similar beam patterns. The beam plots are provided to help identify an estimated detection zone for an application based on the acoustic properties of a target versus the plotted beam patterns.

Each beam pattern is a 2D representation of the detection area of the sensor. The beam pattern is actually shaped like a 3D cone (having the same pattern both vertically and horizontally). Beam patterns for dowels are used to show the beam pattern of each sensor. Dowels are long cylindrical targets of a given diameter. The dowels provide consistent target detection characteristics for a given size target which allows easy comparison of one MaxSonar sensor to another MaxSonar sensor.

For each part number, the four patterns (A, B, C, and D) represent the detection zone for a given target size. Each beam pattern shown is determined by the sensor's part number and target size.

The actual beam angle changes over the full range. Use the beam pattern for a specific target at any given distance to calculate the beam angle for that target at the specific distance. Generally, smaller targets are detected over a narrower beam angle and a shorter distance. Larger targets are detected over a wider beam angle and a longer distance.

**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.



# MB7560-MB7580 SCXL-MaxSonar® -WR™ Beam Pattern and Uses

The SCXL-MaxSonar-WR self-cleaning product line has a narrow sensor beam and provides reliable long range detection zones.

## MB7560-1XX MB7580-1XX

### SCXL-MaxSonar® -WR/WRT™ 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.

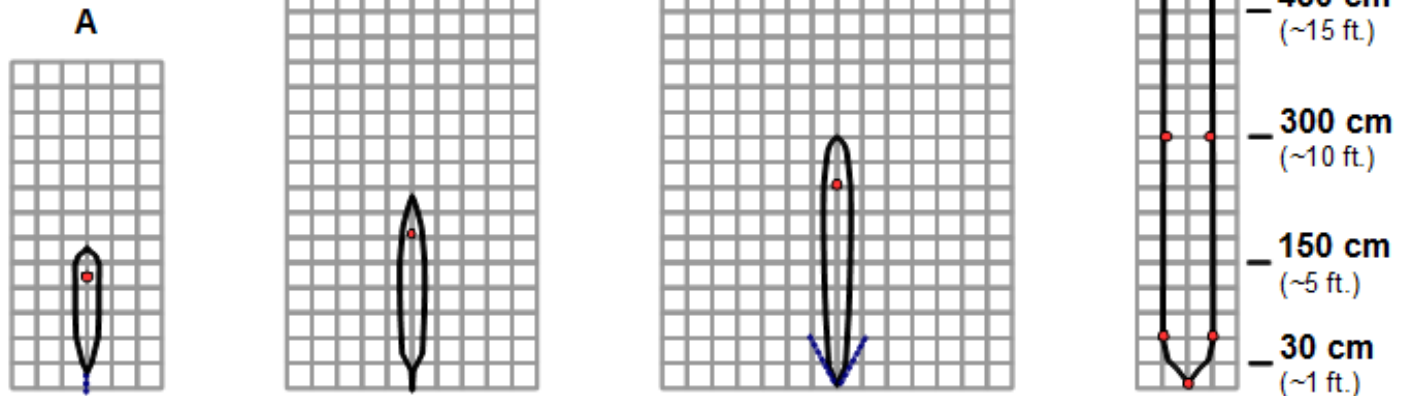
- A 6.1-mm (0.25-inch) diameter dowel
- B 2.54-cm (1-inch) diameter dowel
- C 8.89-cm (3.5-inch) diameter dowel

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.

