260-705

User Manual

260-705

260-705-12V

Ultrasonic Snow Depth Sensor

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Receiving and Unpacking

Carefully unpack all components and compare to the packing list. Notify NovaLynx Corporation immediately concerning any discrepancy. Inspect equipment to detect any damage that may have occurred during shipment. In the event of damage, any claim for loss must be filed immediately with the carrier by the consignee. Damages to equipment sent via Parcel Post or UPS require the consignee to contact NovaLynx Corporation for instructions.

Returns

If equipment is to be returned to the factory for any reason, call NovaLynx between 8:00 a.m. and 4:00 p.m. Pacific Time to request a Return Authorization Number (RA#). Include with the returned equipment a description of the problem and the name, address, and daytime phone number of the sender. Carefully pack the equipment to prevent damage or additional damage during the return shipment. Call NovaLynx for packing instructions in the case of delicate or sensitive items. If packing facilities are not available take the equipment to the nearest Post Office, UPS, or other freight service and obtain assistance with the packaging. Please write the RA# on the outside of the box.

Warranty

NovaLynx Corporation warrants that its products are free from defects in material and workmanship under normal use and service for a period of one year from the date of shipment from the factory. NovaLynx Corporation's obligations under this warranty are limited to, at NovaLynx's option: (i) replacing; or (ii) repairing; any product determined to be defective. In no case shall NovaLynx Corporation's liability exceed product's original purchase price. This warranty does not apply to any equipment that has been repaired or altered, except by NovaLynx Corporation, or that has been subjected to misuse, negligence, or accident. It is expressly agreed that this warranty will be in lieu of all warranties of fitness and in lieu of the warranty of merchantability.

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1 FORWARD

Thank you for purchasing NovaLynx products. NovaLynx has been designing and manufacturing weather instruments since 1988. NovaLynx represents several well-known brands of quality manufacturers, including Gill Instruments, RM Young, Kipp & Zonen, and Vaisala. It is our hope that our products will meet all your monitoring requirements.

2 INTRODUCTION

The **260-705 Ultrasonic Snow Depth Sensor** is a low cost, non-contact, rugged sensor for reliable snow depth measurement. Ultrasonic sensors measure the time of flight for sound transmitted to and reflected back from nearby objects within a defined area. Based upon the time of flight, the sensor outputs a range reading. Temperature compensation is applied to every reading using an integrated temperature sensor. (*NOTE: For highest accuracy an external temperature sensor can be connected.*) Multiple sensor readings are analyzed using algorithms optimized for snow measurement, ensuring accurate results. The 260-705 can interface with most data loggers.

3 SPECIFICATIONS

Model	**260-705**	**260-705-12**
Power	Regulated 5.0 Vdc @ 3.1 mA	9-15 Vdc (7 mA @ 12 V)
Absolute maximum input voltage	5.5 Vdc	15 Vdc
Analog output (filtered)	ratiometric*	0.5 to 5.0 V (buffered)
Scale factor	Vcc / 5120 per 1 mm	1 mm / mV
Digital output	RS232 (ASCII 9600 baud 8-N-1)	
Accuracy	±1% Typical	
Resolution	5 mm analog output, 1 mm serial output	
Range	1.64 to 16.4 feet (0.5 to 5 meters)	
Beam angle	~20 degrees	
Electrical		
Cable	PVC Jacket, 5 conductor, 24 AWG, 25 feet (7.6 meters)	
Environmental		
Enclosure	IP67 rated junction box, sealed electronics	
Mounting	3/4" NPT	
Operating temperature range	-40°F to +149°F (-40°C to +65°C)	
Shipping		
Dimensions	9.2" x 4.1" x 1.8" (23.4 x 10.4 x 4.6 cm)	
Weight	1.2 lb (0.55 kg)	

