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SCXL-MaxSonar®- WRS™ Series

Self-Cleaning, High Resolution, IP67 Weather Resistant Ultrasonic Snow Depth Sensor

MB7534, MB7544, MB7554, MB7564, MB7574, MB7584[5]

The SCXL-MaxSonar-WRS sensor line is optimized for 'soft acoustic' targets such as snow and includes an effective self-cleaning capability designed to reduce the impact of condensation in closed or high-moisture (dew, frost, etc.) environments providing high accuracy and high resolution ultrasonic proximity detection and ranging in air, with an IP67 weather resistant rating. This sensor line features 1-mm resolution, target-size and operating-voltage compensation for improved accuracy, superior rejection of outside noise sources, internal speed of sound temperature compensation and optional external speed-of-sound temperature compensation. The SCXL MaxSonar-WRS self-cleaning sensors have a maximum range of 5-meters. This ultrasonic sensor 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

- Self-cleaning algorithm runs during normal operation
- 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
- Determines range to first detectable object
- Internal temperature compensation is standard & optional external temperature compensation
- Excellent clutter rejection
- Additional chemical resistance available[3]

Range Outputs

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

Easy to use Component Module

- 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

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 range from -40°C to +65°C [4]
- Operating voltage from 2.7V to 5.5V [4]
- IP67 Rated
- Best operated at 5V for snow applications
- 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

Applications & Uses

- Weather station monitoring
- Snow level measurement (MB7554, MB7574)
- Bin level measurement
- Corn level measurement
- People detection

Notes:

[1] Users are encouraged to evaluate the sensor performance in their application
[2] by design
[3] F-Option provides additional protection from hazardous chemical environments
[4] Please reference page 3 for minimum operating voltage verses temperature information
[5] Please reference page 16 for part number key.

Close Range Operation

Applications requiring 100% reading-to-reading reliability should not use MaxSonar sensors at a distance closer than 50cm. Although most users find MaxSonar sensors to work reliably from 0 to 50cm for detecting objects in many applications, MaxBotix® Inc. does not guarantee operational reliability for objects closer than the minimum reported distance. Because of ultrasonic physics, these sensors are unable to achieve 100% reliability at close distances.

Warning: Personal Safety Applications

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

SCXL-MaxSonar-WR Pin Out

Pin 1- Temperature Sensor Connection: Leave this pin unconnected if an external temperature sensor is not used. For best accuracy, this pin is optionally connected to the HR-MaxTemp temperature sensor. Some additional information for the temperature sensor can be found on page 8 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 SCXL-MaxSonar-WRS self-cleaning 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 SCXL-MaxSonar-WRS self-cleaning 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 SCXL-MaxSonar-WRS self-cleaning sensors will stop ranging. Bring high for 20uS or longer to command a range reading.

Pin 5-Serial Output: The MB7534, MB7554, and MB7564 sensors have an RS232 data format (with 0V to Vcc levels) and the MB7544, MB7574, and 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).

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

V+ Pin 6 - Positive Power, Vcc: The sensor operates on voltages from 2.7V - 5.5V DC. The SCXL-MaxSonar-WRS self-cleaning sensors have a current draw of ~34mA at 3.3V and ~68mA at 5V. For best operation, the sensor requires that the DC power be free from electrical noise. (For installations with known dirty electrical power, a 100uF capacitor placed at the sensor pins between V+ and GND will typically correct the electrical noise.) Please reference page 3 for minimum operating voltage verses temperature information.

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

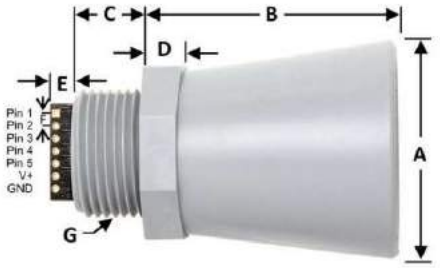
About Ultrasonic Sensors

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

SCXL-MaxSonar-WRS

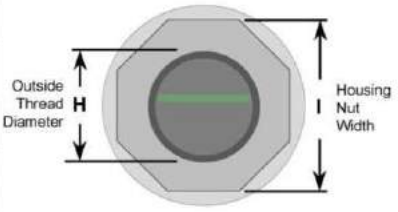
The SCXL-MaxSonar-WRS self-cleaning sensor is a low-cost, rugged ultrasonic snow depth sensor that is optimized for reliable snow depth measurement. Internally, multiple sensor readings are analyzed using algorithms optimized for snow measurement, ensuring accurate snow depth measurements. The sensor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

