# HRXL-MaxSonar®- WR/WRC™ Series

RoHS COMPLIANT

## High Resolution, Precision, IP67 Weather Resistant, Ultrasonic Range Finder

**MB7360, MB7363, MB7364, MB7366, MB7367, MB7369, MB7380, MB7383, MB7384, MB7386, MB7387, MB7389**

*The HRXL-MaxSonar-WR/WRC sensor line is the most cost-effective solution for applications where precision range-finding, low-voltage operation, space saving, low-cost, 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. Additionally, this sensor line allows cost-sensitive designers to choose this precision sensor as a performance upgrade over other lower performance sensors.*

*The HRXL-MaxSonar-WR/WRC 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 HRXL-MaxSonar-WR/WRC models are available in 5-meter or 10-meter models. This ultrasonic sensor detects objects from 1-mm and 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 (MB7360 series) or TTL (MB7380 series). Factory calibration is standard.* *For select sensors this distance is 50-cm, refer to pages 5 and 6.*

## Precision Ultrasonic Range Sensing

- Range-finding at a fraction of the cost of other precision rangefinders
- Reading-to-reading stability of 1-mm at 1-meter is typical[1]
- Accuracy is factory-matched providing a typical accuracy of 1% or better [1,2]
- Compensation provided for target size variation and operating voltage range
- Internal temperature compensation is standard
- Optional external temperature compensation
- Determines range to largest object (MB7369 , MB7389)
- Determines range to first detectable object (MB7360, MB7363, MB7364, MB7366, MB7367, MB7380, MB7383, MB7384, MB7386, MB7387)
- Excellent clutter rejection
- Additional chemical resistance available[9]

## Very Low Power Requirements

- Wide, low supply voltage requirements eases battery powered design
- Low current draw reduces current drain for battery operation
- Fast first reading after power-up eases battery requirements
- Very low-power rangerfinder, excellent for multiple sensor or battery based systems

## Easy to use Component Module

- Gracefully handles other ultrasonic sensors[8]
- Stable and reliable range readings and excellent noise rejection make the sensor easy to use for most users
- Easy to use interface with distance provided in a variety of outputs
- Target size compensation provides greater consistency and accuracy
- Sensor automatically handles acoustic noise [2,4]
- Small and easy to mount
- Calibrated sensor eliminates most sensor to sensor variations

## Range Outputs

- Pulse width, 1uS/mm resolution
- Analog Voltage, 5-mm resolution (5-meter sensors)
- Analog Voltage, 10-mm resolution (10-meter sensors)
- Serial, 1-mm resolution
- Available in RS232 (MB7360 series) or TTL (MB7380 series)

## General Characteristics

- Low cost ultrasonic rangefinder
- Sensor dead zone virtually gone[1]
- Detection out to 5-meters or 10-meters
- Resolution of 1-mm
- Distance sensor from 30-cm to 5-meters or 50-cm to 10-meters based on model
- Excellent [2] Mean Time Between Failure (MTBF)
- Triggered operation yields real-time range data
- Free run operation with superior noise rejection [3]
- Operating temperature range from -40°C to +65°C
- Operating voltage from 2.7V to 5.5V
- Nominal current draw of 2.3mA at 3.3V, and 3.1mA at 5V
- IP67 Rated

## Applications & Uses

- Grain sensor[5]
- Tank level measurement[6]
- Weather station monitoring[7]
- Bin level measurement
- Corn and grain level measurement[5]
- Proximity zone detection
- People detection
- Robot ranging sensor
- Long range object detection
- Environments with acoustic and electrical noise
- Height monitors
- Auto sizing
- Box dimensions
- Automated factory systems
- This product is not recommended as a device for personal safety

**Notes:**

[1] Refer to section that compares WR to WRC on page 4
[2] Users are encouraged to evaluate the sensor performance in their application
[3] Reference pages 8-9 for part specific timing information
[4] by design
[5] MB7363 or MB7383 is the recommended sensor
[6] MB7369 or MB7389 is the recommended sensor
[7] MB7364 or MB7384 is the recommended sensor
[8] See page 7 for multi-sensor operation
[9] F-Option provides additional protection from hazardous chemical environments

## HRXL-MaxSonar-WR Circuit

The sensor functions using a variety active components which create an excellent ultrasonic sensor solution. The schematic is shown to provide the user with detailed connection information.

## HRXL-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 7 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 (MB7360, MB7364, MB7367, MB7369, MB7380, MB7384, MB7387, and MB7389) 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 (MB7363, MB7366, MB7383, and MB7386) 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 x 5 = 300), and 1000 counts corresponds to 5,000-mm (where 1000 x 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 x 10 = 300), and 1000 counts corresponds to 10,000-mm (where 1000 x 10 = 10,000-mm).

**Pin 4- Ranging Start/Stop:** 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 HRXL-MaxSonar-WR will stop ranging. Bring high for 20uS or longer to command a range reading.

**Filtered Range Data:** When pin 4 is left high on the sensors, the sensors will continue to range. The data that is output includes a filter for increased accuracy. The 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 ins

## About Ultrasonic Sensors

The HRXL-MaxSonar-WR 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[1] | Optimized for snow depth | Compact WRC | Soft/Small Target Detection[2] | 5 Meter Range | 10 Meter Range |
|---|---|---|---|---|---|---|---|---|---|
| MB7360 | RS232 | Yes | | Yes | | | | Yes | |
| MB7363 | RS232 | Yes | | Yes | | | Yes | | Yes |
| MB7364 | RS232 | Yes | | Yes | Yes | | Yes | Yes | |
| MB7366 | RS232 | Yes | | Yes | | | | | Yes |
| MB7367 | RS232 | Yes | | Yes | | Yes | | Yes | |
| MB7369 | RS232 | | Yes | Yes | | | | Yes | |
| MB7380 | TTL | Yes | | Yes | | | | Yes | |
| MB7383 | TTL | Yes | | Yes | | | Yes | | Yes |
| MB7384 | TTL | Yes | | Yes | Yes | | Yes | Yes | |
| MB7386 | TTL | Yes | | Yes | | | | | Yes |
| MB7387 | TTL | Yes | | Yes | | Yes | | Yes | |
| MB7389 | TTL | | Yes | Yes | | | | Yes | |

**Notes**

[1] 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.

[2] Higher gain and other calibration allows better performance to soft targets such as grain.

## Auto Calibration

Each time a HRXL-MaxSonar-WR series sensor 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 HRXL-MaxSonar-WR 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%[1], regardless of target size[1]. 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 HRXL-MaxSonar-WR 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:** [1] Refer to section that compares WR to WRC on page 4

## Base sensor (MB7360 and MB7380)

The MB7360 and MB7380 are the base model of the HRXL-MaxSonar-WR 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.

