HRXL & SCXL-MaxSonar® - WRS™ Series

High Resolution, IP67 Weather Resistant, Ultrasonic Snow Depth Sensor

MB7334, MB7344, MB7354, MB7364, MB7374, MB7384[6] (HRXL-MaxSonar –WRS™ Series)
MB7534, MB7544, MB7554, MB7564, MB7574, MB7584[6] (SCXL-MaxSonar –WRS™ Series)

The HRXL & SCXL-MaxSonar-WRS sensor lines are optimized for 'soft acoustic' targets such as snow (The SCXL line includes an effective self-cleaning capability designed to reduce the impact of condensation in closed or high-moisture (dew, frost, etc.) environments). Both lines are a cost-effective solution for applications where precision range-finding, low-voltage operation, space saving and IP67 weather resistance rating is needed. This sensor component module allows users of other, more costly precision ultrasonic snow depth measurement 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. Both sensor lines provide high accuracy and high resolution ultrasonic proximity detection and ranging in air, with an IP67 weather resistant rating. They also feature 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& SCXL-MaxSonar-WRS sensors have a maximum range of 5-meters.

This ultrasonic sensor detects objects from 1-mm and ranges to objects from 50-cm to maximum range. Objects closer than 50-cm are typically reported as 50-cm. The interface output formats are pulse width, analog voltage, and digital serial in either RS232 or TTL . Factory calibration is standard.

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 first detectable object
- Excellent clutter rejection
- Additional chemical resistance available[4]
- For the SCXL line self-cleaning algorithm runs during normal operation

Range Outputs

- Pulse width, 1uS/mm resolution
- Analog Voltage, 5-mm resolution
- Serial, 1-mm resolution
- Available in RS232 or TTL

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[3]
- 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 [1,2]
- Small and easy to mount
- Calibrated sensor eliminates most sensor to sensor variations

Applications & Uses

- Weather station monitoring
- Snow level measurement (MB7354, MB7374, MB7554, MB7574)
- Bin level measurement
- Corn level measurement
- People detection
- This product is not recommended as a device for personal safety

General Characteristics

- Low cost ultrasonic rangefinder
- Detection out to 5-meters
- Resolution of 1-mm
- Distance sensor from 50-cm to 5-meters
- Excellent[1] Mean Time Between Failure (MTBF)
- Operating temperature from -40°C to +65°C [5]
- Operating voltage from 2.7V to 5.5V[5]
- IP67 Rated
- Best operated at 5V for snow applications.
- HRXL nominal current draw of 2.3mA at 3.3V, and 3.1mA at 5V
- SCXL nominal current draw of ~34mA at 3.3V, and ~68mA at 5V
- Sensor should remain on and be allowed to free run for self-clean feature to operate
- Triggered operation yields real-time range data
- Free run operation with superior noise rejection[3]

Notes:

[1] Users are encouraged to evaluate the sensor performance in their application
[2] by design
[3] See page 9 for multi-sensor operation
[4] F-Option and P-Option provide additional protection from hazardous chemical environments
[5] Please reference page 12 for minimum operating voltage

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.

About Ultrasonic Sensors

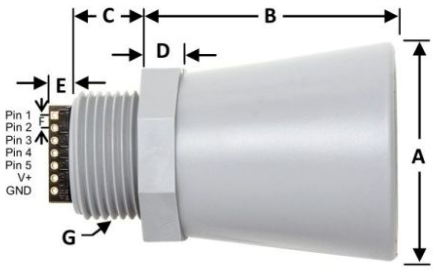
Our ultrasonic sensors are, non-contact object detection and ranging sensors that detect objects in air, within an area. These sensors are not affected by color or other visual characteristics of the detected object. Ultrasonic sensors use high frequency sound to detect and localize objects in a variety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

HRXL & SCXL-MaxSonar-WRS

The HRXL & SCXL-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 temperature sensor (HR-MaxTemp).

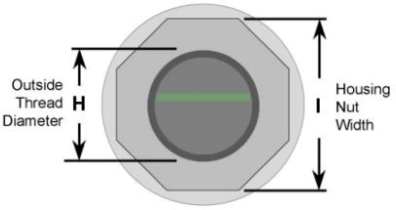
HRXL & SCXL-MaxSonar®-WRS™ Mechanical Dimensions

3/4” NPS WR Housing

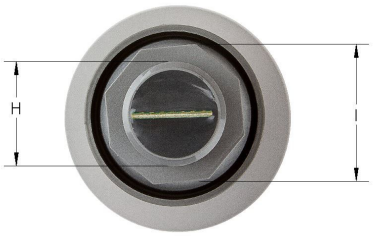


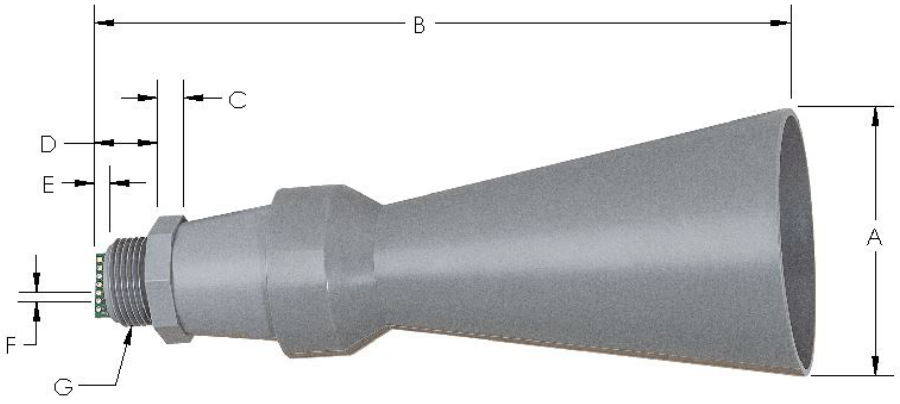
Values Are Nominal

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 National Pipe Thread Straight	
H	1.032” dia.	26.2 mm dia.
I	1.37”	34.8 mm
Weight, 1.76 oz., 50 grams		



Extended Horn





A	3.00” dia.	76.2 mm dia.
B	8.25”	209.6 mm
C	0.31”	7.9 mm
D	0.58”	14.7 mm
E	0.23”	5.8 mm
F	0.10”	2.54 mm
G	3/4”-14 NPS	
H	1.03” dia.	26.2 mm dia.
I	1.37”	34.8 mm
Weight, 150 grams		

Values Are Nominal

Package Types Currently Available
Full Horn – 3/4” NPT straight; back mounted thread
Extended Horn – 3/4” NPT straight; back mounted thread. Enhanced detection of snow.
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.