SCXL-MaxSonar-WRS Mechanical Dimensions



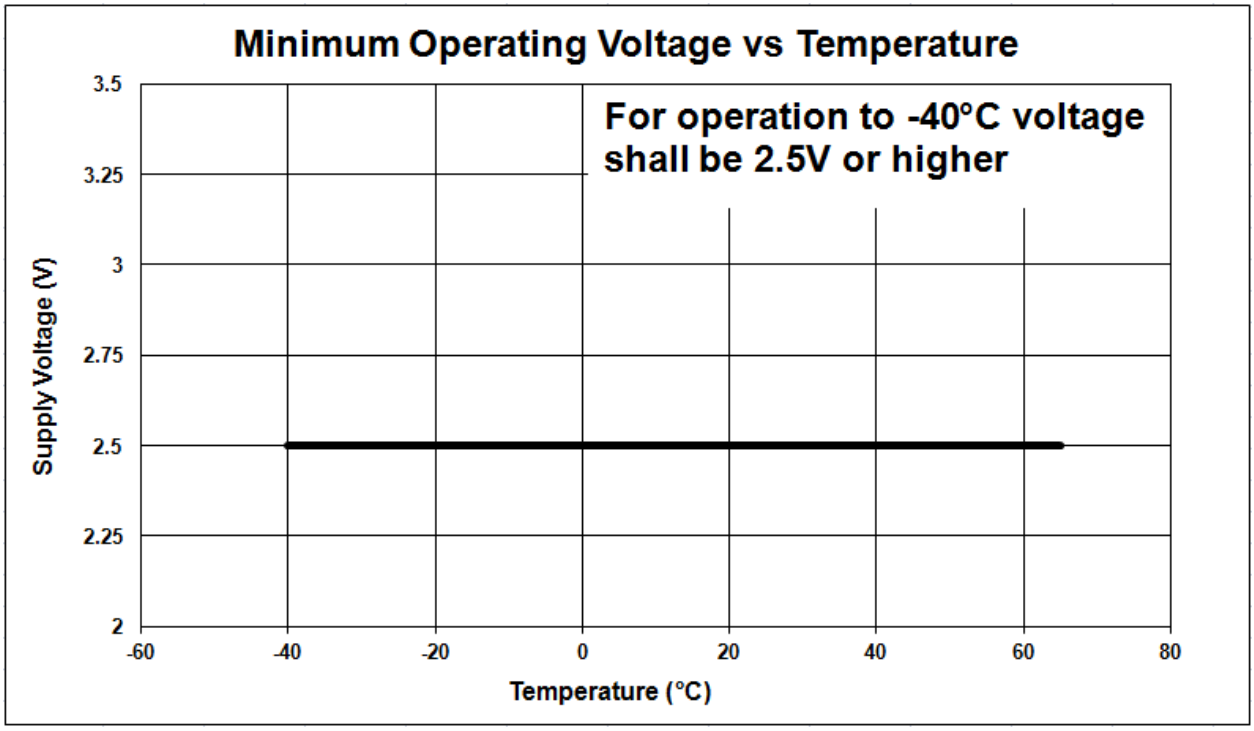
Values Are Nominal

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		



Voltage vs Temperature

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



Self-Cleaning Description

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

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

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

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

Single-sensor operation

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

Multiple-sensor operation

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

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

1.) (Note: this low-power strategy maximizes sensor availability while allowing self-cleaning cycle to run – for lower-moisture environments, or where maximum data is needed):

a. Run each sensor for seven (7) seconds in sequence. Take a range reading from each sensor sequentially.

2.) (Note: This strategy is designed for high-moisture environments, saves battery when condensation is not expected. For example, during the portion of the night when the temperature is dropping):

a. Run all sensors continually when condensation is expected.

b. Only run a sensor when range information is needed. At this time, shut down (by holding the RX pin LOW) all the other sensors and cycle the desired sensor for seven (7) seconds.

c. Timing of sensor cycles should be based on other data (i.e. time of day/year, temperature, etc.)

3.) (Note: This strategy maximizes self-cleaning cycles over time - for high-moisture environments):

a. Run all sensors continually while ignoring range output (keeps sensors condensation-free but no range readings during this time – maximizes self-cleaning cycles over time)

b. When a reading is desired, shut down the sensors, trigger each individual sensor one at a time for seven (7) seconds and take a range reading for each sensor

c. Go back to step 1 (keep all sensors running).

MaxBotix recommends choosing an SCXL-MaxSonar-WR product for applications that are in high-moisture environments, or which are vulnerable to occasional condensation. These sensors are IP67 rated, so water or ice will not damage the sensor. However, water or ice on the transducer surface will impede the sensitivity of the sensor, as outlined above.

Sensor Mounting

It is recommended that several factors be taken into account when using the SCXL-MaxSonar-WRS self-cleaning 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 SCXL-MaxSonar-WRS self-cleaning sensor and HR-MaxTemp sensor.

The first component is a shroud that is assembled over the top of the SCXL-MaxSonar-WRS self-cleaning 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 SCXL-MaxSonar-WRS self-cleaning sensor.

The third component is a fan housing which holds either an AC or DC cooling fan under the temperature housing, see 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 to use standard hardware for mounting to new or existing weather stations or other mounting components.

Figure 4 shows the recommended mounting for the SCXL-MaxSonar-WRS self-cleaning 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

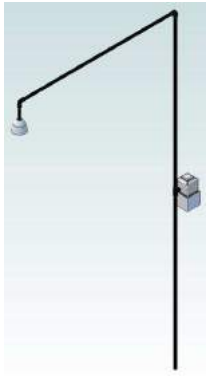


Figure 4

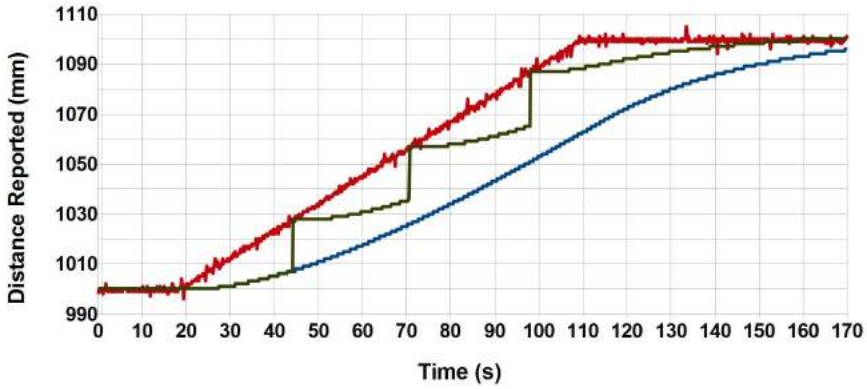
Model Selection

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

Part Number	Serial Interface	Filter Reset Window	High Performance HR Filter[1]	Recom-mended Application	5 Meter Range
MB7534	RS232	2%	Yes	Water/Outdoors	Yes
MB7544	TTL	2%	Yes		Yes
MB7554	RS232	*Never*	Yes	Outdoors/Snow	Yes
MB7564	RS232	N/A	Yes	Any	Yes
MB7574	TTL	*Never*	Yes	Outdoors/Snow	Yes
MB7584	TTL	N/A	Yes	Any	Yes

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

The MB7554 and 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.



Top (red): MB7564 reporting a target moved from 1 meter to 1.1 meters in a linear fashion.
Middle (green): MB7534 responding to the same target, notice the steps when the target moves > 2%.
Bottom (blue): MB7554 responding to a target moved from 1 meter to 1.1 meters in a linear fashion.

