260-700-x

User Manual

Ultrasonic Snow Depth Sensor

260-700-2.5

260-700-5

With 0-2.5V or 0-5V Analog Output

Phone (530) 823-7185
Email nova@novalynx.com **Website** www.novalynx.com

DOC 260-700 UM 20230407

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 **260-700 Ultrasonic Snow Depth Sensor** is a low cost, non-contact, rugged sensor for reliable snow depth or water level 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. Multiple sensor readings are analyzed using algorithms optimized for snow measurement, ensuring accurate results. The 260-700 can interface with most data loggers.

Accurate measurement of snow depth poses many difficult problems. The **260-700 Ultrasonic Snow Depth Sensor** has proven very effective in measuring snow depth, which makes it well suited for other various applications.

3 SPECIFICATIONS

Analog Ultrasonic Snow Depth Sensor	**260-700-2.5**	**260-700-5**
Analog output	0 - 2.5 Vdc	0 - 5 Vdc
Scale factor, centimeters	500 cm/volt	250 cm/volt
Scale factor, inches	196.85 inches/volt	98.43 inches/volt
Air Temperature scale factor, Kelvin	200°K / volt	100°K / volt
Range	0.5 to 10 meters (1.6 to 32.8 feet)	
Range accuracy	1 cm or 0.4% distance to target	
Range resolution	3 mm (0.12 inches)	
Temperature range	-40°C to +70°C (-40°F to +158°F)	
Temperature sensor accuracy	1°C, -40°C to +85°C	
Temperature sensor resolution	0.5 °C	
Beam angle	~22 degrees	
Electrical		
Power	+12 to +24 Vdc, 50 mA (maximum sample time 2.6 seconds)	
Cable	25 feet (7.6 meters). Maximum cable length 1000' (304 meters)	
Environmental		
Enclosure	Enclosure rating IP66	
Mounting	1/2" NPT female pipe coupling	
Operating temperature range	-40°C to +70°C (-40°F to +158°F)	
Shipping		
Dimensions	3" x 3" x 5" (8 x 8 x 13 cm)	
Weight	1.70 lb (0.77 kg)	
Weight of additional cable (25')	0.55 lb (0.25 kg)	

4 OPERATING PRINCIPLES

The 260-700 operates at a frequency of 49.4 kilohertz, which is above the human range of hearing. In default mode, multiple pulses are processed to improve the reliability of the measurement. For each measurement cycle two measurements are made and compared. If the difference is less than one centimeter, then the last measurement is saved and output. If the difference is greater than one centimeter, the oldest sample is discarded and a new measurement and comparison made. This retry algorithm will continue up to a maximum of ten times. If a valid measurement cannot be made, or no echo is returned, a value of 3-5 millivolts is output (essentially zero).

The speed of sound in air varies proportionally with the air temperature. In order to make an accurate measurement of distance, the air temperature is measured and the speed of sound calculated. The resulting correction factor is applied to the measured time-of-flight of the pulse to calculate the distance. The built-in temperature sensor on the 260-700 provides the necessary data for these calculations.

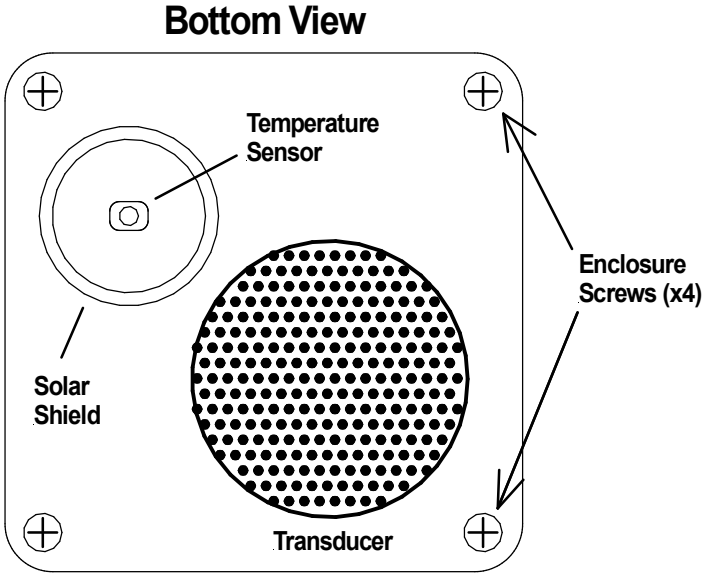
5 CONFIGURATION

The 260-700 is pre-configured by NovaLynx according to the information provided when the sensor was ordered. Please check the label attached to the side of the sensor for the settings applied to your unit. The following information is provided in case the end user needs to change the operation of the sensor.