## HRXL-MaxSonar-WRLS (MB7363 and MB7383)

The HRXL-MaxSonar-WRLS sensors are 10 meter sensors with a higher sensitivity than other HRXL-MaxSonar-WR products. This sensor is recommended for applications in which objects do not reflect enough ultrasonic sound, such as people and grain, to be detected. Users are encouraged to test the sensor in their application to verify usability.

## HRXL-MaxSonar-WRC (MB7367, MB7387)

The HRXL-MaxSonar-WRC has the smallest size of this product line and is designed for applications with specific mounting restrictions.

The HRXL-MaxSonar-WRC is less accurate then the base HRXL-MaxSonar-WR sensors by about 1.0%. The HRXL-MaxSonar-WRC also has a dead zone between 0-4cm. The HRXL-MaxSonar-WRC sensor is also the least sensitive sensor in the HRXL-MaxSonar-WR sensor line.

## HRXL-MaxSonar-WRM (MB7369 and MB7389)

The HRXL-MaxSonar-WRM 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. (The sensor will also reject periodic noise, even noise that has a higher amplitude than the acoustic return from the target.) This gives users the flexibility to consistently range larger targets in the presence of clutter and noise. If the largest target is removed from the field of view, the HRXL-MaxSonar-WRM will switch to the target that gives the next largest detectable return.

The HRXL-MaxSonar-WRM 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 HRXL-MaxSonar-WR sensors which will report the distance to the first detectable target.

In general, the HRXL-MaxSonar-WRM 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.

# Snow Sensor - MB7364 and MB7384

## HRXL-MaxSonar-WRS (MB7364 and MB7384)

The HRXL-MaxSonar-WRS is a low-cost, rugged ultrasonic snow depth sensor that is optimized for reliable snow depth measurement. Internally, multiple sensor readings are analyzed using algorithms optimized for snow measurement, ensuring accurate snow depth measurements. The sensor accurately applies temperature compensation to every reading, using either the integrated temperature sensor or the optional external tempera sensor (HR-Max Temp).

## Sensor minimum distance - No sensor dead zone (MB7364 and MB7384)

The 5 meter high sensitivity HRXL-MaxSonar-WRS sensors have a minimum reported distance of 50-cm (19.7 inches). However, the HRXL-MaxSonar-WRS will report targets up to the sensor face. For the 5 meter HRXL-MaxSonar-WRS sensors, targets closer than 500-mm will typically range as 500-mm.

## Sensor Mounting (MB7364 and MB7384)

It is recommended that several factors be taken into account when using the MB7364 or the MB7384 ultrasonic snow depth sensors.

Due to the high gain of the sensor, the first recommendation is to mount the sensor far enough away from any supporting masts or towers. For a mast that is 5 meters high (or higher) the sensor should be mounted at least 100cm away from the mast. For a mast that is 2.5 meters high (or lower) the sensor should be at least 75cm away from the mast. (This corresponds to a mounting clearance angle of 11.3 degrees)

For users desiring the highest accuracy, it is recommended to use a properly mounted external temperature sensor.

MaxBotix Inc., is developing several components to assist in high accuracy readings and protection of the HRXL-MaxSonar-WRS and HR-MaxTemp sensors.

The first component is a shroud that is assembled over the top of the HRXL-MaxSonar-WRS sensor housing, figure 1. This shroud is a UV shield for the sensor. The shroud is also acts to protect the sensor from hail, heavy snow, and snow build up.

The second component is a louver design housing to protect the temperature sensor from direct and reflective UV rays, figure 2. This housing has been created to maintain a real time accurate temperature. This component is separate from the shroud that covers the HRXL-MaxSonar-WRS.

The third component is a fan housing which is able hold either an AC or DC cooling fan under the temperature housing, figure 3. This has been created for maximum airflow to the temperature sensor housing. The fan housing helps to ensure the temperature sensor is the same temperature as the surrounding environment.

All the components listed above are designed with the intent to use standard hardware for mounting to new or existing weather stations or other mounting components.

Figure 4 shows the recommended mounting for the HRXL-MaxSonar-WRS snow depth sensor with the HR-MaxTemp temperature sensor.

Mounting information for the snow sensor can be found in the application note here: ww.maxbotix.com/articles/070.htm


Figure 1


Figure 2


Figure 3

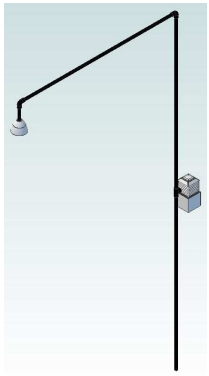


Figure 4

## Sensor minimum distance - No sensor dead zone

**(MB7360, MB7367, MB7369, MB7380, MB7387, and MB7389)**

The 5 meter sensors have a minimum reported distance of 30-cm (11.8 inches). However, the HRXL-MaxSonar-WR will report targets up to the sensor face (for the WR sensors)[1] and to within 1-mm of the front sensor face (for the WRC sensors)[1]. For the 5 meter HRXL-MaxSonar-WR sensors, targets closer than 300-mm will typically range as 300-mm.

Notes: [1] refers to section that compares WR to WRC on page 4

## Sensor minimum distance - No sensor dead zone

**(MB7363, MB7366, MB7383, and MB7386)**

The 10 meter sensors have a minimum reported distance of 50-cm (19.7 inches). However, the HRXL-MaxSonar-WRL will report targets up to the sensor face. For the 10 meter HRXL-MaxSonar-WRL sensors, targets closer than 500-mm will typically range as 500-mm.

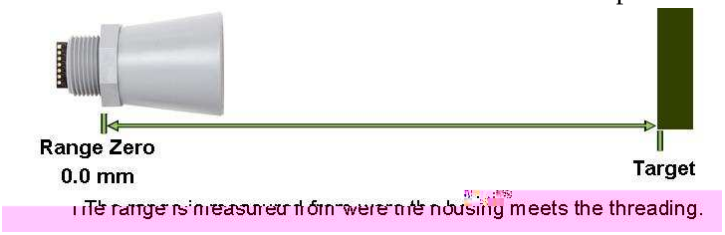
## Sensor operation from 30-cm to 50-cm

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 HRXL-MaxSonar-WR farther than 50-cm away from objects.