* Input impedance of the monitoring equipment should be 30k ohms or more

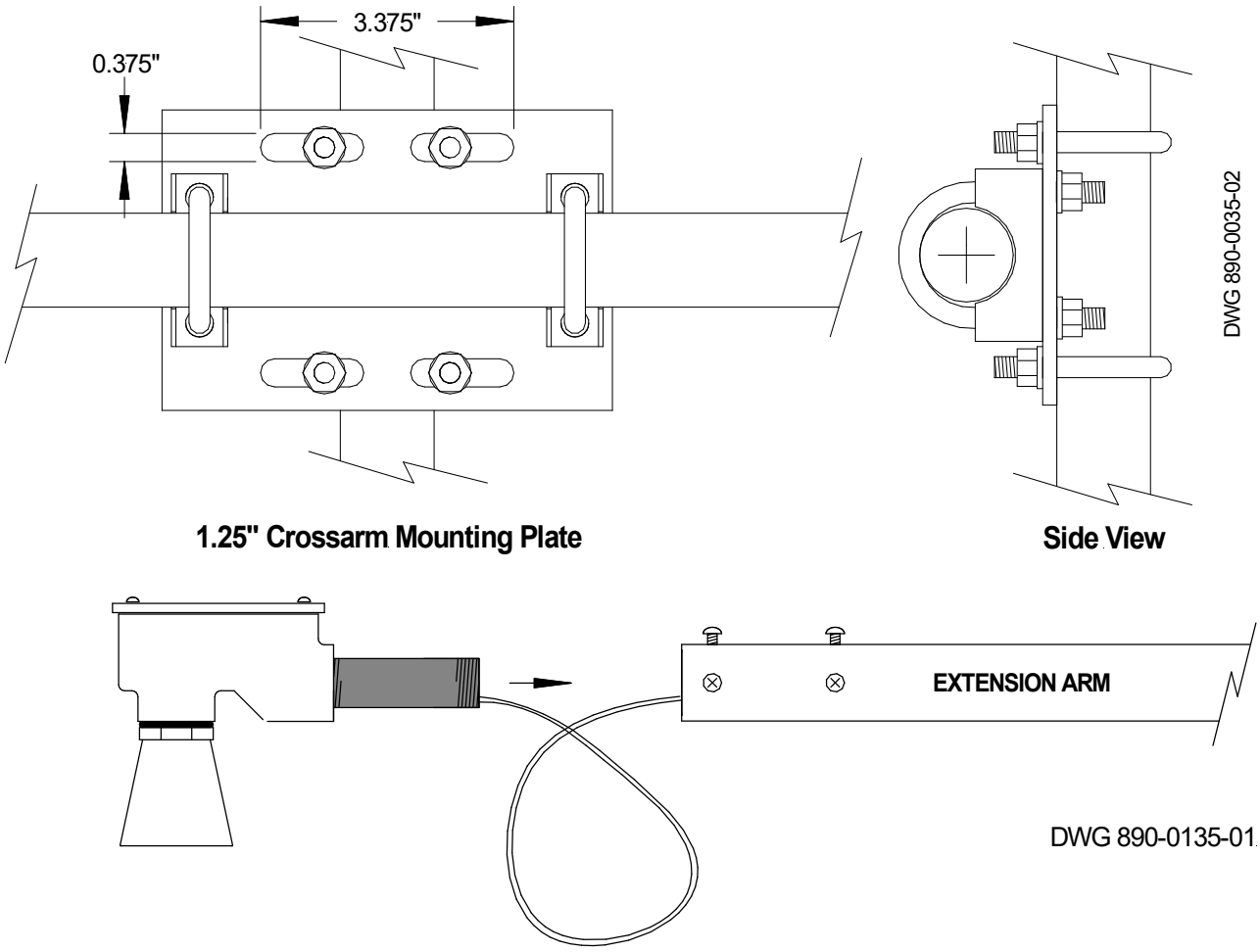
4 ACCESSORIES

The following accessories are sold separately and are designed to simplify installation and improve the overall accuracy of the readings.

4.1 Mounting Arms

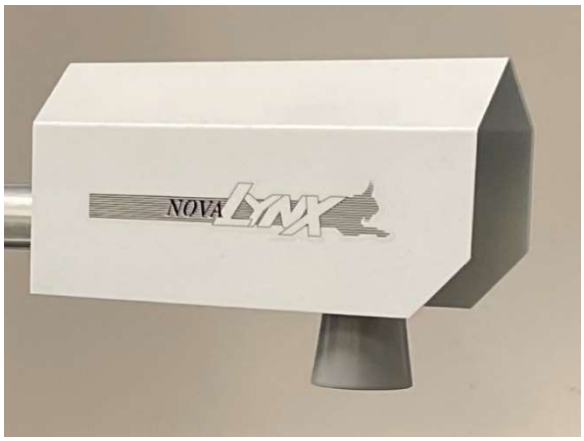
The **260-705-TM** includes a 5-foot extension arm for mounting sensors away from a vertical support pole. The central bracket clamps to the support pole (not supplied), while the aluminum extension arm is extended as much as 4.5 feet (1.4 m) to the side.