■ ■ Partial Detection

— 5.0 V

● 3.3 V



**Beam Characteristics are Approximate**

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

### MB7560-MB7580

#### Features and Benefits

- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- High acoustic sensitivity

### MB7560-MB7580

#### Applications and Uses

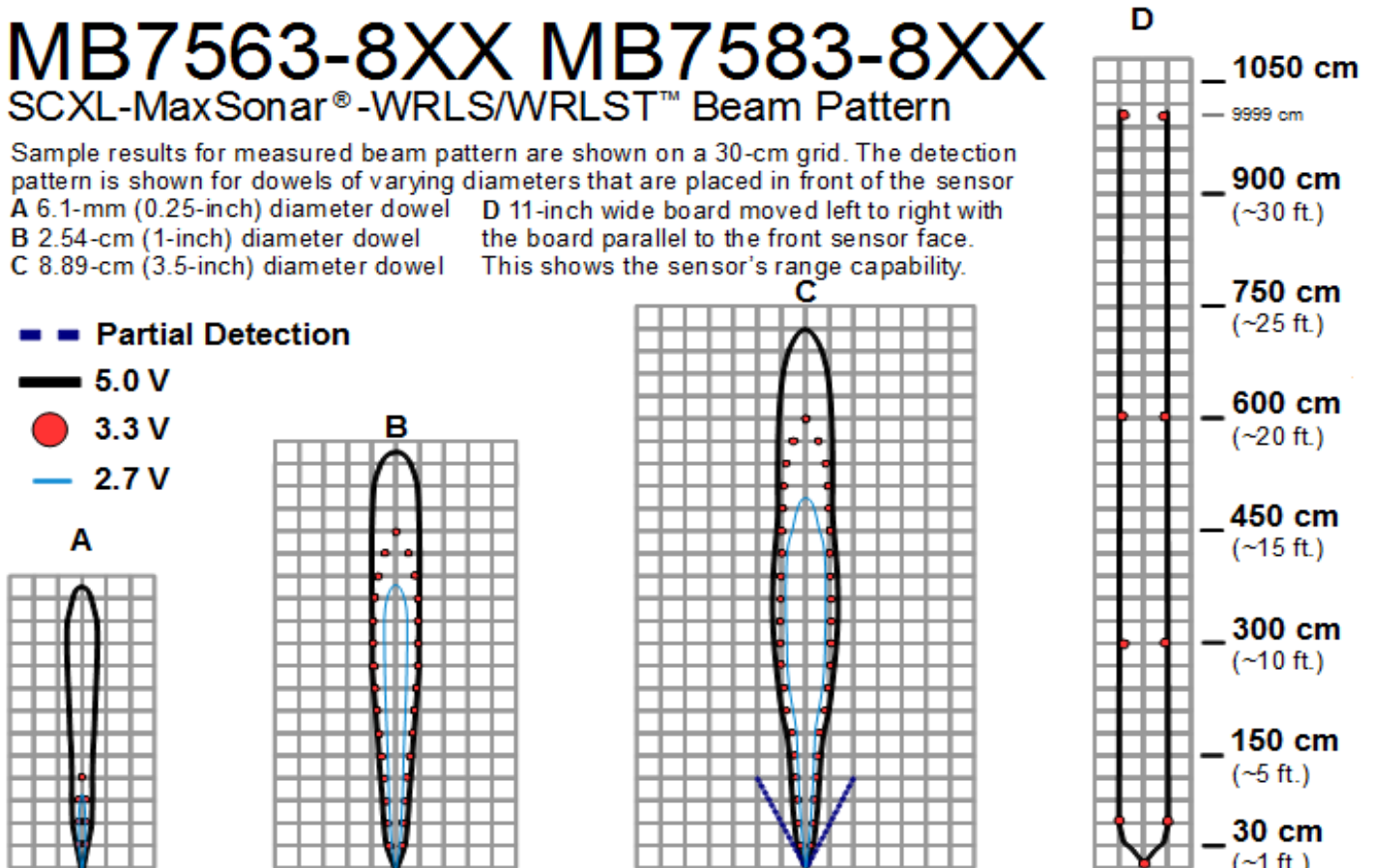
- Autonomous Navigation
- Robot Ranging Sensor
- Bin Level Measurement
- Tank Level Measurement

# MB7563-MB7583 SCXL-MaxSonar®-WRLS™ Beam Pattern and Uses

The SCXL-MaxSonar-WRLS self-cleaning sensors are 10 meter sensors with a higher sensitivity than other SCXL-MaxSonar-WR products. This sensor is recommended for applications in which objects do not reflect enough ultrasonic sound for other sensors to report the range to, such as grain and people.