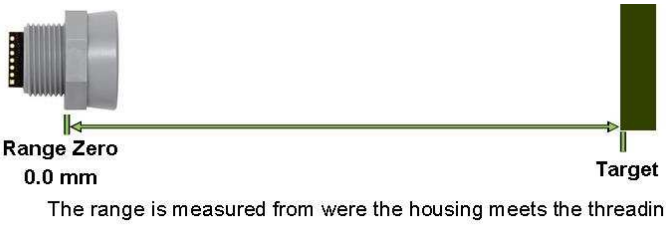
## Range "0" location

The HRXL-MaxSonar-WR 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 HRXL-MaxSonar-WR will report the range to the leading edge of the closest detectable object. Target detection has been characterized in the sensor beam patterns.

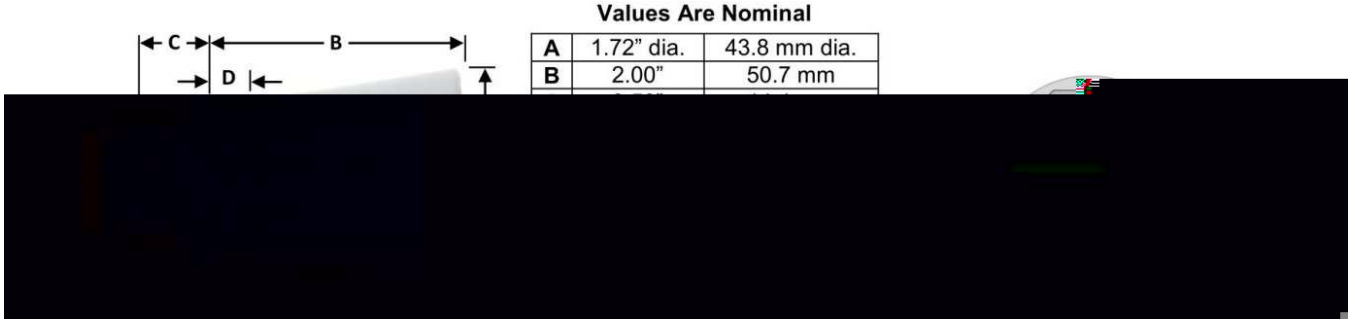



The range is measured from were the housing meets the threading.




The range is measured from were the housing meets the threading.

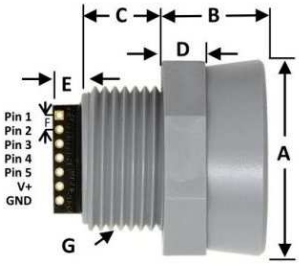
## HRXL-MaxSonar®-WR™ Mechanical Dimensions




Values Are Nominal

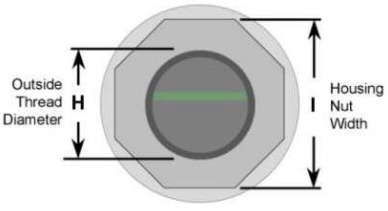
| | | |
|---|---|---|
| A | 1.72" dia. | 43.8 mm dia. |
| B | 2.00" | 50.7 mm |

## HRXL-MaxSonar®-WRC™ Mechanical Dimensions




Values Are Nominal

| | | |
|---|---|---|
| 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 National Pipe Thread Straight | |
| H | 1.032" dia. | 26.2 mm dia. |
| I | 1.37" | 34.8 mm |
| Weight, 1.23 oz., 32 grams | | |



# HRXL-MaxSonar®-WR™ Temperature Compensation

## On Board – Internal Temperature Compensation

The speed of sound in air increases by about 0.6 meters per second, per degree centigrade. Because of this, each HRXL-MaxSonar-WR 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.

## HR-MaxTemp, an External Temperature Sensor

Although the HRXL-MaxSonar-WR has an internal temperature sensor; for best accuracy, users are encouraged to use the optional external temperature sensor. On power-up, the HRXL-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 HRXL-MaxSonar-WR and the expected target.

# HRXL-MaxSonar-WR Sensor Operating Modes

## Free-Run Operation

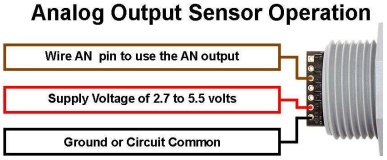
When operating in free run mode, the HRXL-MaxSonar-WR sensors are designed to be used in a variety of outdoor, industrial, or indoor situations. Many acoustic noise sources will have little to no effect on the reported range of the HRXL-MaxSonar-WR sensors. Most range readings are accurately reported. If the range readings are affected, the effect is typically less than 5-mm[1]. This allows users to employ real-time ultrasonic distance sensing without the need for additional supporting circuitry or complicated user software.

Multiple HRXL-MaxSonar-WR sensors can be operated in the same general locations. The internal noise filter is able to filter out the ultrasonic noise from other HRXL-MaxSonar-WR sensors with minimal interference. Typically, when operating with multiple sensors, the range readings will be within ±1 cm of the actual range to the intended target.

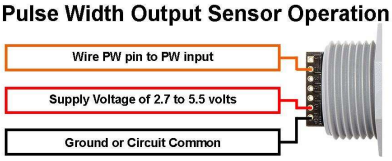
## Independent Sensor Operation

The HRXL-MaxSonar-WR sensors have the capability to operate independently when the user desires. When using the HRXL-MaxSonar-WR 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 HRXL-MaxSonar-WR 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.

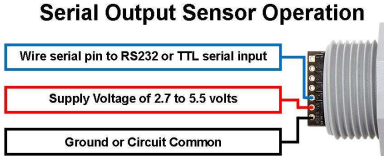
**Analog Output Sensor Operation**




**Pulse Width Output Sensor Operation**




**Serial Output Sensor Operation**




## Using Multiple Sensors in a Single System

Multiple HRXL-MaxSonar-WR sensors can be used simultaneously in the same environment with little to no interference (cross-talk). Even so, some cross-talk may still occur for users wishing to use a large number of sensors in the same environment.

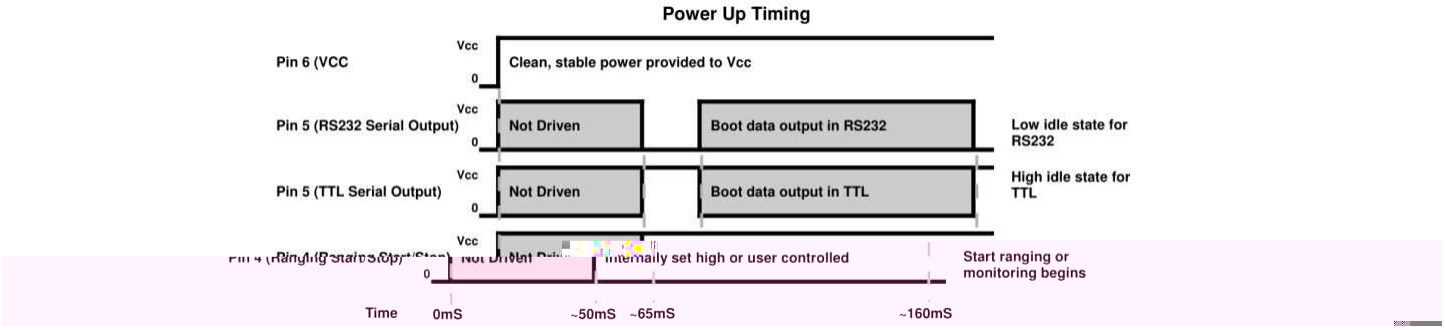
If interference is occurring in the sensor setup please visit www.maxbotix.com/chaining for diagrams on correcting cross-talk between sensors.