HRXL & 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 HRXL & SCXL-MaxSonar-WRS sensors 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.

Using a 10-bit analog to digital converter with the HRXL & SCXL-MaxSonar-WRS 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).

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 & SCXL-MaxSonar-WRS 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 instead allows for more consistent range information to be presented. For sensor specific timing and filter information refer to pages 10, 11, and 12.

Real-time Range Data: When pin 4 is low and then brought high, the sensor will operate in real time and the first reading output will be the range measured from this first commanded range reading. When the sensor tracks that the RX pin is low after each range reading, and then the RX pin is brought high, unfiltered real time range information can be obtained. For timing information please refer to pages 10, 11, and 12.

Pin 5-Serial Output: The MB7334, MB7354, MB7364, MB7534, MB7554 & MB7654 sensors have an RS232 data format (with 0V to Vcc levels) and the MB7344, MB7374, MB7384, MB7544, MB7574 & MB7584 sensors have a 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. A range value of 5000 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). On power up the sensor will send serial data about the sensor. View an example here.

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 HRXL-MaxSonar-WRS sensors have a nominal current draw of 2.3mA at 3.3V, and 3.1mA at 5V and the SCXL-MaxSonar-WRS self-cleaning sensors have a nominal 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 monitoring snow, powering the sensor at 5V will provide the best results. (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 13 for minimum operating voltage verses temperature information.
GND Pin 7 – Sensor ground pin: DC return, and circuit common ground.

Self-Cleaning Notes

Self-cleaning is intended for applications requiring the resistance of condensation in high moisture environment. Our self-cleaning function is designed to run continuously in order for the self-cleaning feature to be active.

WR Exposed Materials

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

While most of our housings are made of PVC, our –8xx style extended horn products are made of ABS plastic. ABS is not compatible for use with gasoline. Direct contact will cause weakening and deformation of the horns. Extended exposure to vapors rising from gasoline may also damage these ABS housings.

Additional Options for Purchase

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

F-Option

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

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

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

Shielded Cable Attach Option

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

P-Option

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

Sensor Mounting

It is recommended that cube corners be taken into account when mounting the HRXL & SCXL-MaxSonar-WRS ultrasonic snow depth sensors.

Due to the high gain of the sensor, the recommendation is to mount the senor 195cm away from any supporting mast or towers. This accounts for any joints that may be in the mast that would cause a cube corner reflection. This would also apply to any other feature in the environment that could cause a corner reflection back to the sensor.

More information on cube corner reflections can be found below:

https://maxbotix.com/blogs/basic-use/cube-corner-reflectors?_pos=1&_sid=076f6a175&_ss=r

Model Selection

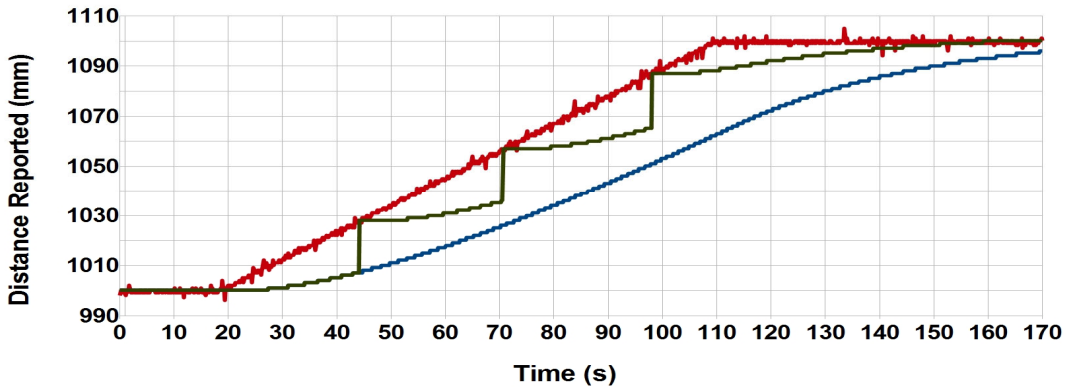
Different applications require different sensors. MaxBotix Inc., has made a variety of snow and high sensitivity sensors available in order to best fit the broad range of potential applications. Users are encouraged to consider our other HRXL & SCXL-MaxSonar-WR products for applications beyond snow.

For this product series the MB7X64 and MB7X84 constitute the base models. The MB7X64 and MB7X84 differ only in the serial output provided. The MB7364 & MB7564 have 0-Vcc RS232 serial data (inverted data that can be fed directly into a computer equipped with a DB9 port), and the MB7384 & MB7584 have TTL serial data.

The MB7354, MB7374, MB7554, & MB7574 have an additional filter on the data output for use in outdoor applications with stationary or slow moving targets. This filter has been shown to improve sensor accuracy and usability in snow depth monitoring applications and will allow the user to get consistent data even if the user only uses one reading to measure distance. In order for this filter to run the sensor must be operated in free-run mode.

The MB7334, MB7344, MB7534 & MB7544 have an additional filter similar to the MB7354, MB7374, MB7554 & MB7574 except that the filter will reset to targets that are considered valid outside of a 2% distance to target window. This makes the sensor an ideal balance for accurately monitoring slow or stationary targets that occasionally move rapidly.

Part Number	Serial Interface	Filter Reset Window	High Performance HR Filter[1]	Recommended Application	5 Meter Range
MB7334 & MB7534	RS232	2%	Yes	Water/Outdoors	Yes
MB7344 & MB7544	TTL	2%	Yes		Yes
MB7354 & MB7554	RS232	*Never*	Yes	Outdoors/Snow	Yes
MB7364 & MB7564	RS232	N/A	Yes	Any	Yes
MB7374 & MB7574	TTL	*Never*	Yes	Outdoors/Snow	Yes
MB7384 & MB7584	TTL	N/A	Yes	Any	Yes



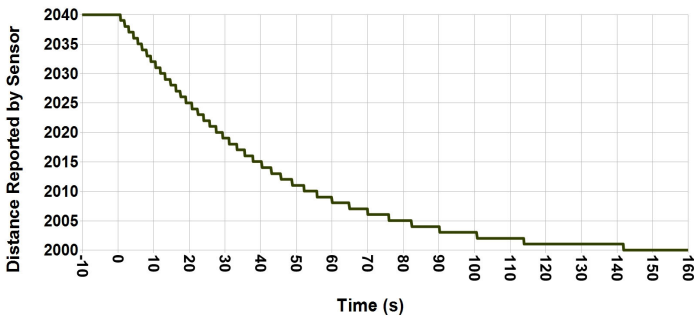
Top (red): MB7364 & MB7564 reporting a target moved from 1 meter to 1.1 meters in a linear fashion.