## MB7563-1XX MB7583-1XX MB7563-8XX MB7583-8XX SCXL-MaxSonar®-WRLS/WRLST™ 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.



**Beam Characteristics are Approximate**

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

### MB7563-MB7583

#### Features and Benefits

- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- High acoustic sensitivity

### MB7563-MB7583

#### Applications and Uses

- Autonomous Navigation
- Robot Ranging Sensor
- Bin Level Measurement
- Tank Level Measurement
- Grain Level Measurement

# MB7566-MB7586 SCXL-MaxSonar® -WRL™ Beam Pattern and Uses

The SCXL-MaxSonar-WRL self-cleaning sensors are a long range, 10 meter ultrasonic sensor.

## MB7566-1XX MB7586-1XX

### SCXL-MaxSonar® -WRL/WRLT™ 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.

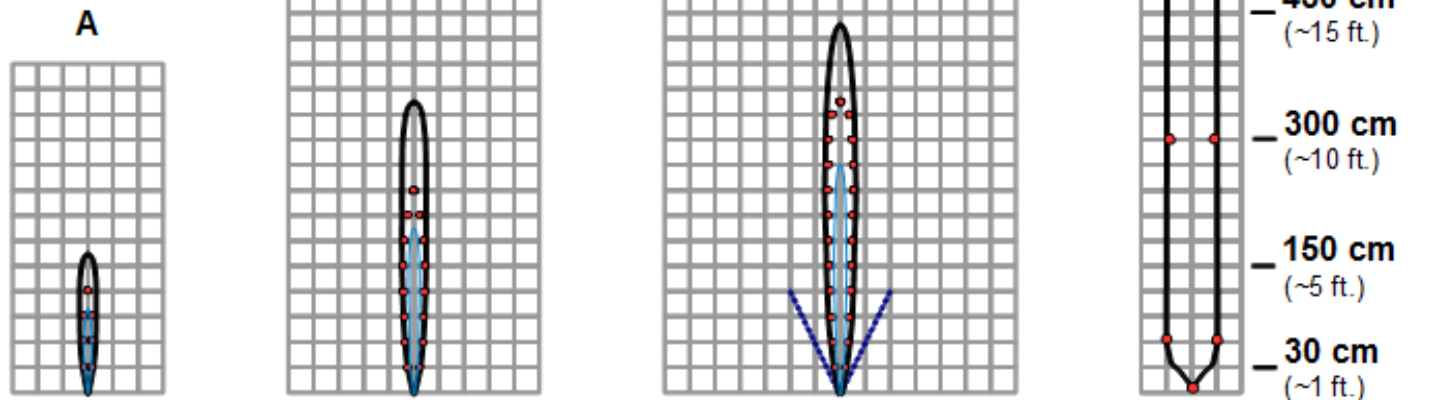
**Note:** For people detection the pattern typically falls between charts A and B.

■ Partial Detection

— 5.0 V

● 3.3 V

— 2.7 V



**Beam Characteristics are Approximate**

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

### MB7566-MB7586

#### Features and Benefits

- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- 10 meter range to large targets

### MB7566-MB7586

#### Applications and Uses

- Autonomous Navigation
- Robot Ranging Sensor
- Bin Level Measurement
- Tank Level Measurement
- Long Range Measurement

# MB7568-MB7588 SCXL-MaxSonar® -WRML™ Beam Pattern and Uses

The SCXL-MaxSonar-WRML self-cleaning sensors are a long range, 10 meter ultrasonic sensor with advance filtering that ranges to targets with the largest ultrasonic reflection, while ignoring smaller clutter.