The MB7534 and MB7544 have an additional filter similar to the MB7554 and 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.

Auto Calibration

Each time a SCXL-MaxSonar-WRS self-cleaning sensor series takes a range reading, it calibrates itself. The sensor then uses this data to range objects. If the temperature, humidity, or applied voltage changes during sensor operation, the sensor will continue to function normally over the rated temperature range while applying compensation for changes caused by temperature and voltage.

Target Size Compensation

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

The SCXL-MaxSonar-WRS self-cleaning sensor line compensates for target size differences. This means that, provided an object is large enough to be detected, the sensor will report the same distance, typically within 1%, 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

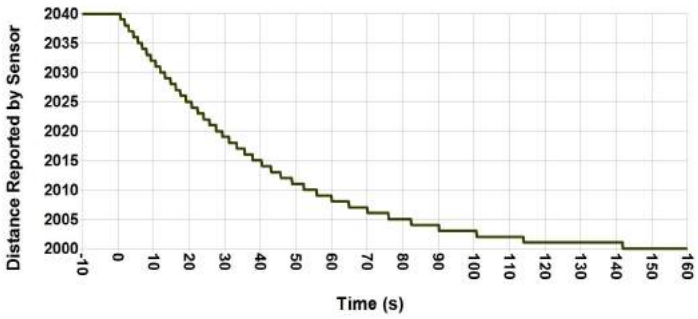
Because of acoustic effects in the near field, objects between 30-cm and 50-cm may experience acoustic phase cancellation of the returning wave, resulting in inaccuracies of up to 5-mm. These effects become less prevalent as the target distance increases, and have not been observed past 50-cm. For this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

MB7534, MB7544 Filter – 2% distance to target filter

The MB7534 and 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 MB7564 and MB7584)

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.



The MB7534 range output when responding to a 4cm change.

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.

For example, below is an example sample sensor data-set of a filling grain bin. The MB7534 has little to no noise when the grain is at rest and functions similar to the MB7554 in this environment. However, as the bin fills at a constant rate the distance slowly chases until such a point that it exceeds the 2% threshold, at this point the sensor distance "resets." This process continues until the grain has finished filling and the sensor settles on the new value.

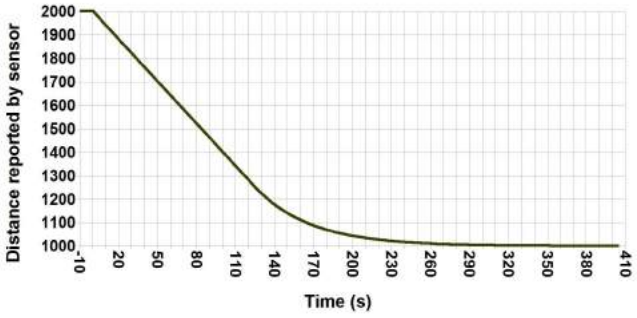
MB7554, MB7574 Filter

The MB7554 and 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 MB7564 and MB7584)

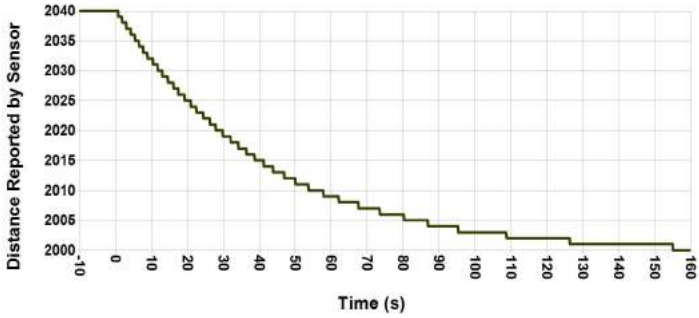
This filter can be reset at any time by bringing pin 4 (RX) of the sensor low.

This filter will initialize 40 readings 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 1 mm per reading. This filter is designed to monitor stable, or slow moving objects, if a filter update is required this can be accomplished with the RX pin.



MB7554 responding to a 1 meter change. This shows the 7-mm rate limit along with the exponential filter.



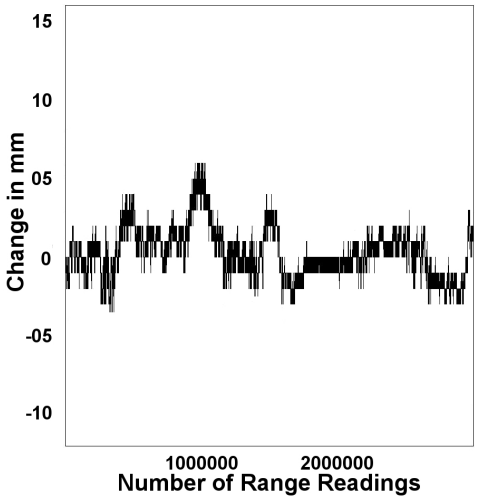
MB7554 responding to a 4 centimeter change. This shows the 7-mm rate limit along with the exponential filter.

Sensor Performance Information

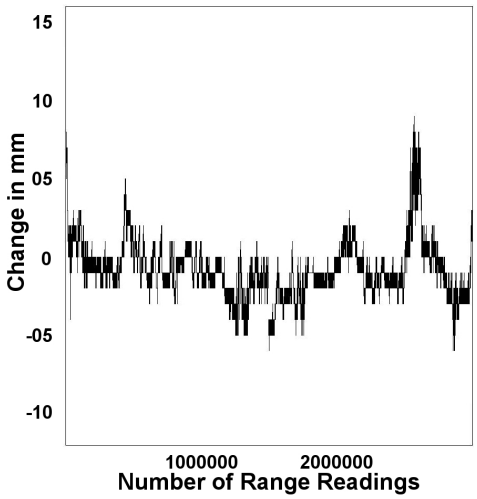
Accuracy Information

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.