Middle (green): MB7334 & MB7534 responding to the same target, notice the steps when the target moves > 2%.

Bottom (blue): MB7354 & MB7554 responding to a target moved from 1 meter to 1.1 meters in a linear fashion.

Auto Calibration

Each time a HRXL & SCXL-MaxSonar-WRS 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.



The MB7334 range output when responding to a 4cm change.

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.

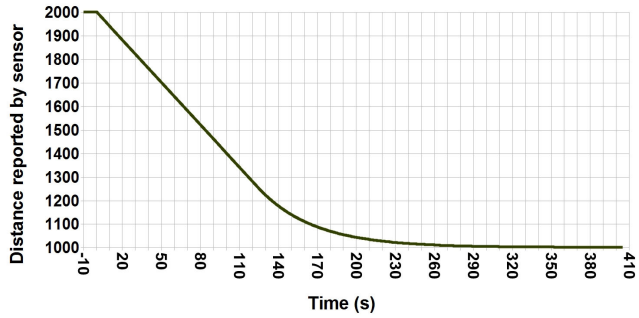
The HRXL & SCXL-MaxSonar-WRS sensor line compensates for target size differences. This means that, provided an object is large enough to be detected, the sensor will report the same distance, typically within 1%, regardless of target size. Smaller targets can have additional detection noise that may 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.

Sensor operation from 30-cm to 50-cm

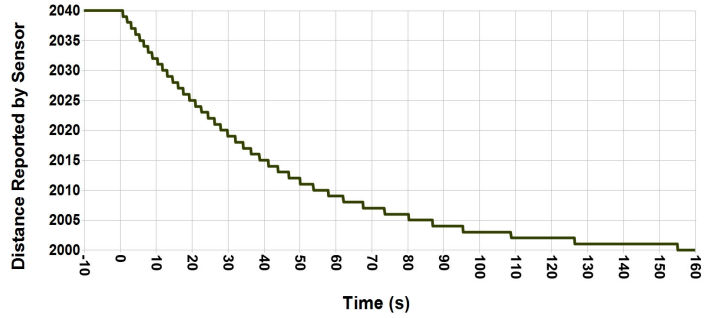
Because of acoustic effects in the near field, objects between 30-cm and 50-cm may experience acoustic phase cancellation of the returning wave, resulting in inaccuracies of up to 5-mm. These effects become less prevalent as the target distance increases, and have not been observed past 50-cm. For this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

MB7334, MB7344, MB7534, MB7544 Filter – 2% distance to target filter

The MB7334, MB7344, MB7534 & MB7544 have a 2% distance to target filter designed to provide more accurate information in real-world environments. This filter improves sensor accuracy and stability by reducing the influence of wind, acoustic noise, thermal pockets, and other effects on the sensor output. (This is in addition to the HR filtering already available on the MB7364, MB7384, MB7564 & MB7584)



MB7354 responding to a 1 meter change. This shows the 7-mm rate limit along with the exponential filter.



MB7354 responding to a 4 centimeter change. This shows the 7-mm rate limit along with the exponential filter.

This filter can be reset at any time by bringing pin 4 (RX) of the sensor low.

This filter is active whenever the RX pin is brought high, all readings within a 2% distance to target window, are collected and added to the output sent to the user using a recent biased exponential weighted average.

Confirmed readings outside of the 2% distance to target window will cause the filter to reset. This allows the sensor to continue functioning in a reasonable manner where high accuracy measurements are required for most of the sensor operation and quick sensor response is required at other points of operation.

MB7354, MB7374, MB7554, MB7574 Filter

The MB7354, MB7374, MB7554 & MB7574 have a filter that improves sensor accuracy and stability by reducing the influence of wind, acoustic noise, thermal pockets and other effects on the sensor output. (This is in addition to the HR filtering already available on the MB7364, MB7384, MB7564 & MB7584.)

This filter can be reset at any time by bringing pin 4 (RX) of the sensor low.

This filter will initialize 40 readings (about 7 seconds) after sensor power is applied, or after the RX pin is brought high and held high.

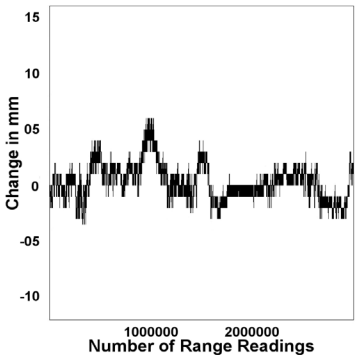
This filter is a recent biased exponential weighted average filter that is also rate limited to change a maximum of seven mm per second taken and is designed to monitor stable, or slow moving objects, if a filter update is required this can be accomplished with the RX pin.

Sensor Performance Information

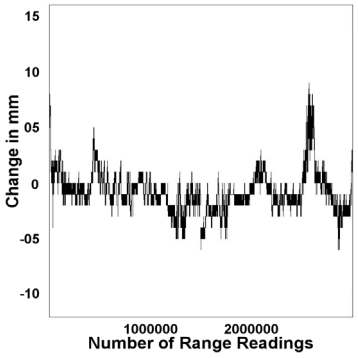
Accuracy Information

Best accuracy during snow measurements is achieved when the air temperature is accurately measured midway between the sensor and the ground. To this end MaxBotix Inc., has tested our snow sensor solution using the internal temperature sensor, external temperature sensor and the external temperature sensor mounted in special Louvre housing with a fan.

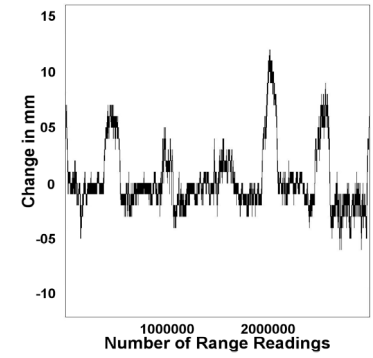
Three million readings in each test configuration were then recorded over five days at our outside our facility with typical temperature swings of 15C per day and the MB7354 & MB7554 ranging to a stable target. All of the readings fell within the 1% tolerance in our test setup. The external temperature sensor, mounted with the special shield and fan provided better performance.