## MB7568-1XX MB7588-1XX

### HRXL-MaxSonar®-WRML/WRMLT™ 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

..... Partial Detection

— 5.0V

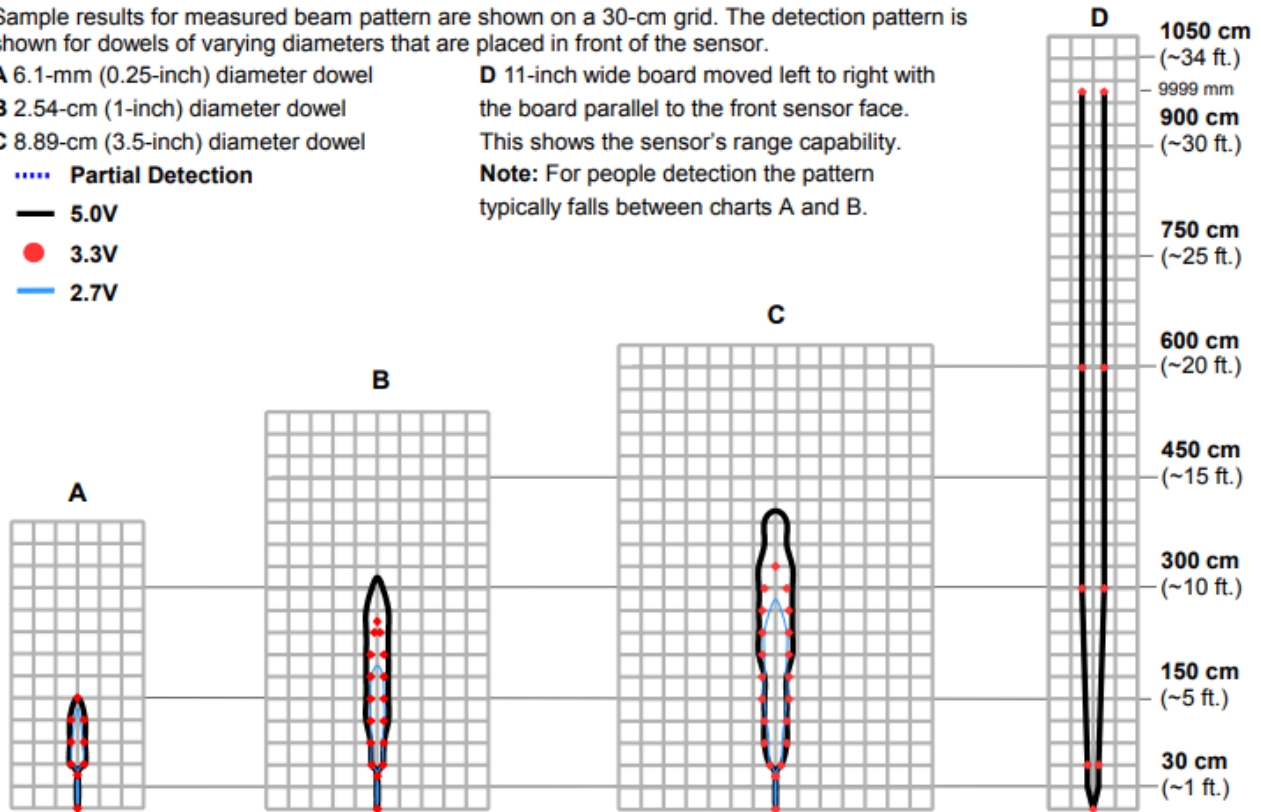
● 3.3V

— 2.7V

**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.**

MaxBotix® Inc.

For more information or latest product datasheets visit: [www.maxbotix.com](http://www.maxbotix.com)

The names MaxBotix, MaxSonar, EZ0, EZ1, EZ2, EZ3, EZ4, AE0, AE1, AE2, AE3, AE4, and WR1 are trademarks of MaxBotix Inc.