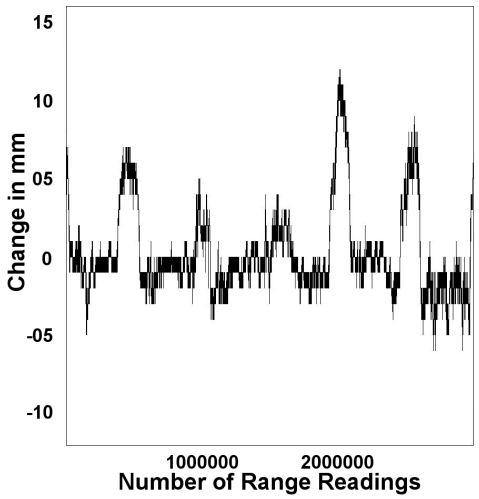
Three million readings in each test configuration were then recorded over five days at our outside our facility with typical temperature swings of 15C per day and the MB7554 ranging to a stable target. All of the readings fell within the 1% tolerance in our test setup. The external temperature sensor,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



MB7554 with external temperature sensor and circulation fan

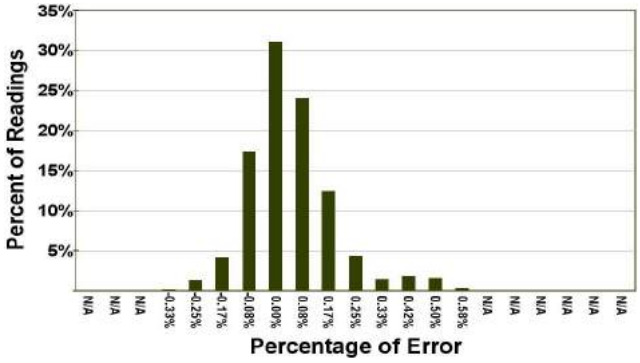


MB7554 with external temperature sensor and no circulation fan

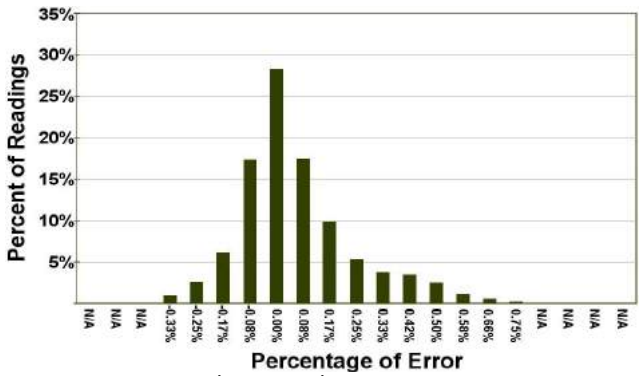


MB7554 without external temperature sensor

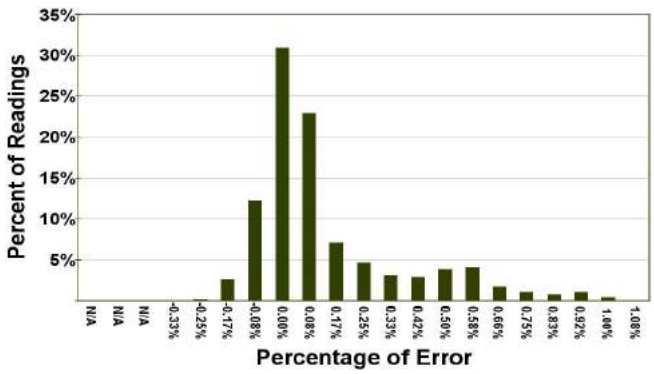
Below is a histogram, by quantity, of each reading observed.



MB7554 with External Temperature Sensor and Fan



MB7554 with External Temperature Sensor



MB7554 without External Temperature Sensor

Supply Voltage Compensation

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

Range "0" location

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

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

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

SCXL-MaxSonar-WRS Temperature Compensation

On Board – Internal Temperature Compensation

(Not recommended during sensor operation)

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

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

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

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

HR-MaxTemp, an External Temperature Sensor

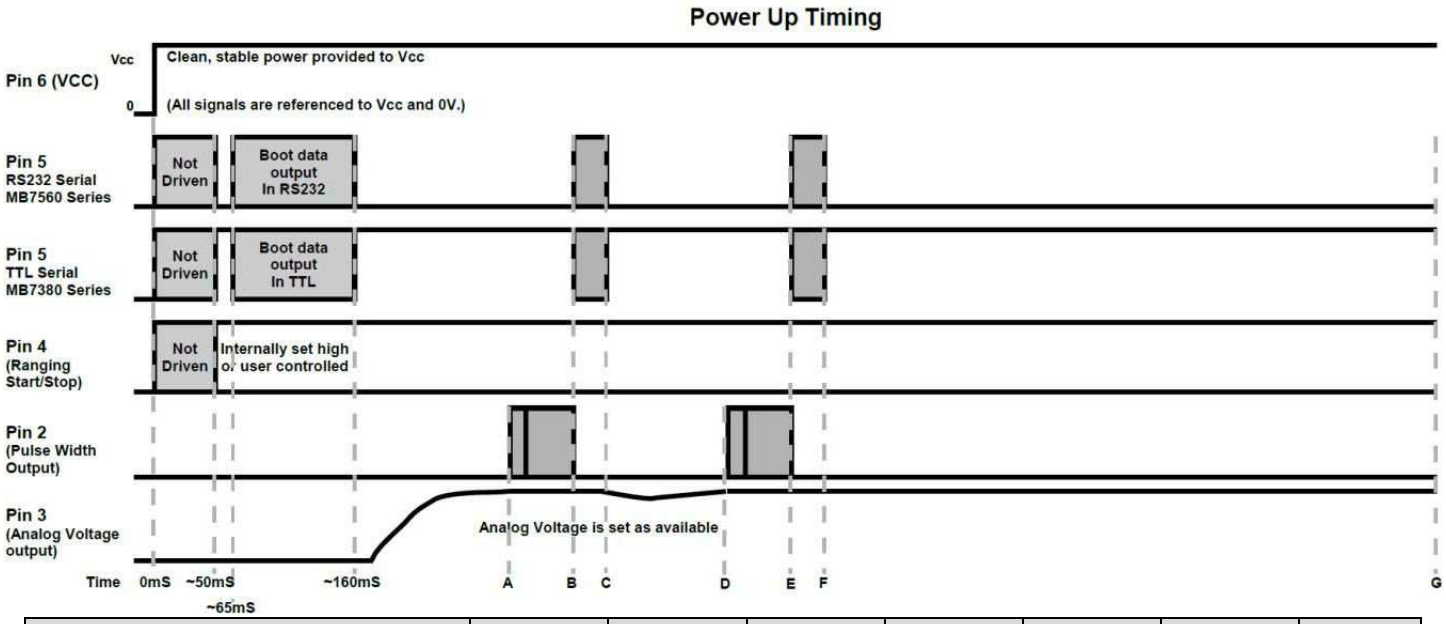
(Required for accurate readings)