The **260-705-TM-2** includes two 3-foot extension arm sections that fit together for a total length of 5.5 feet. The central bracket clamps to the support pole (not supplied). This compact design is easier to transport and may lower shipping costs.



Installation of the Ultrasonic Snow Depth Sensor on the Extension Arm

4.2 Sunshield



The **260-705-S Ultrasonic Sensor Shield** protects ultrasonic snow depth and water level sensors from heating effects of direct sunlight exposure. This is particularly important when the internal temperature sensor is used for compensating the range readings. The durable shield also deflects hail and prevents snow from accumulating on the sensor.

4.3 Temperature Compensation Sensor

The **260-705-T Ultrasonic Temperature Compensation** sensor provides an external reference for ultrasonic snow depth or water level sensors.

Temperature compensation is applied to every ultrasonic range reading, because the speed of sound in air changes with temperature. Placing the 260-705-T sensor midway between the ultrasonic sensor and its target maximizes the accuracy of the range reading.

5 SITE SELECTION

The location of the snow depth sensor is very important to the successful operation of the instrument. The most accurate measurements are made in relatively open areas away from trees or buildings and sheltered from wind effects. The site should be level and not subject to snow drifts.

Snow fencing is not recommended because it can create problems if it is not regularly maintained, and some types tend to accumulate extra snow in the area of interest. A better alternative is chain link fencing to keep out unwanted animals.[1]

The sensor should not be located under power lines or any structures where snow might accumulate and then fall onto the area being measured, as this will create an uneven surface below the sensor.

1 Wendy A. Ryan, Nolan J. Doesken and Steven R. Fassnacht, (2006) Evaluation of Ultrasonic Snow Depth Sensors for U.S. Snow Measurements. *JOURNALS ONLINE* Section 5a, Online publication date 1 May 2008

Place a white-painted square of waterproof plywood below the sensor or purchase a "snow board" made for the purpose. In some areas it may be helpful to create a frame under the board to raise it slightly to reduce the effects of heaving caused by freeze / thaw cycles. Calculate the size of snow board needed by multiplying the height of the sensor by 0.4. The sensor must be centered over and perpendicular to the target for best results.

It is good practice to make reference marks on the support mast that are visible from a distance. These marks can be compared with the sensor readings to verify the operation of the sensor once snow has accumulated.

Good locations do not always remain obstruction free. Vegetation can grow quickly, changing an excellent exposure into a poor one. Sites should be inspected regularly in order to properly maintain the exposure of the sensor.

6 INSTALLATION

The support structure (tower or mast) must be sturdy to keep the sensor from vibrating when there are high winds. It must be tall enough for the expected snow accumulation, and the pipe extension that holds the sensor must be long enough so that the sound pulses do not reflect from the mast.

The sensor should be mounted at least 1.64 feet (0.5m) above the highest expected snow level, to a maximum of 16.4 feet (5m). A simple formula is the following:

Sensor height = (max observed snow level x 1.25) + 1.64 feet (or 0.5m)