Please take note that when the HRXL-MaxSonar-WR sensors are operating in a chaining sequence the internal free-run filter of the sensor is disabled, and the sensor will range in real-time.

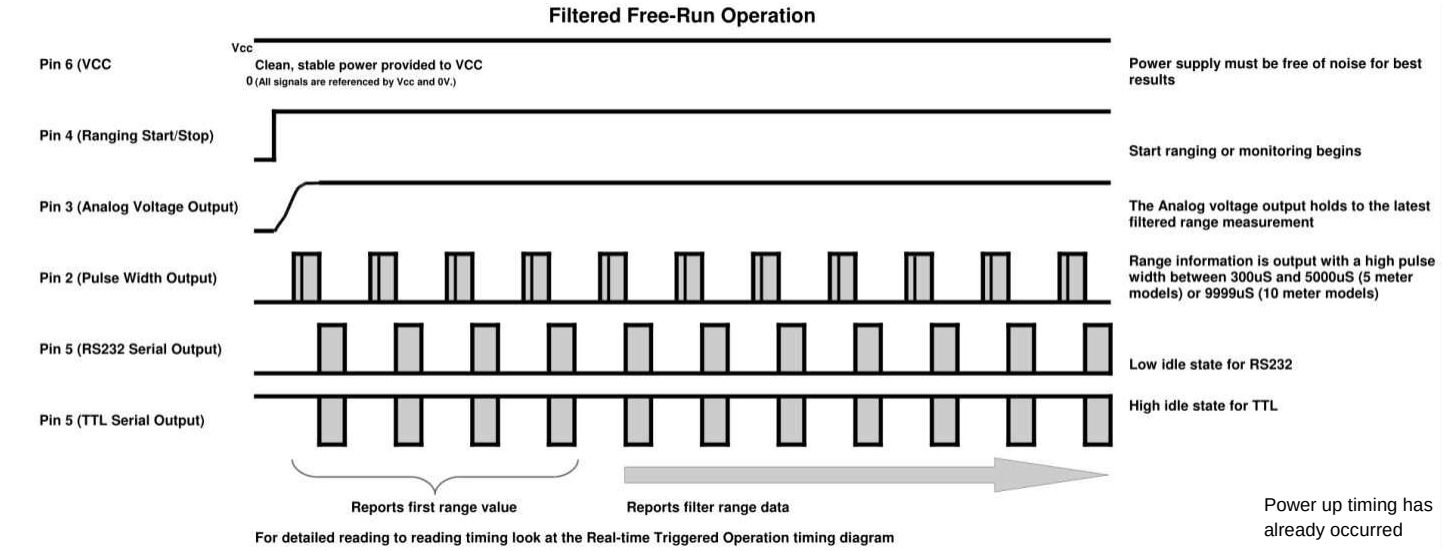
**Notes:** [1] Refer to section that compares WR to WRC on page 4

# 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 Range Cycle |
|---|---|---|---|---|---|---|
| MB7360, MB7367, MB7380, MB7387 | 7.5 Hz | 1.5Hz | ~118mS | ~123mS | ~132mS | ~133mS |
| MB7364, MB7369, MB7384, MB7389 | 6.67Hz | 1.33Hz | ~135mS | ~140mS | ~147mS | ~148mS |
| MB7363, MB7366, MB7383, MB7386 | 6Hz | 1.2Hz | ~148mS | ~158mS | ~165mS | ~166mS |

When operating in free run mode, the HRXL-MaxSonar-WR 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 HRXL-MaxSonar-WR sensors[1]. Most range readings are accurately reported[1]. If the range readings are affected, the effect is typically less than 5-mm[1]. This allows users to employ real-time ultrasonic distance sensing without the need for additional supporting circuitry or complicated user software.

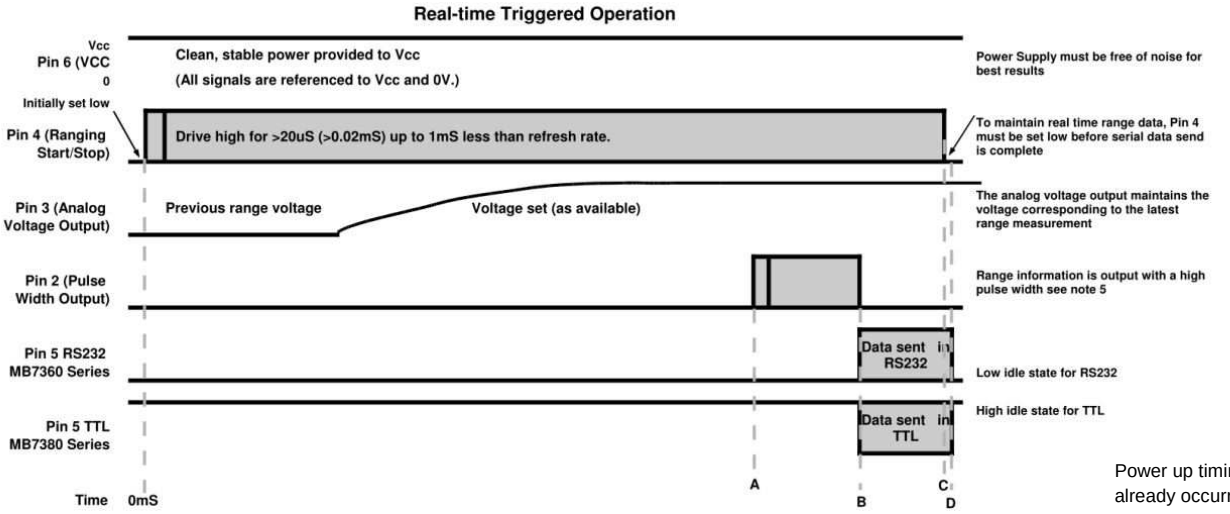
The HRXL-MaxSonar-WR use an internal filter to process range data. This filter improves the sensor's performance for accuracy, noise rejection, and reading to reading stability. The filtering in the free-run operation also permits additional acoustic and electrical noise tolerance.