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

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

Sensor Timing Diagrams

Power Up Timing



Product	Pulse Width sent (A)	Serial Data sent (B)	Serial Data end (C)	Pulse Width sent (D)	Serial Data sent (E)	Self Clean Cycle start (F)	End of Power up (G)
MB7534, MB7544, MB7554 MB7564, MB7374, MB7584	~295mS	~300mS	~301mS	~436mS	~441mS	~442mS	~2.004 seconds

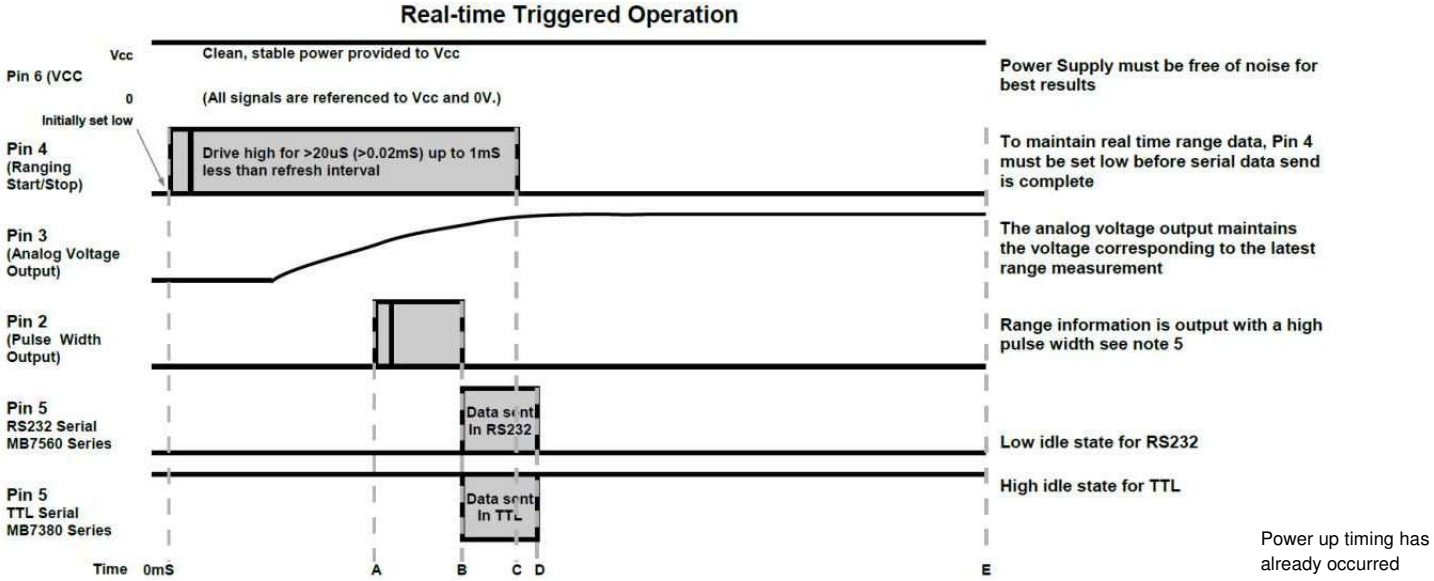
Sensor Free-Run Timing

When operating in free run mode, the SCXL-MaxSonar-WRS self-cleaning sensors are designed to be used in a variety of outdoor, industrial, or indoor environments. Many acoustic noise sources will have little to no effect on the reported range of the SCXL-MaxSonar-WRS sensors. Most range readings are accurately reported. 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.

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

On the 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 SCXL-MaxSonar-WRS self-cleaning sensors will output the range based on recent range information. The filter does not affect the speed at which data is made available to the user but instead allows for more consistent range information to be presented.

Sensor Timing Diagrams Cont.



Product	Maximum Refresh Rate[1]	Pulse Width sent (A)	Serial Data sent (B)	RX Pin set low (C)	Begin Self Cleaning Cycle (D)	End of Self Cleaning Cycle	End of range cycle (E)
MB7534, MB7544, MB7554 MB7564, MB7374, MB7584	0.582 Hz	~135mS	~140mS	~147mS	~148mS	~1.710 seconds	~1.711 seconds

Triggered—Real-time Operation Timing

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 SCXL-MaxSonar-WRS self-cleaning sensors 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 SCXL-MaxSonar-WRS self-cleaning sensors 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.

SCXL-MaxSonar-WRS Sensor Operating Modes

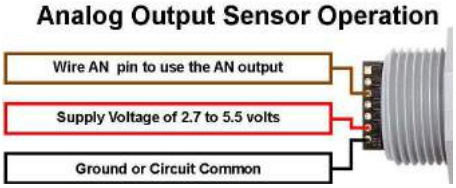
Free-Run Operation

When operating in free run mode, the SCXL-MaxSonar-WRS self-cleaning sensors are designed to be used in a variety of outdoor, industrial, or indoor situations. Many acoustic noise sources will have little to no effect on the reported range of the SCXL-MaxSonar-WRS self-cleaning sensors. Most range readings are accurately reported. 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.