MB7354 with external temperature sensor and circulation fan

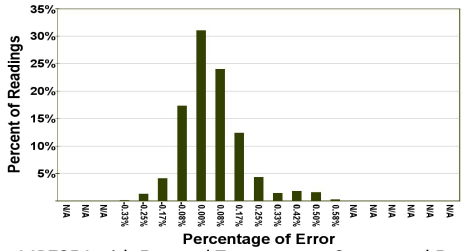


MB7354 with external temperature sensor and no circulation fan

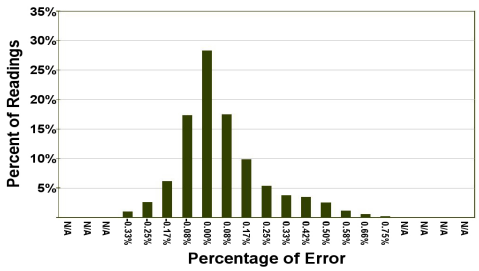


MB7354 without external temperature sensor

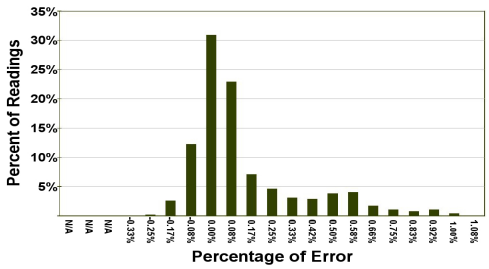
Below is a histogram, by quantity, of each reading observed.



MB7354 with External Temperature Sensor and Fan



MB7354 with External Temperature Sensor



MB7354 without External Temperature Sensor

Sensor Performance Information

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Supply Voltage Compensation

During power up, the HRXL & SCXL-MaxSonar-WRS sensors 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.

Sensor minimum distance

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

Range “0” location

The HRXL & SCXL-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.

The range is measured from were the housing meets the threading

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

In general, the HRXL & SCXL-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.

HRXL & SCXL-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 & SCXL-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.

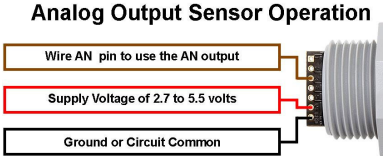
For SCXL sensors, operating the sensor using the internal temperature sensor will result in range readings being increased by approximately 1% . This is because the self-cleaning function does result in a slight temperature increase of the sensor.

HR-MaxTemp, an External Temperature Sensor

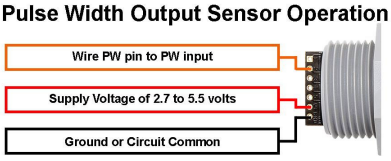
Although the HRXL & SCXL-MaxSonar-WR has an internal temperature sensor; for best accuracy, users are encouraged to use the optional external temperature sensor. On power-up, the HRXL & SCXL-MaxSonar-WR will automatically detect an attached HR-MaxTemp temperature sensor and begin to apply temperature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

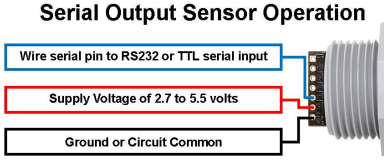
Analog Output Sensor Operation



Pulse Width Output Sensor Operation



Serial Output Sensor Operation



HRXL & SCXL-MaxSonar-WRS Sensor Operating Modes

Independent Sensor Operation

The HRXL & SCXL-MaxSonar-WRS sensors have the capability to operate independently when the user desires. When using the HRXL & SCXL-MaxSonar-WRS 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 & SCXL-MaxSonar-WRS sensors have three separate outputs that update the range data simultaneously: Analog Voltage, Pulse Width, and Serial Data. Above are diagrams on how to connect the sensor for each of the three outputs for single or independent sensor operation.

For the SCXL self-cleaning feature to work, the sensor must remain on, and continue normal ranging operation.

Using Multiple HRXL Sensors in a Single System

Multiple HRXL-MaxSonar-WRS 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-WRS 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

Using Multiple SCXL Sensors in a Single System

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):

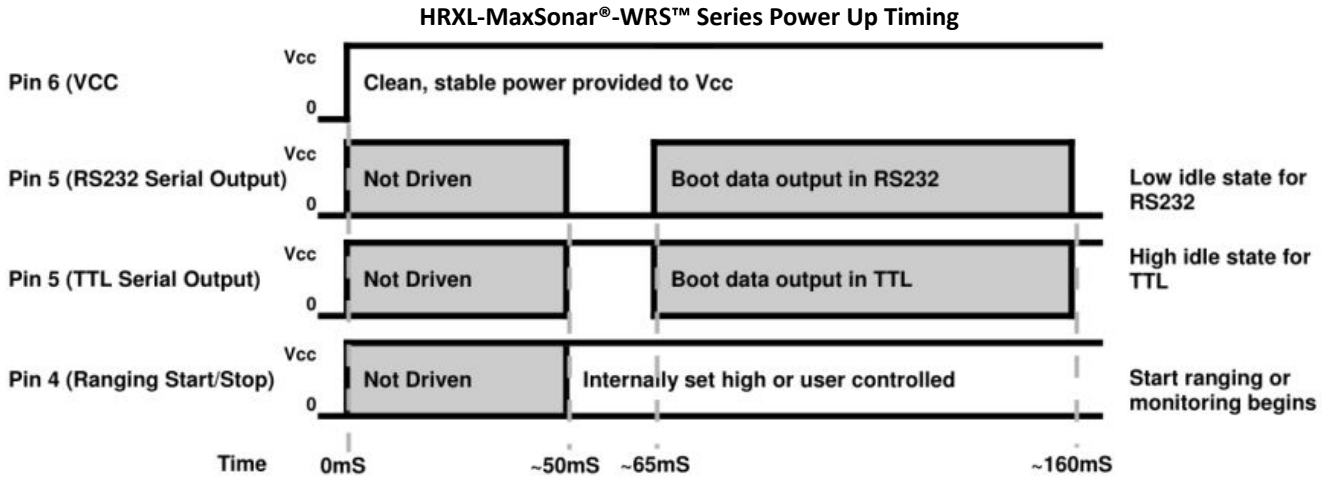
a. Run all sensors continually when condensation is expected.

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.)

Sensor Timing Diagrams

Power Up Timing



The SCXL series will take 2 range readings immediately after power up before the first self-cleaning cycle as shown above

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.

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.