## MB7568-MB7588

### Features and Benefits

- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- 10 meter range to large targets

## MB7568-MB7588

### Applications and Uses

- Bin Level Measurement
- Tank Level Measurement
- Long Range Measurement

# MB7569-MB7589 SCXL-MaxSonar® -WRM™ Beam Pattern and Uses

The SCXL-MaxSonar-WRM self-cleaning sensor product line has a narrow sensor beam and advance filtering that ranges to targets with the largest ultrasonic reflection, while ignoring smaller clutter.

## MB7569-1XX MB7589-1XX

### SCXL-MaxSonar® -WRM/WRMT™ 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.

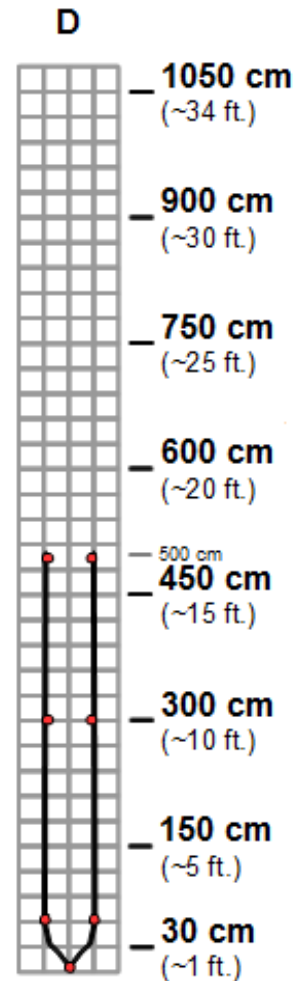
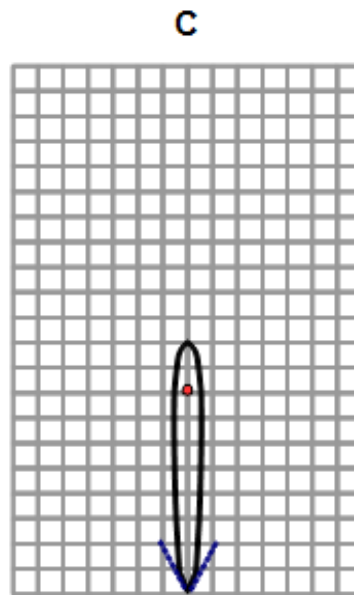
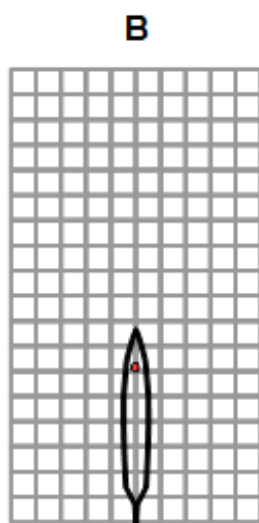
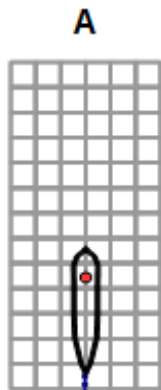
This shows the sensor's range capability.

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

■ Partial Detection

— 5.0 V

● 3.3 V



**Beam Characteristics are Approximate**

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

### MB7569-MB7589

#### Features and Benefits

- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- Superior clutter rejection

### MB7569-MB7589

#### Applications and Uses

- Bin Level Measurement
- Tank Level Measurement



## MB756X-MB758X SCXL-MaxSonar-WRC Beam Pattern and Uses

The SCXL-MaxSonar-WRC self-cleaning sensor product line has select models that are available in alternative housings that include a compact WRC form factor, 1" NPS pipe threading, 1" BSPP pipe threading, and 30mm1.5 pipe threading.