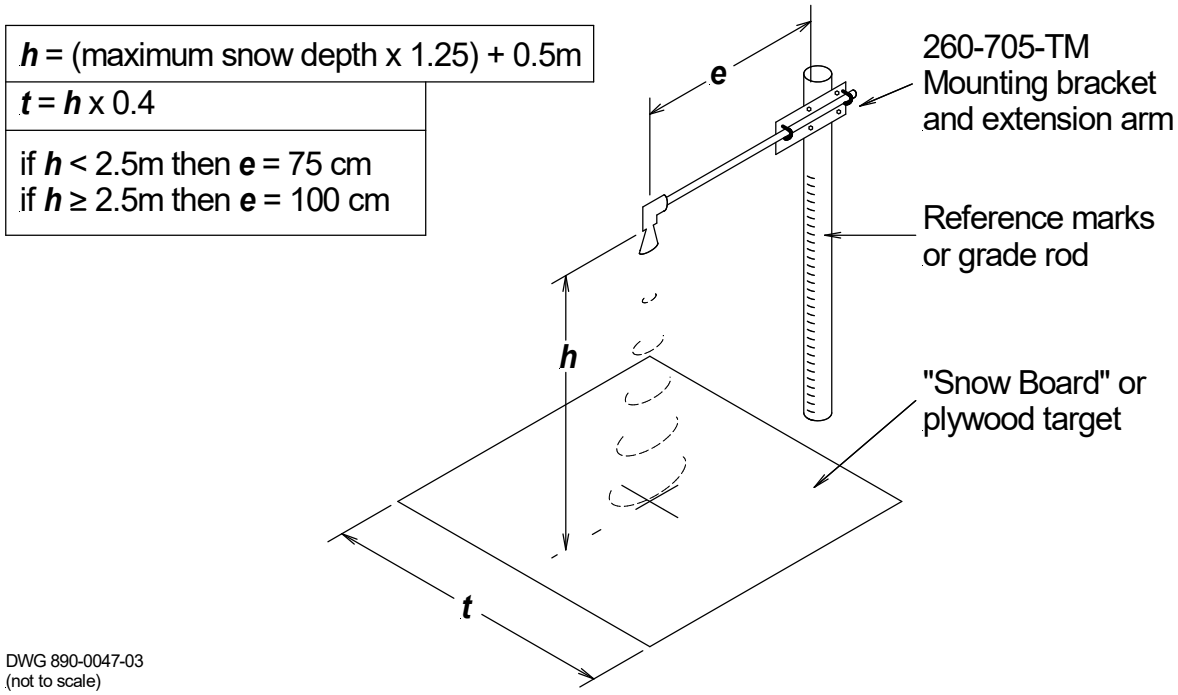
NOTE: The lower the sensor can be mounted the stronger the echo from the snow.
Determine the distance between the sensor and support tower or mast from the following:

- If the sensor is less than 8 feet (2.5m) above the ground, offset the sensor at least 30 inches (75cm) from the mast.
- If the sensor is 8 feet (2.5m) or higher above the ground, offset the sensor by at least 40 inches (100cm) from the mast.

NOTE: If the sensor is too close to the mast or tower the sound pulses may reflect from the mast and confuse the distance measurement.

The 260-705-TM kit (sold separately) contains parts for mounting the sensor to a mast or tower. If you purchased the kit then follow the installation instructions that came with the kit. Otherwise, a suitable mounting structure can be made with parts from a local hardware store.

The 260-705 Ultrasonic Snow Depth Sensor is provided with a ¾" NPT x 6" PVC nipple. The PVC nipple slides into the 260-705-TM extension arm and is secured with four screws. If the extension arm is not used, the PVC nipple can be removed and the sensor head can be screwed onto a ¾" NPT galvanized pipe. Apply Teflon tape to the pipe threads, feed the cable through the pipe and then screw the pipe into the sensor firmly by hand. Do not over-tighten, and take care that the cable does not become twisted. Attach the pipe to your mast or tower and secure the cable with cable ties so that the wind cannot cause it to whip around. Close off any openings in the pipe so that water cannot collect inside.



7 WIRING

Ultrasonic Snow Depth Sensor			Temperature Compensation Sensor
Pin	**Color**	**Signal**	**Color**
1	Brown	External temperature	Red
2	-		
3	White	Analog output	
4	-		
5	Green	Serial output	
6	Red	Power	
7	Black	Ground	Black
-	Silver	Shield	Shield

The **Brown** wire must be insulated when not in use. It is for connection to an external temperature sensor which is used to compensate for air temperature changes that affect the speed of sound. When the external sensor is not connected, then the internal temperature sensor is automatically selected for compensation. If external compensation is used, connect the brown wire to the temperature sensor's red wire.

The **White** wire is the analog (0.5 V to 5.0 V) signal that is proportional to distance. Insulate if not used.

The **Green** wire is the digital output which can be monitored on a terminal program on your computer, or a data logger can be programmed to receive the information. This wire should be insulated when not in use.

The **Red** wire connects power to the sensor. Be very careful to apply the correct voltage depending on the model of sensor you purchased (see Specifications in Section 3). The warranty does not cover damage due to applying an incorrect voltage.

The **Black** wire connects power supply ground to the sensor. If external temperature compensation is used, connect its black wire to the same point.

The **Silver** (shield) wire should be connected to an earth ground. This will reduce noise in the signal as well as help protect the sensor from static. Connect the shield from the temperature compensation cable (if used) to the same point.

NOTE: Pin numbers refer to connections on the sensor itself which are not user accessible.