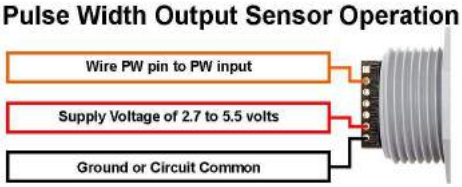
Independent Sensor Operation

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

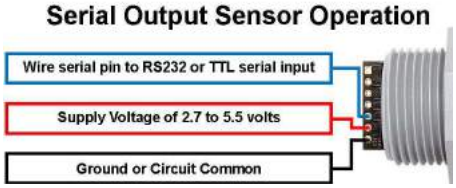
Analog Output Sensor Operation



Pulse Width Output Sensor Operation



Serial Output Sensor Operation



SCXL-MaxSonar-WRS Beam Patterns

Background Information Regarding our Beam Patterns

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

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.

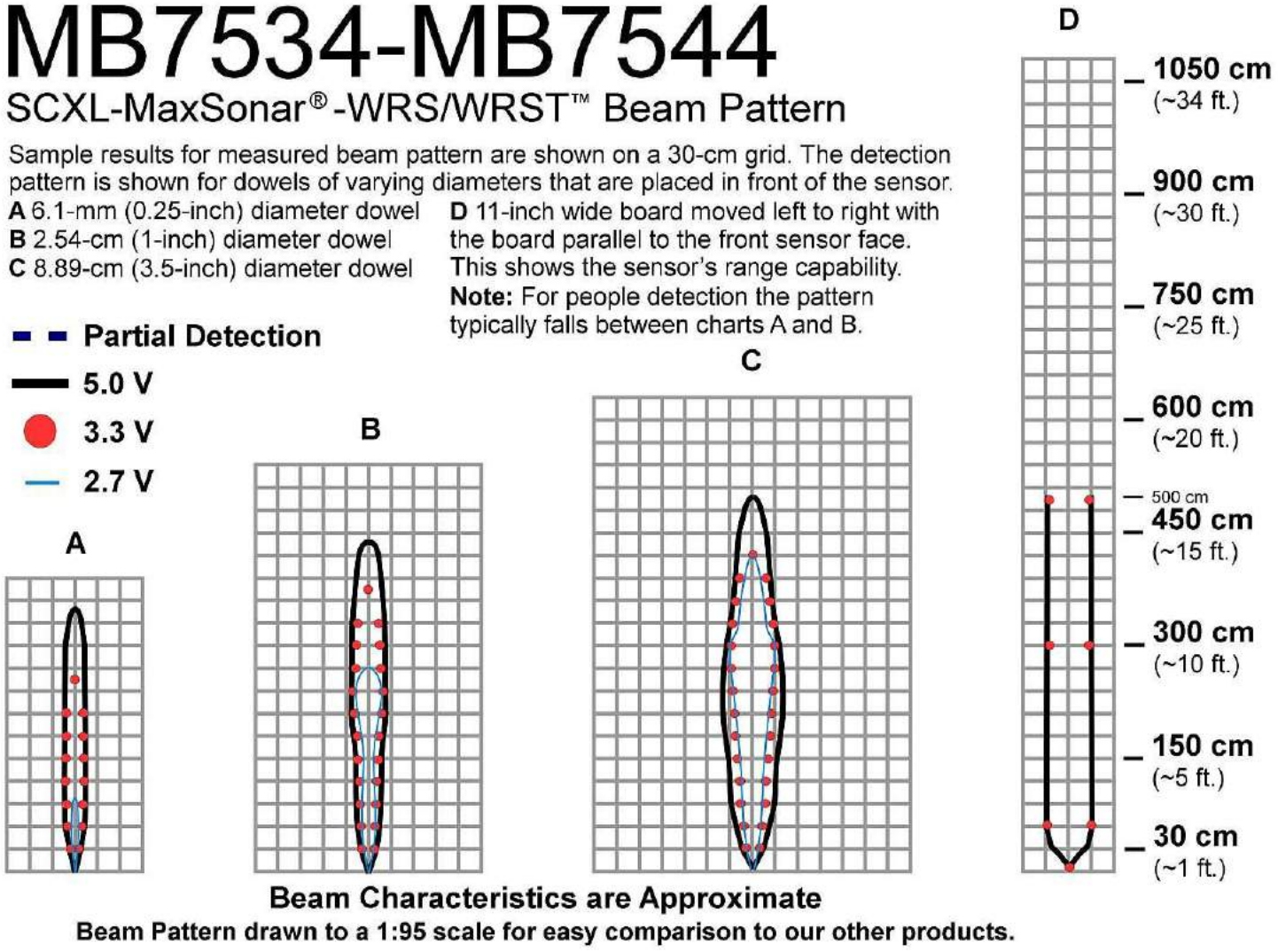
Each beam pattern is a 2D representation of the detection area of the sensor. The beam pattern is actually shaped like a 3D cone (having the same pattern both vertically and horizontally). Beam patterns for dowels are used to show the beam pattern of each sensor. Dowels are long cylindrical targets of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

MB7534-MB7544 SCXL-MaxSonar®-WRS™ Beam Pattern and Uses

The SCXL-MaxSonar-WRS self-cleaning sensor 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. This is the recommended self-cleaning sensor for water level measurement.