<b>MB7560-2XX</b>	<b>MB7569-2XX</b>	<b>MB7580-2XX</b>	<b>MB7589-2XX</b>
<b>MB7560-5XX</b>	<b>MB7569-5XX</b>	<b>MB7580-5XX</b>	<b>MB7589-5XX</b>
<b>MB7560-6XX</b>	<b>MB7569-6XX</b>	<b>MB7580-6XX</b>	<b>MB7589-6XX</b>
<b>MB7560-7XX</b>	<b>MB7569-7XX</b>	<b>MB7580-7XX</b>	<b>MB7589-7XX</b>

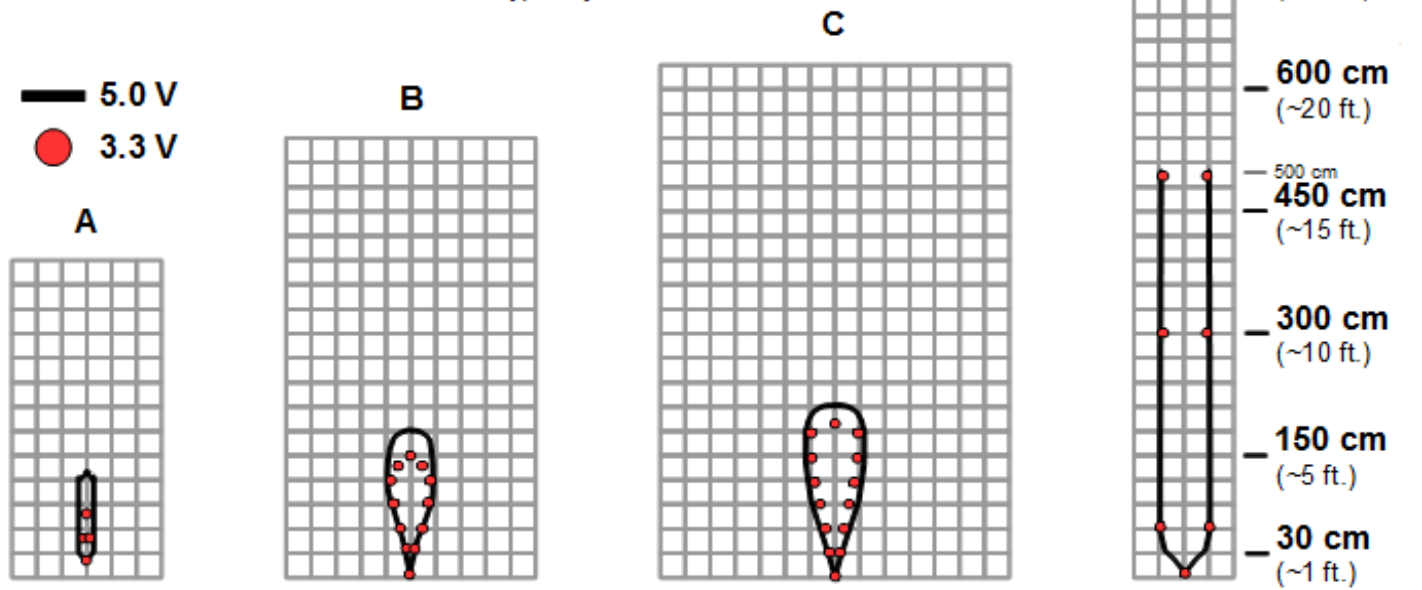
### SCXL-MaxSonar® - Beam Pattern

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.

### MB756X-MB758X

#### Features and Benefits

- Extra Compact Housing
- Designed for outdoor or indoor environments
- Lightweight, compact, weather resistant design
- Low cost IP67 sensor
- Reliable and stable range data
- Can be flush mounted in an application
- Available in both metric and imperial housing sizes