8 ANALOG OUTPUT

8.1 Initialization and Timing

The **260-705 Ultrasonic Snow Depth Sensor** operates in free-run mode so that filtering can be applied, which improves consistency and accuracy in snow depth measurements. When power is applied, the sensor initializes in about 50 mS and sets the output low until the first sample is taken. The filter accumulates 40 readings, taking about 7 seconds, to arrive at a stable output. The filter is designed to monitor stable or slow moving objects (such as snow accumulation) and therefore responds slowly to step changes (such as moving the target abruptly).

The snow depth sensor can be operated continuously, thereby keeping the filtered output up-to-date. If power to the sensor must be switched off between readings, then enough time must be allowed after turning the sensor back on for the signal to stabilize. At a minimum, power the sensor 7 to 10 seconds before taking a reading.

8.2 Electrical Range

The **Model 260-705** must be powered from a regulated supply because the output is proportional to the supply voltage (ratiometric). The sensor operating range is 2.7 to 5.5 volts. However, for best results in snow applications the power supply should operate at about 5 volts.

Use the scale factor to calculate the maximum output (example Vcc = 5V):

Scale Factor:	Vcc / 5120 = 1 mm
	5 volts / 5120 = 0.009766 volts
Maximum Output:	5000 mm x 0.009766 volts = 4.883 volts
Minimum Output:	0 volts

The **Model 260-705-12** includes a voltage regulator that is set to 5.120 volts. Using the above formula we can calculate the maximum output:

	5.120 volts / 5120 = 0.001 volts
Maximum Output:	5000 mm x 0.001 = 5 volts
Minimum Output:	0 volts

NOTE: In both the cases above the Minimum Output is 0 volts for purposes of scaling the logger. However, the sensor cannot reliably measure closer than 0.5 meters. Objects closer than 0.5 meters are typically reported as 0.5 meters.

8.3 Units Selection

The Full Scale Output can be expressed in various equivalent units:

5 meters = 500 cm = 5000 mm

5 meters = 16.404 feet = 196.85 inches

8.4 Normalization

The voltage output of the ultrasonic sensor increases the farther the distance to the snow. Since we are interested in how deep the snow is as it accumulates (gets closer to the sensor), we need to program the monitoring equipment to calculate the increase. Some loggers want to know how the electrical range relates to the units range. Other loggers want to know the slope and offset to apply.

Calibration by range:

Electrical range:

Minimum	0 volts
Maximum	(calculated Maximum Output, above)

Units range:

Minimum	(use the Full Scale Output in the units of your choice, above)
Maximum	0

Calibration by slope & offset:

The direction of increase is reversed in the logger by entering the offset as a positive number and the slope as a negative number.

The offset is the Full Scale Output in the units of your choice.

The slope depends on the requirement of your logger. In some cases it is expressed as the units per bit of the A/D converter used in the logger. In other cases it might be units per mV. In either case, multiply by -1 to get a negative number so that the result will show an increasing value as snow accumulates.

8.5 Zero Offset

In the calculations above we used the full scale range of the sensor to calibrate the logger. These numbers would be sufficient if the sensor were mounted exactly 5 meters above the "snow board" or plywood target. Chances are the sensor is not mounted at full range, so an offset needs to be introduced to make the sensor read "zero" when there is no snow on the target.

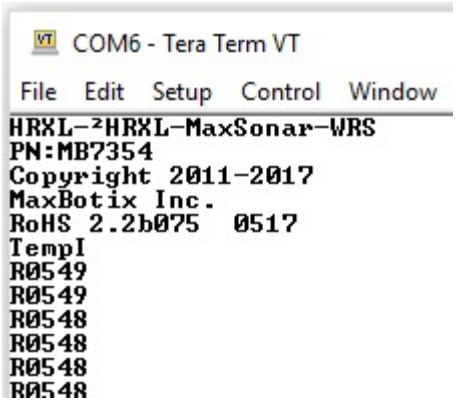
The zero offset could be calculated, but a simpler method is to operate the unit after it is installed and get stable readings while it is looking at the target (without any snow, of course). The value reported is the amount of correction that needs to be factored into the logger calculation. If the logger has a zero offset calibration term, enter the correction there. If using the slope & offset method, subtract the correction from the offset: Zero offset = Full Scale Output – correction factor.

8.6 Verification

The following tests may be done after all installation and wiring is completed. These same tests can be part of a routine maintenance program to ensure the sensor is working properly before a snow season begins.

- Operate the sensor when there is nothing on the plywood target below the sensor. Verify the sensor reads +/- 5 mm (+/- 0.2"). Adjust the zero offset calibration if needed.
- Obtain a square of plywood or corrugated cardboard about 18" square. Support the movable target at various measured distances above the ground in line with the sensor. Compare the height of the target with each logger reading. The measurements should agree within about 5 mm (+/- 0.2").