MB7534-MB7544
Features and Benefits

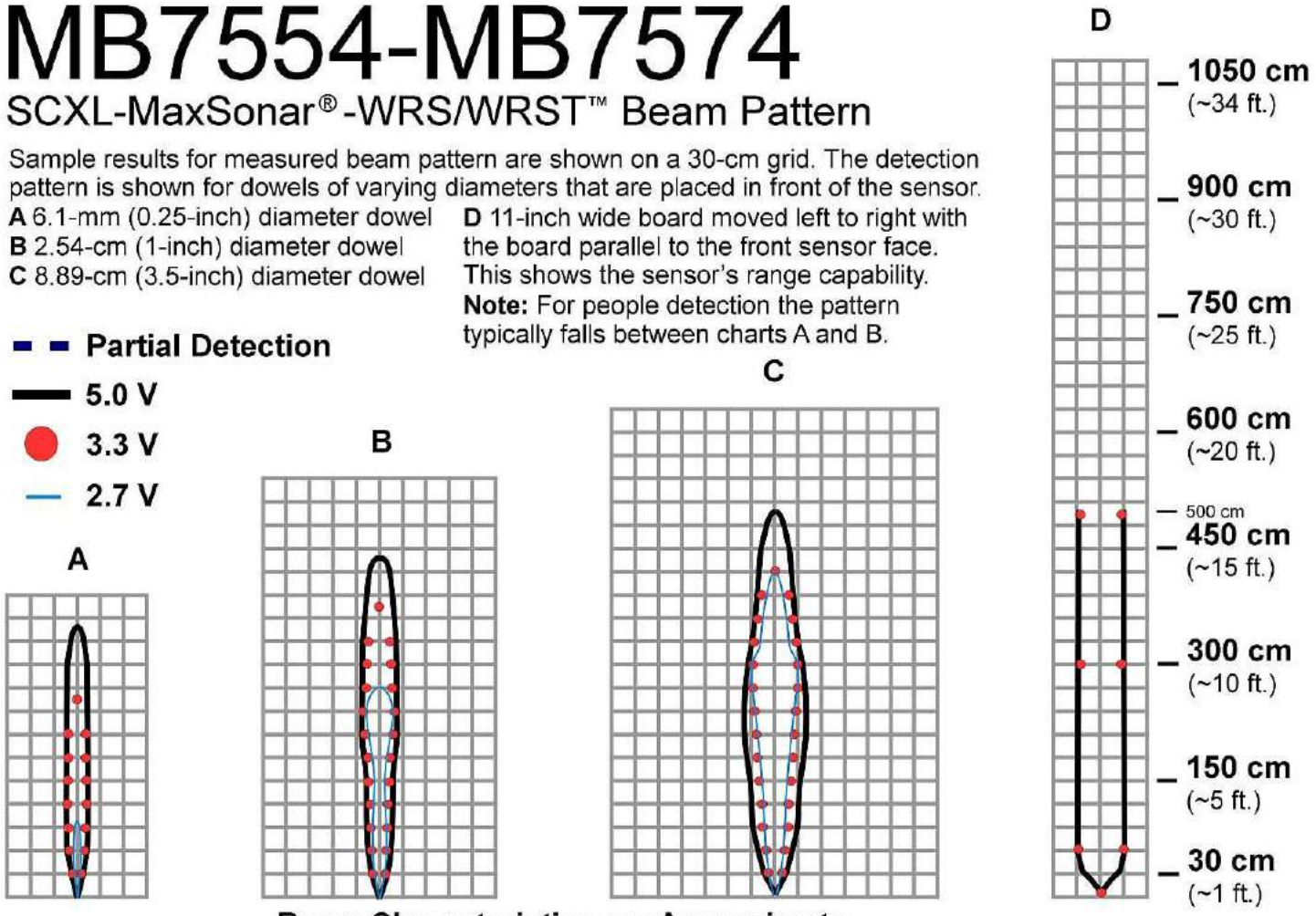
- Factory calibrated beam width
- All range outputs are active simultaneously
- High acoustic sensitivity

MB7534-MB7544
Applications and Uses

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

MB7554-MB7574 SCXL-MaxSonar®-WRS™ Beam Pattern and Uses

The SCXL-MaxSonar-WRS self-cleaning sensor 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. This is the recommended self-cleaning sensor for snow-depth measurement applications.



MB7554-MB7574
Features and Benefits

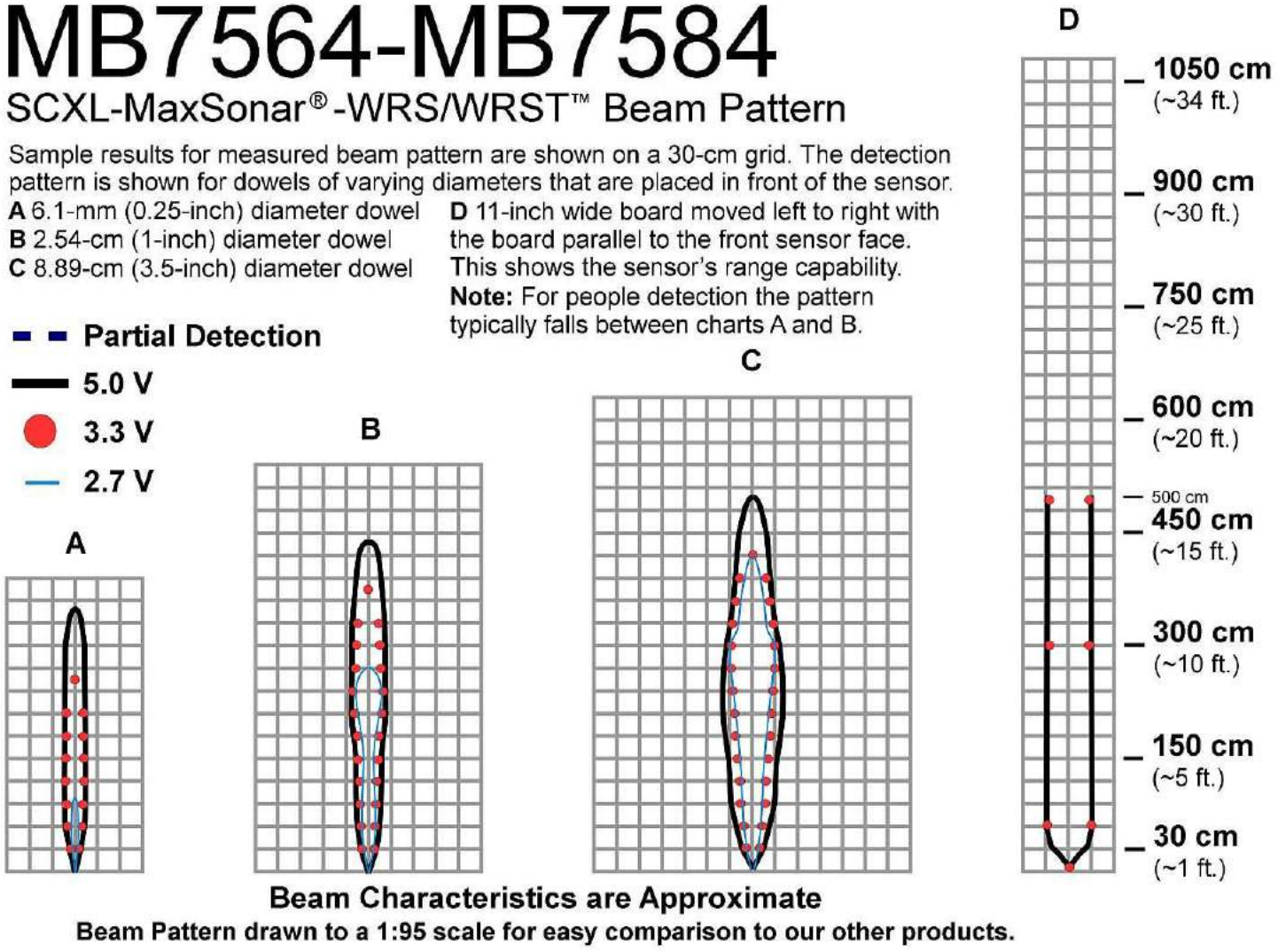
- Factory calibrated beam width
- All range outputs are active simultaneously
- High acoustic sensitivity