### MB756X-MB758X

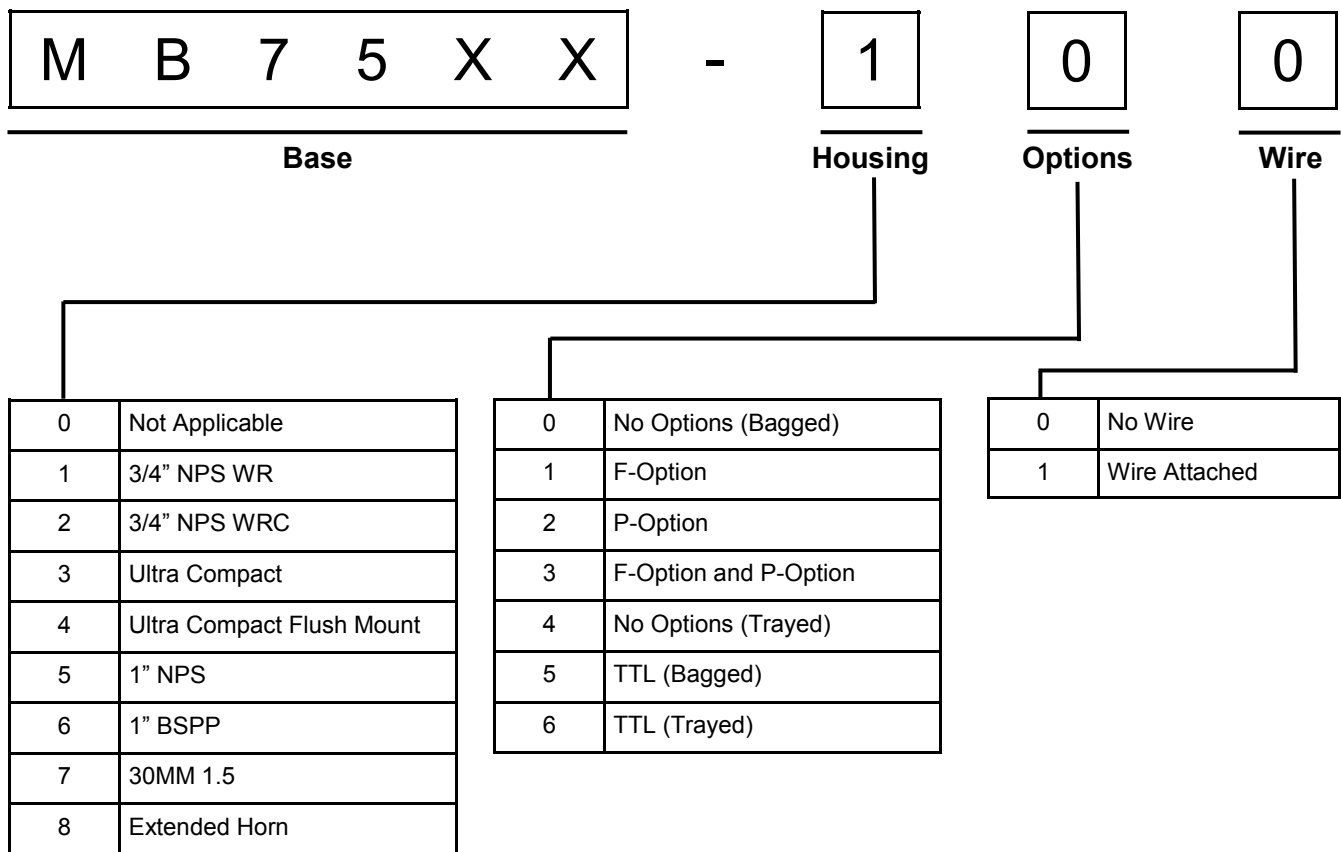
#### Applications and Uses

- Applications with strict mounting conditions
- Tank level measurement
- Bin level measurements
- Environments with ice and condensation

## 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 20 and 21.



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

Active Part Numbers for MB7560							
MB7560-100	MB7560-101	MB7560-110	MB7560-111	MB7560-120	MB7560-121	MB7560-130	MB7560-131
MB7560-200	MB7560-201	MB7560-210	MB7560-211	MB7560-220	MB7560-221	MB7560-230	MB7560-231
MB7560-500	MB7560-501	MB7560-510	MB7560-511	MB7560-520	MB7560-521	MB7560-530	MB7560-531
MB7560-600	MB7560-601	MB7560-610	MB7560-611	MB7560-620	MB7560-621	MB7560-630	MB7560-631
MB7560-700	MB7560-701	MB7560-710	MB7560-711	MB7560-720	MB7560-721	MB7560-730	MB7560-731