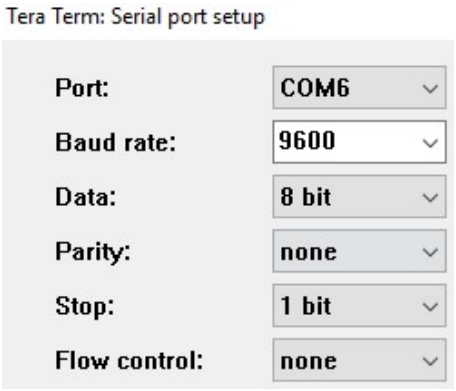
9 SERIAL OUTPUT



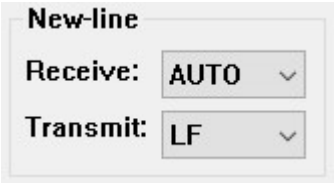
The serial output of the 260-705 Ultrasonic Snow Depth Sensor has higher resolution than the analog output and should be used if your monitoring equipment can accept it.

The RS232 format (with 0 to Vcc levels) is an "R" followed by four ASCII character digits representing the range in millimeters. The maximum reading is 4999. A reading of 5000 represents an error condition where the target could not be detected.

For testing purposes, the sensor can be monitored by connecting it to a computer that is running a terminal program such as HyperTerminal, Putty, or TeraTerm. The terminal settings are 9600 baud, 8 bits, no parity, 1 stop bit, no handshake.



The data doesn't include a line-feed (LF) character, so set the terminal to AUTO to get a line feed.



The 260-705 Ultrasonic Snow Depth Sensor is not user programmable. It is wired to operate in free-run mode, which incorporates filtering to optimize accuracy in snow monitoring applications. When power is applied, the sensor initializes in about 50mS, then begins taking samples. The filter initializes 40 readings, taking about 7 seconds, to arrive at a stable output. The filter is designed to monitor stable or slow moving objects (such as snow accumulation) and therefore responds slowly to step changes (such as moving the target abruptly).

The snow depth sensor can be operated continuously, thereby keeping the filtered output up-to-date. If power to the sensor must be switched off between readings, then enough time must be allowed after turning the sensor back on for the signal to stabilize. The sensor will output readings during this interval, which must be ignored by the monitoring equipment if filtering is desired. At a minimum, power the sensor 7 to 10 seconds before accepting a reading.

NOTE: It is possible to monitor the serial output of the sensor at the same time as a data logger is sampling the analog output. This might be useful as a troubleshooting tool, if needed.

10 MAINTENANCE

A properly installed sensor will require little maintenance. However, harsh conditions and freeze/thaw cycles can cause problems that should be addressed.

1. The pipe that supports the sensor should be sealed so that snow melt and condensation do not accumulate inside. If water has collected in the pipe, dry it out and then check the junction box also to ensure that it is dry inside.
2. Check any exposed cable for cracks or wear. Secure loose cable so that it does not whip around in the wind.
3. Look up into the horn and make sure insects have not built a nest inside. Clean it out carefully so as not to damage the transducer.
4. Clean the target surface (the white-painted waterproof plywood piece below the sensor) and remove any weeds from around the area. Repaint the board when necessary.
5. Aim the sensor perpendicular to the target.
6. Verify the calibration (Section 8.6)

11 TROUBLESHOOTING TIPS

Please refer to the following checklist if there are any problems with the functionality of the sensor.

- Ensure the sensor is perpendicular to the target surface. If the sensor is off-axis the reflected sound waves will be weak or miss the sensor.
- Check the target surface. If it is rough or uneven the sound waves will be scattered. A piece of white-painted waterproof plywood laid on the ground below the sensor makes a suitable target.
- Check the opening of the sound horn to ensure it is free of ice or insect nests.
- Low density snow (<5%) is a poor reflector of sound. The snow depth measurement may be uncertain in these conditions.
- Strong winds may mask the echo, causing uncertain measurements. Discount anomalous readings in high winds.

- Do not operate other ultrasonic sensors near the snow depth sensor, as the signals may confuse the measurement.
- If the sensor is likely to be warmer than the surrounding air, provide a sun shield over the sensor. In some cases it may be necessary to provide an external temperature sensor for better air temperature compensation.