Sensor Free-Run Operation

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

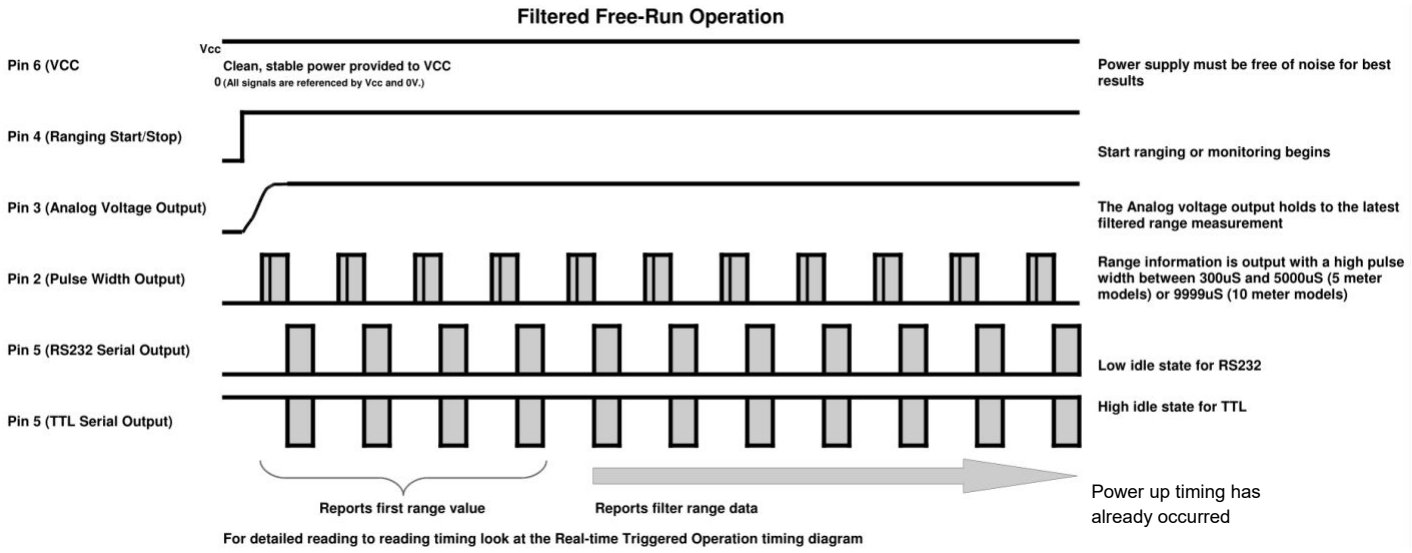
Multiple HRXL-MaxSonar-WRS sensors can be operated in the same general locations. The internal noise filter is able to filter out the ultrasonic noise from other HRXL-MaxSonar-WRS sensors with minimal interference. Typically, when operating with multiple sensors, the range readings will be within ±1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

Sensor Free-Run Timing

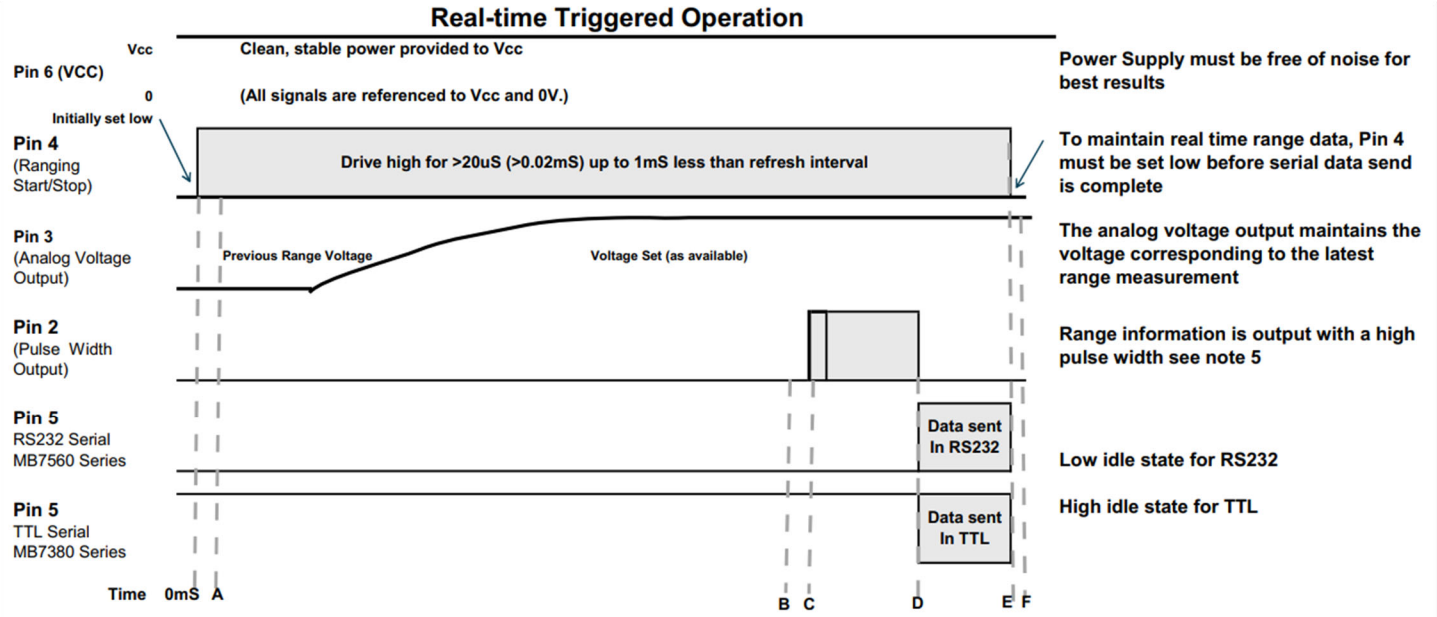
The HRXL & SCXL-MaxSonar-WRS use an internal filter to process range data. This filter improves the sensor's performance for accuracy, noise rejection, and reading to reading stability. The filtering in the free-run operation also permits additional acoustic and electrical noise tolerance.

On the HRXL & SCXL-MaxSonar-WRS 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 & SCXL-MaxSonar-WRS 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.