On the HRXL-MaxSonar-WR 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 HRXL-MaxSonar-WR 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:** [1] Refer to section that compares WR to WRC on page 4

# Sensor Timing Diagrams Cont.

## Triggered—Real-time Operation Timing




| Product | Maximum Refresh Rate | Pulse Width sent (A) | Serial Data sent (B) | RX Pin set low (C) | End of range cycle (D) |
|---|---|---|---|---|---|
| MB7360, MB7367, MB7380, MB7387 | 7.5 Hz | ~118mS | ~123mS | ~132mS | ~133mS |
| MB7364, MB7369, MB7384, MB7389 | 6.67Hz | ~135mS | ~140mS | ~147mS | ~148mS |
| MB7363, MB7366, MB7383, MB7386 | 6Hz | ~148mS | ~158mS | ~165mS | ~166mS |

Real-time or triggered operation allows users to take advantage of a few functions unavailable during free run mode. When operating in triggered mode, an unfiltered maximum refresh rate can be achieved. This triggered operation allows users to range targets moving away from or closer to the sensor faster than 240mm per reading.

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, then Pin 4 is brought high. When Pin 4 is brought high, a brand new range cycle starts and the HRXL-MaxSonar-WR will output 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 sensor is sampling range at a time.

**Pulse Width data sent (Colum 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 (Colum 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 HRXL-MaxSonar-WR 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.

**End of Range Cycle (Colum D) -** Column D shows the approximate time each range cycle takes to complete for each sensor.

# HRXL-MaxSonar®-WR™ Beam Patterns

## Background Information Regarding our Beam Patterns

Each HRXL-MaxSonar-WR 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.

**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.

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.

# MB7360-MB7380 HRXL-MaxSonar®-WR™ Beam Pattern and Uses

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


## MB7360-MB7380
## Features and Benefits

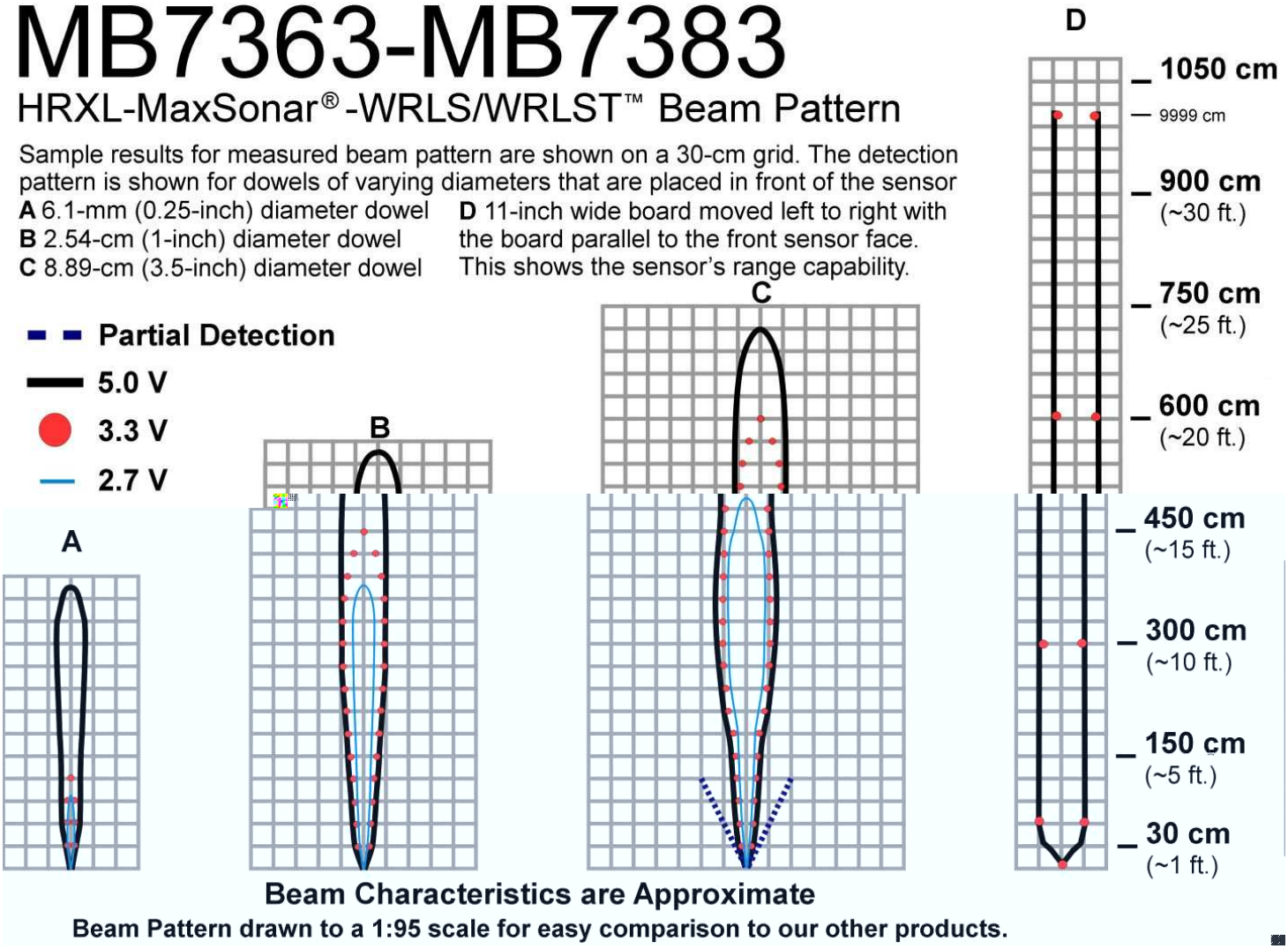
- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- High acoustic sensitivity

## MB7360-MB7380
## Applications and Uses

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

# MB7363-MB7383 HRXL-MaxSonar®-WRLS™ Beam Pattern and Uses

The HRXL-MaxSonar-WRLS sensors are 10 meter sensors with a higher sensitivity than other HRXL-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, people, and grain.