Active Part Numbers for MB7563							
MB7563-100	MB7563-101	MB7563-110	MB7563-111	MB7563-120	MB7563-121	MB7563-130	MB7563-131
MB7563-800	MB7563-801	MB7563-810	MB7563-811	MB7563-820	MB7563-821	MB7563-830	MB7563-831

Active Part Numbers for MB7566							
MB7566-100	MB7566-101	MB7566-110	MB7566-111	MB7566-120	MB7566-121	MB7566-130	MB7566-131

Active Part Numbers for MB7568							
MB7568-100	MB7568-101	MB7568-110	MB7568-111	MB7568-120	MB7568-121	MB7568-130	MB7568-131

Active Part Numbers for MB7569							
MB7569-100	MB7569-101	MB7569-110	MB7569-111	MB7569-120	MB7569-121	MB7569-130	MB7569-131
MB7569-200	MB7569-201	MB7569-210	MB7569-211	MB7569-220	MB7569-221	MB7569-230	MB7569-231
MB7569-500	MB7569-501	MB7569-510	MB7569-511	MB7569-520	MB7569-521	MB7569-530	MB7569-531
MB7569-600	MB7569-601	MB7569-610	MB7569-611	MB7569-620	MB7569-621	MB7569-630	MB7569-631
MB7569-700	MB7569-701	MB7569-710	MB7569-711	MB7569-720	MB7569-721	MB7569-730	MB7569-731

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

Active Part Numbers for MB7580							
MB7580-100	MB7580-101	MB7580-110	MB7580-111	MB7580-120	MB7580-121	MB7580-130	MB7580-131
MB7580-200	MB7580-201	MB7580-210	MB7580-211	MB7580-220	MB7580-221	MB7580-230	MB7580-231
MB7580-500	MB7580-501	MB7580-510	MB7580-511	MB7580-520	MB7580-521	MB7580-530	MB7580-531
MB7580-600	MB7580-601	MB7580-610	MB7580-611	MB7580-620	MB7580-621	MB7580-630	MB7580-631
MB7580-700	MB7580-701	MB7580-710	MB7580-711	MB7580-720	MB7580-721	MB7580-730	MB7580-731

Active Part Numbers for MB7583							
MB7583-100	MB7583-101	MB7583-110	MB7583-111	MB7583-120	MB7583-121	MB7583-130	MB7583-131
MB7583-800	MB7583-801	MB7583-810	MB7583-811	MB7583-820	MB7583-821	MB7583-830	MB7583-831

Active Part Numbers for MB7586							
MB7586-100	MB7586-101	MB7586-110	MB7586-111	MB7586-120	MB7586-121	MB7586-130	MB7586-131

Active Part Numbers for MB7588							
MB7588-100	MB7588-101	MB7588-110	MB7588-111	MB7588-120	MB7588-121	MB7588-130	MB7588-131

Active Part Numbers for MB7589							
MB7589-100	MB7589-101	MB7589-110	MB7589-111	MB7589-120	MB7589-121	MB7589-130	MB7589-131
MB7589-200	MB7589-201	MB7589-210	MB7589-211	MB7589-220	MB7589-221	MB7589-230	MB7589-231
MB7589-500	MB7589-501	MB7589-510	MB7589-511	MB7589-520	MB7589-521	MB7589-530	MB7589-531
MB7589-600	MB7589-601	MB7589-610	MB7589-611	MB7589-620	MB7589-621	MB7589-630	MB7589-631
MB7589-700	MB7589-701	MB7589-710	MB7589-711	MB7589-720	MB7589-721	MB7589-730	MB7589-731

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## 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](mailto: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.