Product	Maximum Refresh Rate	Free Run Filter	Pulse Width Reported	Serial Data Reported	Pin 4 Brought Low	End of Range Cycle
MB7334, MB7344, MB7354, MB7364, MB7374, MB7384	6.67Hz	1.33Hz	~135mS	~140mS	~147mS	~148mS
MB7534, MB7544, MB7554, MB7564, MB7574, MB7584	0.54Hz	0.11Hz	~1812mS	~1818mS	~1824mS	~1838mS



Sensor Timing Diagrams Cont.
Triggered—Real-time Operation Timing



Product	Maximum Refresh Rate	Begin Self Cleaning Cycle (A)	End of Self Cleaning Cycle (B)	Pulse Width sent (C)	Serial Data sent (D)	RX Pin set low (E)	End of range cycle (F)
MB7334, MB7344, MB7354, MB7364, MB7374, MB7384	6.67Hz	NA	NA	~135mS	~140mS	~147mS	~148mS
MB7534, MB7544, MB7554, MB7564, MB7574, MB7584	0.582 Hz	~0mS	~1620mS	~1812mS	~1818mS	~1824mS	~1838mS

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 & SCXL-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.

Beginning of Self Cleaning Cycle (Column A) - Column A shows the approximate time when the sensor will begin its self cleaning cycle. This does not apply to HRXL-MaxSonar-WR.

End of Self Cleaning Cycle (Column B) - Column B shows the approximate time the self cleaning cycle will end. After this the sensor will begin a range cycle. This does not apply to HRXL-MaxSonar-WR.

Pulse Width data sent (Column C) - Column C 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.

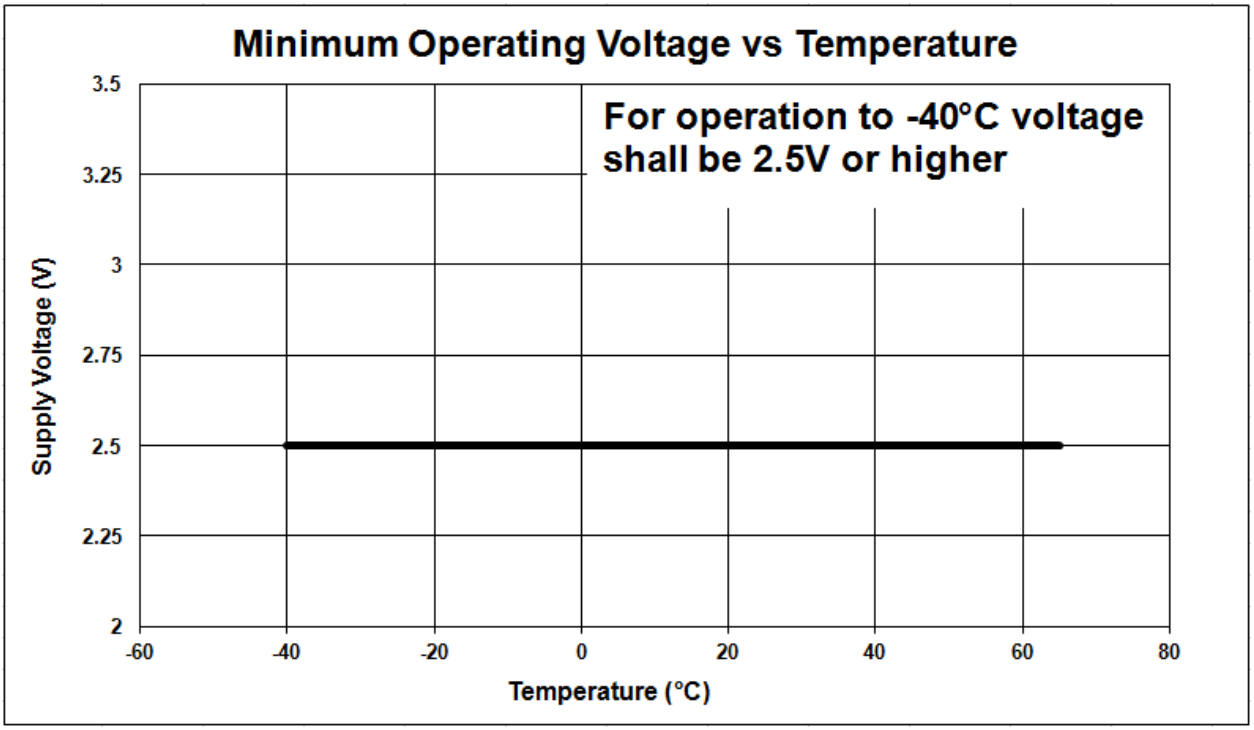
Serial data sent (Column D) - Column D shows the approximate time during each range cycle when the serial data is output for the sensor. Range data takes ~8mS to be reported from the serial data output.

RX Pin set low (Column E) - When operating the HRXL & SCXL-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 E in the chart above. If Pin 4 remains high for a period of time greater than the value in Column E, the sensor will switch into free-run filter operation.

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

Voltage vs Temperature

The graph below shows minimum operating voltage of the sensor verses temperature.



HRXL & SCXL-MaxSonar®-WR™ Beam Patterns

Attenuation of Ultrasound

Attenuation, specifically absorption of sound through the air, restricts the maximum range of ultrasonic rangefinders. As sound waves travel through the air, that air absorbs some of their energy. High frequency sounds like ultrasound are often attenuated more quickly than lower frequency sounds. In addition to frequency, relative humidity also affect attenuation. Warm air masses with low relative humidity will typically attenuate sound waves faster. As such performance of ultrasonic devices may be limited at low relative humidity, especially when trying to detect targets at longer ranges.

Background Information Regarding our Beam Patterns

Each HRXL & SCXL-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.

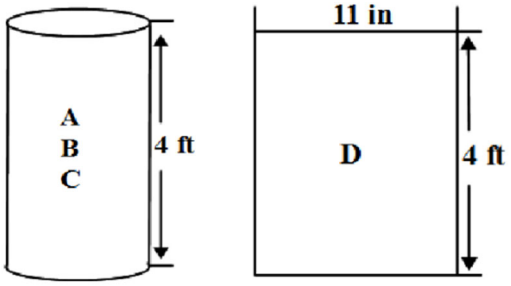
Each beam pattern is a 2D representation of the detection area of the sensor. The beam pattern is actually shaped like a 3D cone (having the same pattern both vertically and horizontally). Beam patterns for dowels are used to show the beam pattern of each sensor. Dowels are long cylindrical targets of 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.

Beam Pattern Target Shapes

A 6.1-mm (0.25-inch) diameter dowel 4ft length
B 2.54-cm (1-inch) diameter dowel 4ft length
C 8.89-cm (3.5-inch) diameter dowel 4ft length
D 11-inch wide board 4ft in length moved left to right with the board parallel to the front sensor face. This shows the sensor's range capability.