## MB7363-MB7383
## 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

## MB7363-MB7383
## Applications and Uses

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

# MB7364-MB7384 HRXL-MaxSonar®-WRS™ Beam Pattern and Uses

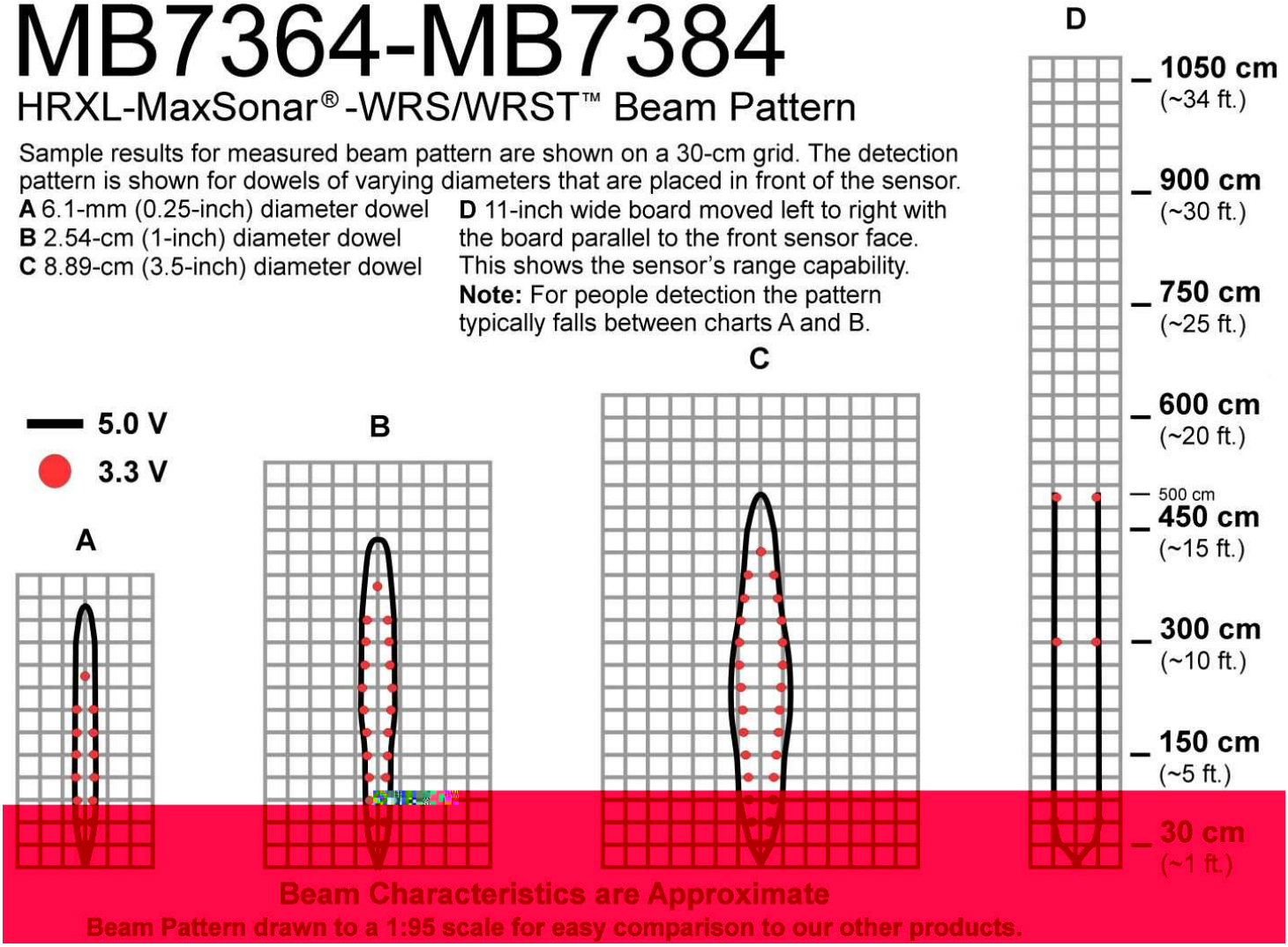
The HRXL-MaxSonar-WRS is a low-cost, rugged ultrasonic snow depth sensor that is optimized for reliable snow depth measurement. Sensor readings are optimized for snow measurement, ensuring accurate snow depth measurement

## MB7364-MB7384

### HRXL-MaxSonar® -WRS/WRST™ 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.




## MB7364-MB7384
## Features and Benefits

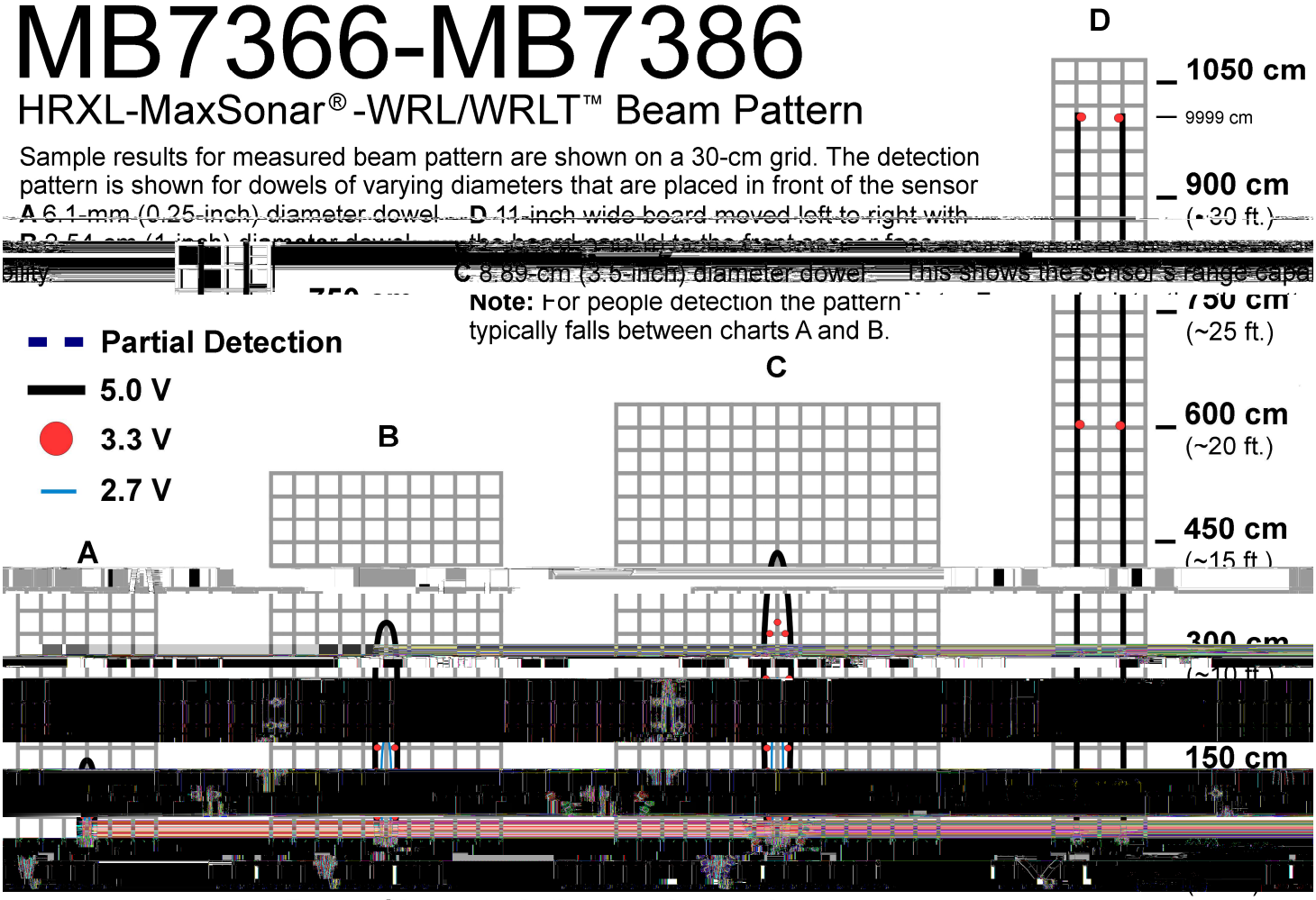
- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- High acoustic sensitivity