MB7554-MB7574
Applications and Uses

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

MB7564-MB7584 SCXL-MaxSonar®-WRS™ Beam Pattern and Uses

The SCXL-MaxSonar-WRS self-cleaning sensor is a low-cost, rugged ultrasonic snow depth sensor that is optimized for reliable snow depth measurement. Sensor readings are optimized to ensure accurate snow depth measurement. This is the base model of the SCXL-MaxSonar-WRS self-cleaning sensor series.



MB7564-MB7584 Features and Benefits

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

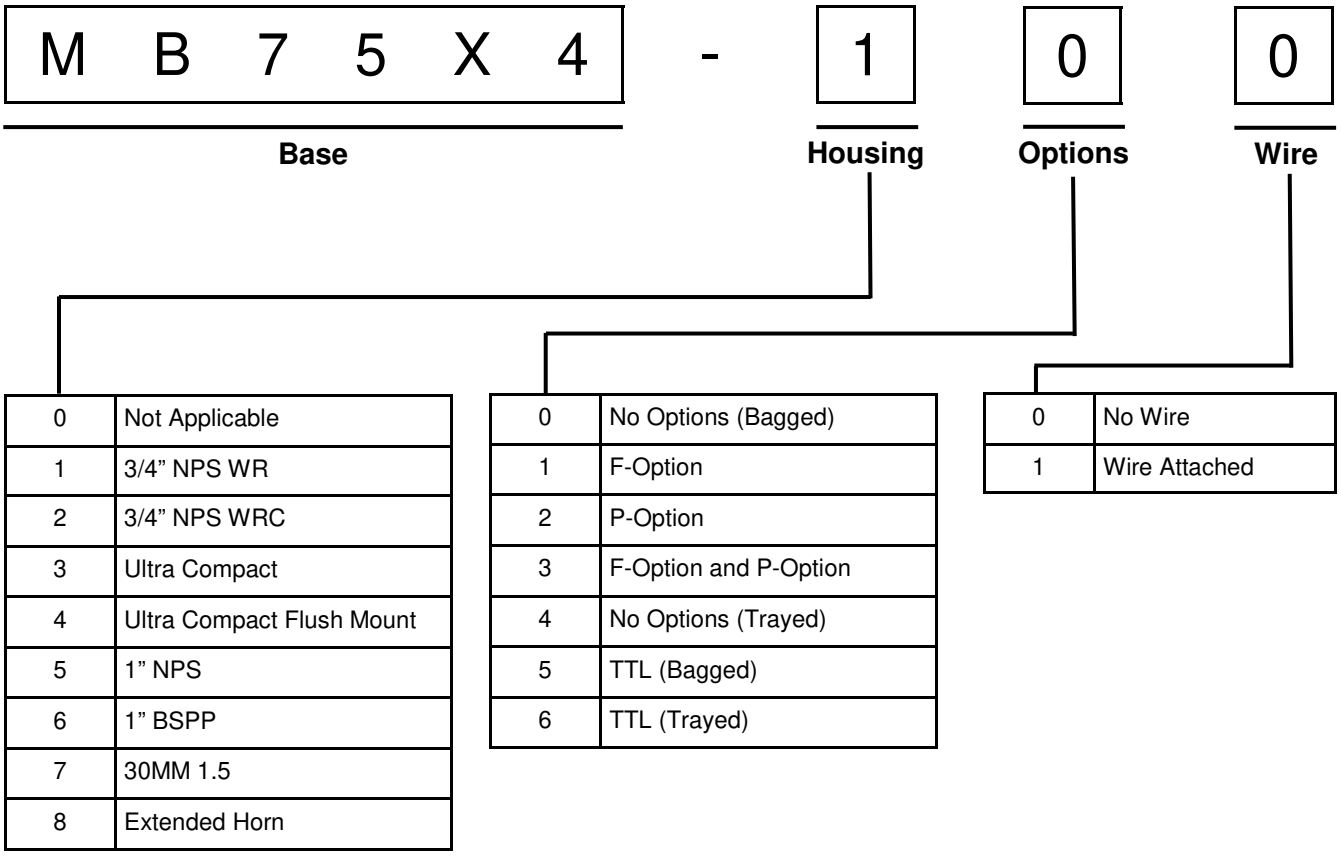
MB7564-MB7584 Applications and Uses

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

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
2	3/4” NPS WRC
3	Ultra Compact
4	Ultra Compact Flush Mount
5	1” NPS
6	1” BSPP
7	30MM 1.5
8	Extended 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 Wire
1	Wire Attached

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

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

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

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

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

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

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