Corner Reflectors

Sometimes when using an ultrasonic sensor, users experience detection of unwanted objects that appear outside the expected beam pattern. These types of detections are the result of reflectors present in the environment. Corner reflectors can be surprisingly small, yet present a large reflection back to the sensor. Certain objects are prone to causing corner reflections. One of the most common corner reflectors is two flat surfaces joining together to create a 90° angle. A half-circle also acts as a similar reflector. You can learn more about corner reflectors in our Cube Corner Reflectors article.

HRXL & SCXL-MaxSonar®-WRS™ Beam Pattern and Uses

The HRXL & SCXL-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

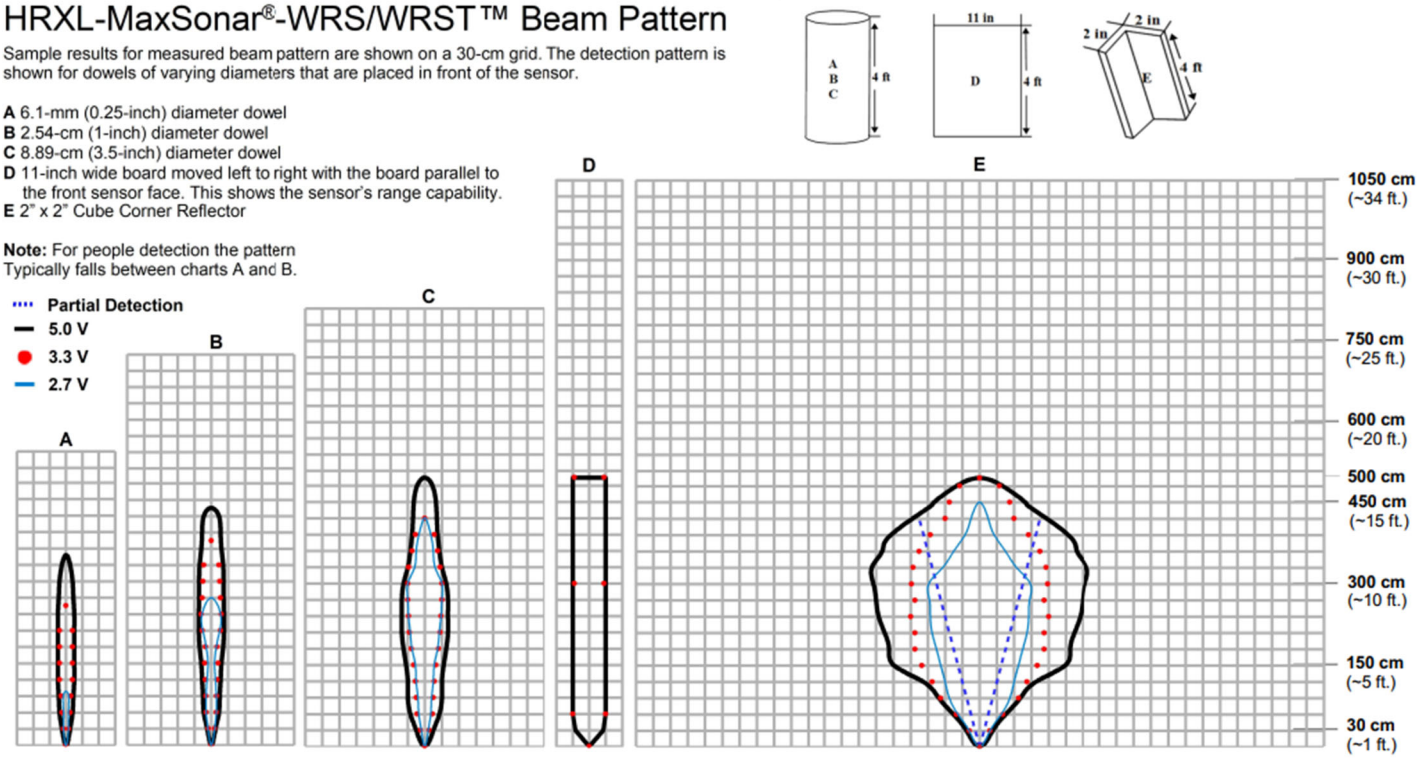
MB7X34-1XX, MB7X44-1XX, MB7X54-1XX, MB7X64-1XX, MB7X74-1XX, MB7X84-1XX

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.
E 2" x 2" Cube Corner Reflector

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



Beam Characteristics are Approximate

MaxBotix® Inc. For more information or latest product datasheets visit: www.maxbotix.com

Features and Benefits

- Factory calibrated beam width
- All range outputs are active simultaneously
- High acoustic sensitivity

Applications and Uses

- Snow depth measurement
- Weather station monitoring
- Soft target detection
- Water
- Outdoors applications

HRXL & SCXL-MaxSonar®-WRS™ Beam Pattern and Uses

The HRXL &SCXL-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

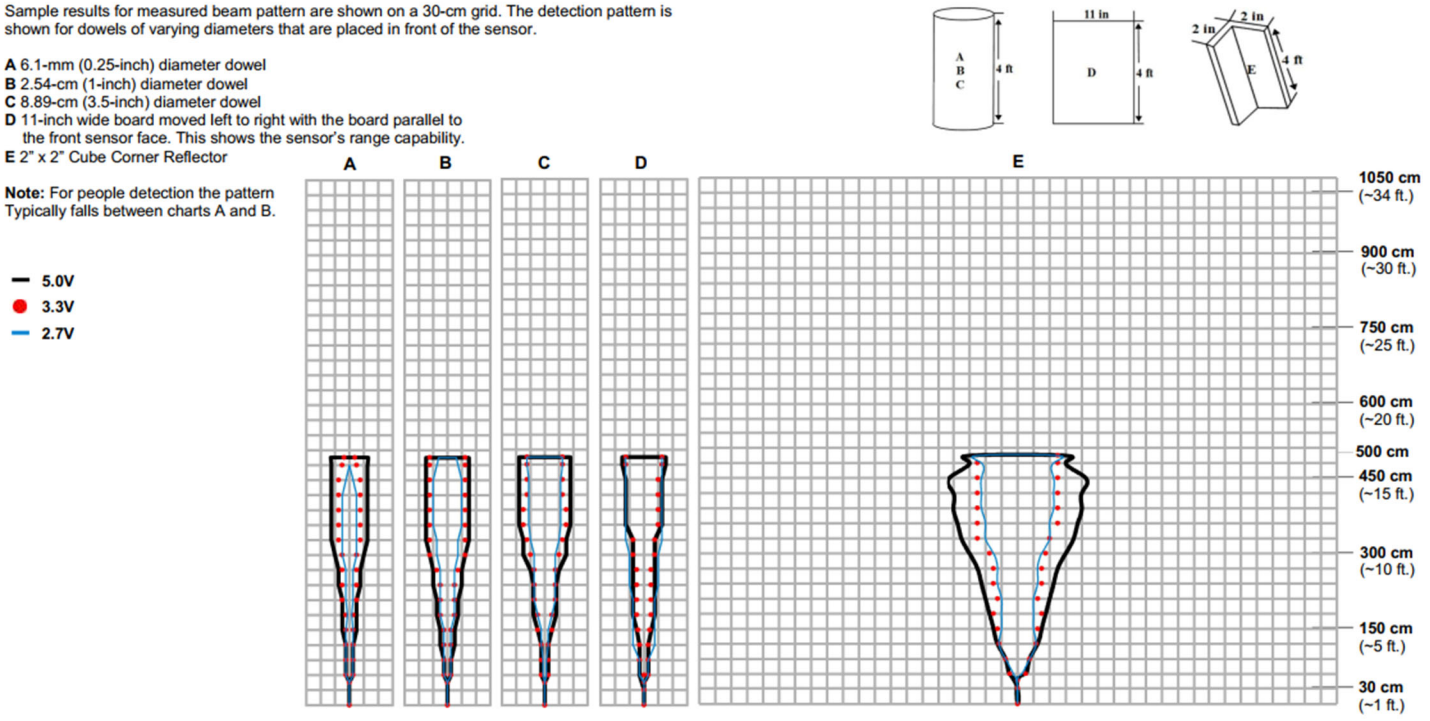
MB7X34-8XX, MBX344-8XX, MB7X54-8XX, MB7X64-8XX, MB7X74-8XX, MB7X84-8XX