## MB7364-MB7384
## Applications and Uses

- Snow depth measurement
- Weather station monitoring
- Soft target detection

# MB7366-MB7386 HRXL-MaxSonar®-WRL™ Beam Pattern and Uses

The HRXL-MaxSonar-WRL sensors are a long range, 10 meter ultrasonic sensor.




**Beam Characteristics are Approximate**

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

## MB7366-MB7386 Features and Benefits

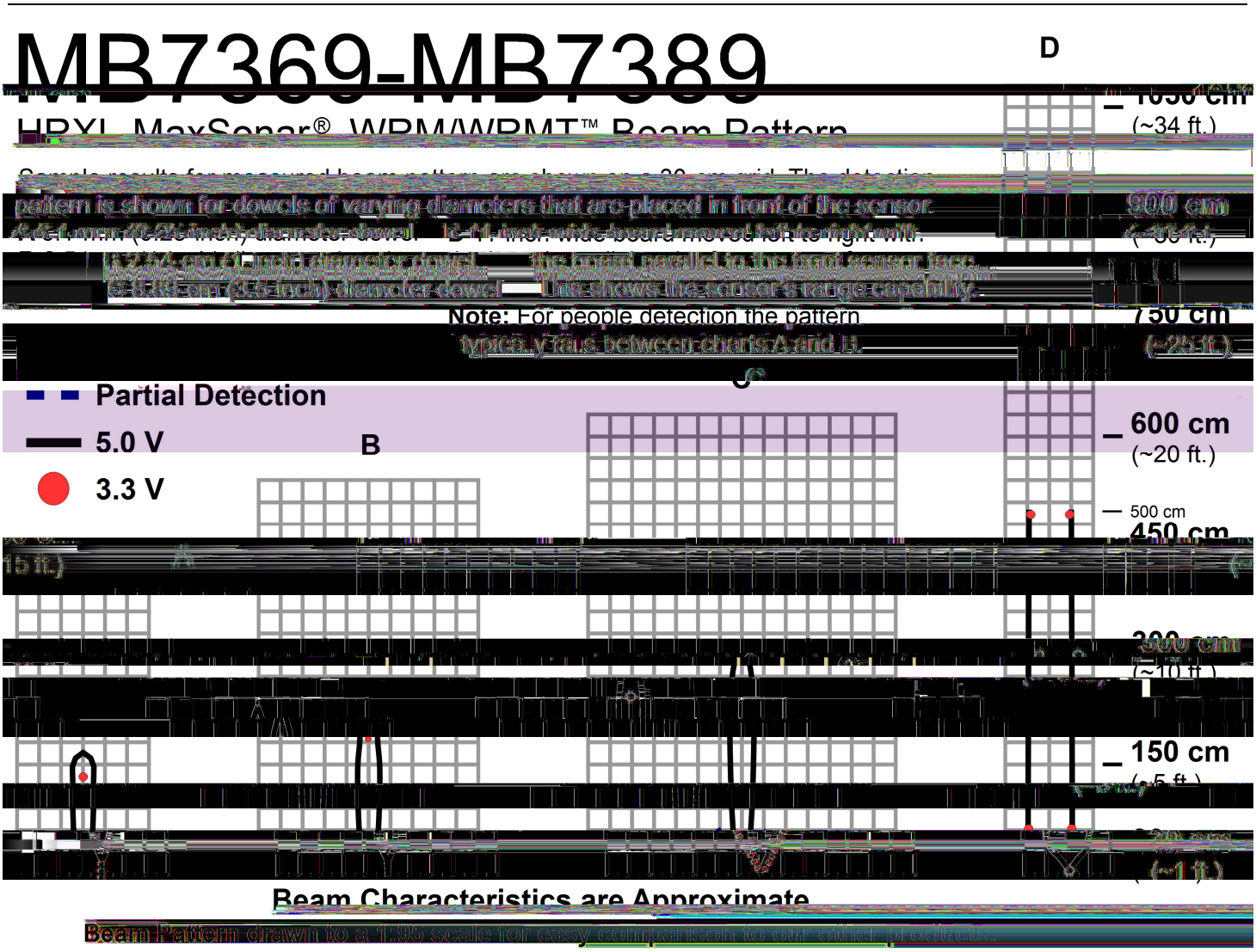
- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- 10 meter range to large targets