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.
E 2" x 2" Cube Corner Reflector

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



Beam Characteristics are Approximate

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Features and Benefits

- Factory calibrated beam width
- All range outputs are active simultaneously
- High acoustic sensitivity

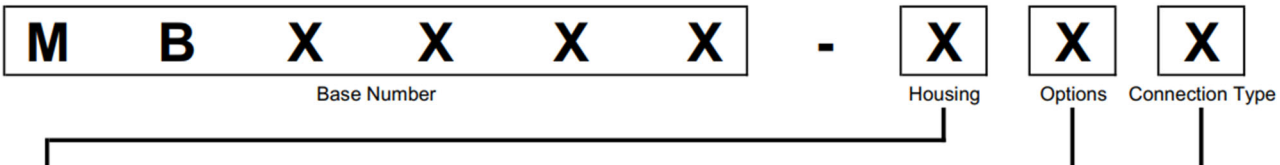
Applications and Uses

- Snow depth measurement
- Weather station monitoring
- Soft target detection
- Water
- Outdoors applications

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 17.



0	Not Applicable
1	3/4" NPS WR (Standard)
2	3/4" NPS WRC (Compact)
3	Ultra Compact
4	Ultra Compact Flush Mount
5	1" NPS
6	1" BSPP
7	30MM 1.5
8	Extended Horn
A	MB7974 Snap On Horn
B	90 Degree Horn
C	Infrared/Ultrasonic High Sensitivity Horn

0	No Options (Bagged)
1	F-Option
2	P-Option
3	F-Option and P-Option
4	No Options (Trayed)
5	TTL (Bagged)
6	TTL (Trayed)

0	No Options
1	7 Strand Wire Attached (MB7984) – 3ft Length
2	90 Degree 7 Pin Header
3	Straight 7 Pin Header
4	7 Pin Molex Connector
5	8 Pin M12 Connector with Cable – 3ft Length
6	7 Pin Screw Block Terminal
7	Radio Bridge Connector with Cable (MB7985) – 5ft Length
8	Custom Connector without Cable
9	Custom Connector with Cable
A	7 Strand Wire Attached (MB7984) – Custom Length
B	USB Connector with Cable (Style A) – 5M Length
C	USB Connector with Cable (Style C) – 5M Length
D	USB Connector with Cable (Style A) – 10M Length
E	USB Connector with Cable (Style C) – 10M Length
F	8 Pin M12 Connector with Cable - Custom Length
G	90 Degree Pin Connector (7 Pin) Attached

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

Active Part Numbers for MB7334 & MB7534							
MB7X34-100	MB7X34-101	MB7X34-110	MB7X34-111	MB7X34-120	MB7X34-121	MB7X34-130	MB7X34-131
MB7X34-800	MB7X34-801	MB7X34-810	MB7X34-811	MB7X34-820	MB7X34-821	MB7X34-830	MB7X34-831

Active Part Numbers for MB7344 & MB7544							
MB7X44-100	MB7X44-101	MB7X44-110	MB7X44-111	MB7X44-120	MB7X44-121	MB7X44-130	MB7X44-131
MB7X44-800	MB7X44-801	MB7X44-810	MB7X44-811	MB7X44-820	MB7X44-821	MB7X44-830	MB7X44-831

Active Part Numbers for MB7354 & MB7554							
MB7X54-100	MB7X54-101	MB7X54-110	MB7X54-111	MB7X54-120	MB7X54-121	MB7X54-130	MB7X54-131
MB7X54-800	MB7X54-801	MB7X54-810	MB7X54-811	MB7X54-820	MB7X54-821	MB7X54-830	MB7X54-831

Active Part Numbers for MB7364 & MB7564							
MB7X64-100	MB7X64-101	MB7X64-110	MB7X64-111	MB7X64-120	MB7X64-121	MB7X64-130	MB7X64-131
MB7X64-800	MB7X64-801	MB7X64-810	MB7X64-811	MB7X64-820	MB7X64-821	MB7X64-830	MB7X64-831

Active Part Numbers for MB7374 & MB7574							
MB7X74-100	MB7X74-101	MB7X74-110	MB7X74-111	MB7X74-120	MB7X74-121	MB7X74-130	MB7X74-131
MB7X74-800	MB7X74-801	MB7X74-810	MB7X74-811	MB7X74-820	MB7X74-821	MB7X74-830	MB7X74-831

Active Part Numbers for MB7384 & MB7584							
MB7X84-100	MB7X84-101	MB7X84-110	MB7X84-111	MB7X84-120	MB7X84-121	MB7X84-130	MB7X84-131
MB7X84-800	MB7X84-801	MB7X84-810	MB7X84-811	MB7X84-820	MB7X84-821	MB7X84-830	MB7X84-831

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 sensors@maxbotix.com or call +1-218-454-0766.

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