## MB7366-MB7386 Applications and Uses

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

# MB7369-MB7389 HRXL-MaxSonar®-WRM™ Beam Pattern and Uses

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




## MB7369-MB7389
## Features and Benefits

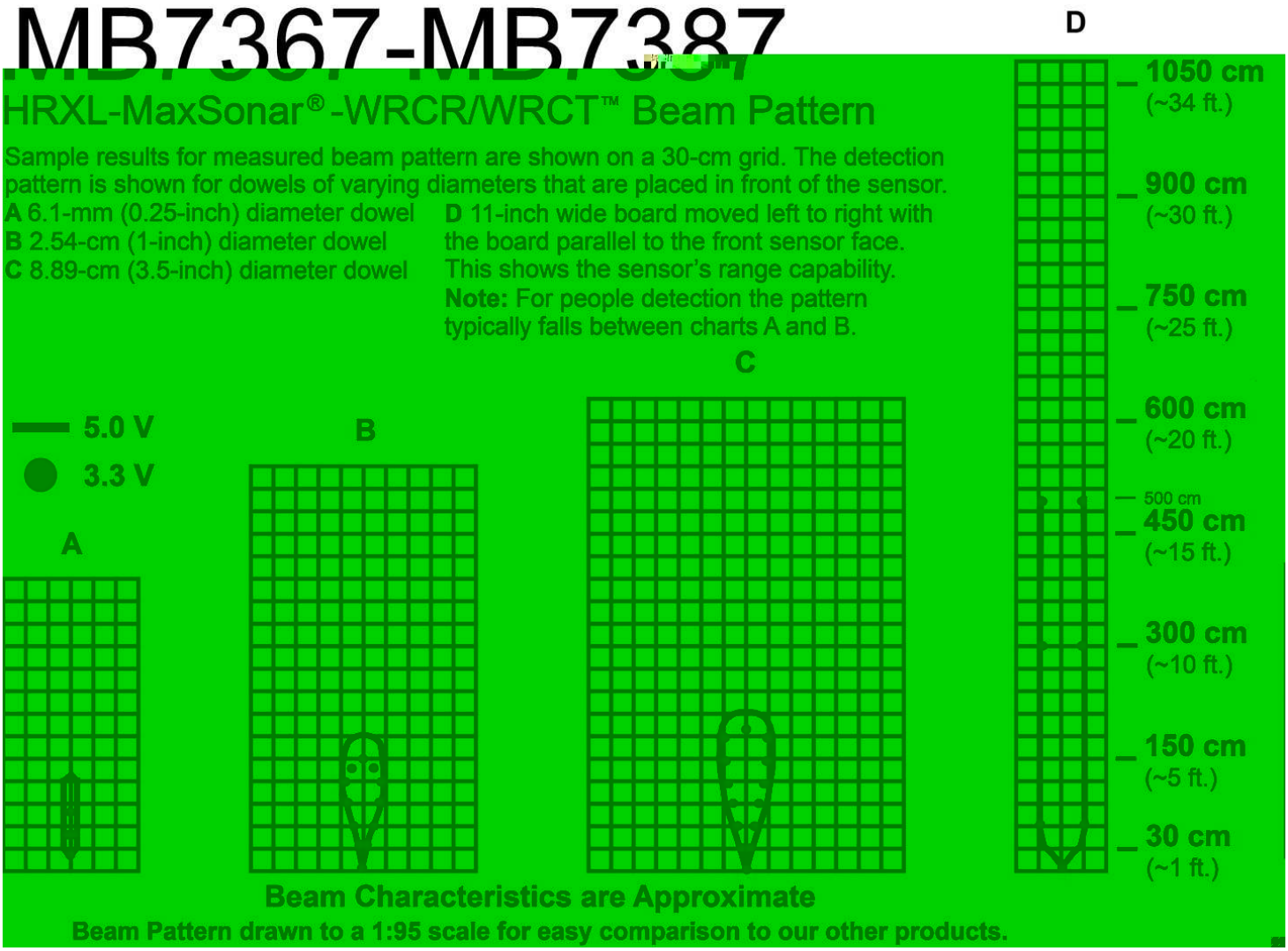
- Factory calibrated beam width
- Low operating voltages from 2.7V to 5.5V
- All range outputs are active simultaneously
- Superior clutter rejection

## MB7369-MB7389
## Applications and Uses

- Bin Level Measurement
- Tank Level Measurement

# MB7367-MB7387 HRXL-MaxSonar®-WRC/WRCT™ Beam Pattern and Uses

The HRXL-MaxSonar-WRC product line offer a more compact housing for use in applications where there are mounting or weight restrictions.




## MB7367-MB7387
## 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

## MB7367-MB7387
## Applications and Uses

- Applications with strict mounting conditions

## Have the right MaxSonar® for your application?

## Check out our MaxSonar® Product Lines

### Indoor Use

### (or protected environments)

**1 mm Resolution**
HRLV-MaxSonar-EZ

**1 in Resolution**
LV-MaxSonar-EZ
LV-ProxSonar-EZ

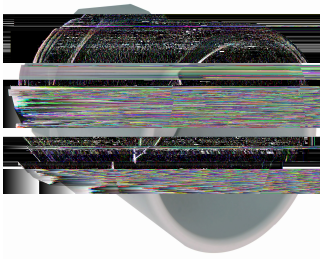
**1 cm Resolution**
XL-MaxSonar-EZ
XL-MaxSonar-AE
XL-MaxSonar-EZL
XL-MaxSonar-AEL
I2CXL-MaxSonar-EZ

**1 mm Resolution**
HRUSB-MaxSonar-EZ

**1in Resolution**
USB-ProxSonar-EZ

### Outdoor Use

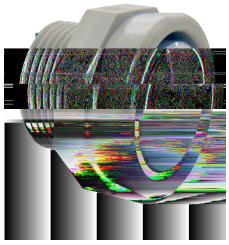
### (or rugged environments) IP67



**1 mm Resolution**
HRXL-MaxSonar-WR
HRXL-MaxSonar-WRT
HRXL-MaxSonar-WRM
HRXL-MaxSonar-WRMT
HRXL-MaxSonar-WRL
HRXL-MaxSonar-WRLT
HRXL-MaxSonar-WRLS
HRXL-MaxSonar-WRLST

**1 cm Resolution**
XL-MaxSonar-WR
XL-MaxSonar-WRL
XL-MaxSonar-WRA
XL-MaxSonar-WRLA
I2CXL-MaxSonar-WR

**F-Option** Available for all WR models. For additional protection when necessary in hazardous chemical environments.

**1 mm Resolution**
HRXL-MaxSonar-WRC
HRXL-MaxSonar-WRCT

**1 cm Resolution**
XL-MaxSonar-WRC
XL-MaxSonar-WRCA
I2CXL-MaxSonar-WRC

## Accessories-More information available online

### MB7954 - Shielded Cable

The MaxSonar Connection Wire is used to reduce interference caused by electrical noise on the lines. This cable is a great solution to use when running the sensors at a long distance or in an area with a lot of EMI and electrical noise.

### MB7950 - XL-MaxSonar-WR Mounting Hardware

The MB7950 Mounting Hardware is selected for use with our outdoor ultrasonic sensors. The mounting hardware includes a steel lock nut and two O-ring (Buna-N and Neoprene) each optimal for different applications.

### MB7955 / MB7956 / MB7957 / MB7958 / MB7959 - HR-MaxTemp

The HR-MaxTemp is an optional accessory for the HR-MaxSonar. The HR-MaxTemp connects to the HR-MaxSonar for automatic temperature compensation without self heating.

### MB7961 - Power Supply Filter

The power supply filter is recommended for applications with unclean power or electrical noise.

### MB7962 / MB7963 / MB7964 / MB7965 - Micro-B USB Connection Cable

The MB7962, MB7963, MB7964, and MB7965 Micro-B USB cables are USB2.0 compliant and backwards compatible with USB 1.0 standards. Varying lengths.