To make changes it is necessary to remove the bottom cover of the sensor by loosening the four Phillips screws.

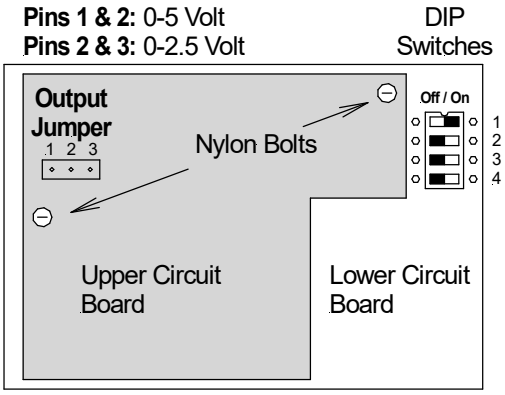
Open the cover carefully and note the position of the desiccant pack and the wiring so these can be re-installed later. The desiccant pack should be dried out in a warm oven (250°F for 16 hours), or replaced if damp.

Do not force the cover when re-installing it as damage could result.

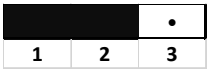


5.1 Output range (0-2.5 V or 0-5 V)

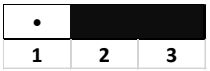
The sensor output has two ranges, 0-2.5 volts and 0-5 volts. The desired range is selected by a jumper connecting the pin combinations shown in the circuit board illustration. To access the output range selection jumpers, remove the nylon bolts that hold the upper circuit board in place. Carefully lift the upper circuit board to reveal the lower circuit board.



0-5 volt output:



0-2.5 volt output:



Replace the upper circuit board using the nylon bolts.

5.2 Operating modes

The 260-700 Ultrasonic Snow Depth Sensor is pre-configured to operate in Free Run Mode with temperature compensation and filtering. In this mode the unit is kept running continuously by holding Sensor Enable high (green wire connected to red Power wire). The sensor uses the internal temperature sensor to calculate the speed of sound, and retry filtering is enabled. The sensor output updates whenever stable readings are available (typically every 1.5 to 3.5 seconds).

DIP Switch 1 (Default ON)

ON Free Run Mode Enabled: Only the distance measurement is output on the signal wire. In this mode the sensor will make continuous repeated measurements with 1-second pauses between cycles (effectively updating the output every 1.5 to 3.5 seconds). The retry algorithm is used to filter spurious measurements. Connect the green Sensor Enable wire to the red Power wire to monitor the distance reading continuously.

OFF Free Run Disabled

DIP Switch 2 (Default OFF)

ON Fast Free Run Mode Enabled: Only the distance measurement is output on the signal wire. The retry algorithm is bypassed so that the output can be updated more frequently. If temperature compensation is turned off (DIP Switch 3) then the output is updated four times per second. With temperature compensation turned on, the update rate is twice per second.

OFF Fast Free Run Disabled

DIP Switch 3 (Default OFF)

ON Temperature Compensation Disabled: The raw distance measurement is output on the signal wire. To correct for the effect of temperature on the speed of sound, an external temperature sensor is needed and the following computations applied to the data:

- Calculate the compensation factor: CF = ((Temp C + 273) / 273) ^ 0.5
- Calculate the distance: Distance = CF * raw distance measurement

OFF Temperature Compensation Enabled

DIP Switch 4 (Default OFF)

ON Long Temperature Signal:

- Assert the green Sensor Enable wire (+5 to +24V)
- Temperature reading available from 600 to 1800 mS
- Distance reading available from 3600 mS
- De-assert Sensor Enable (0 V)

OFF Short Temperature Signal:

- Assert the green Sensor Enable wire (+5 to +24V)
- Temperature reading available from 400 to 800 mS
- Distance reading available from 2600 mS
- De-assert Sensor Enable (0 V)

6 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.

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

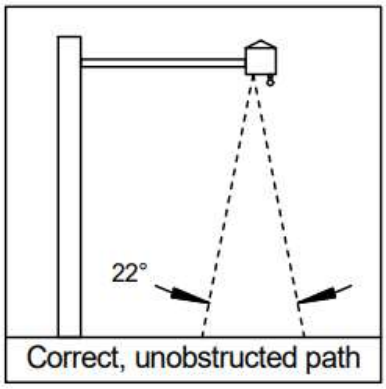
board needed by multiplying the height of the sensor by 0.4. The sensor must be centered over and perpendicular to the target for best results.

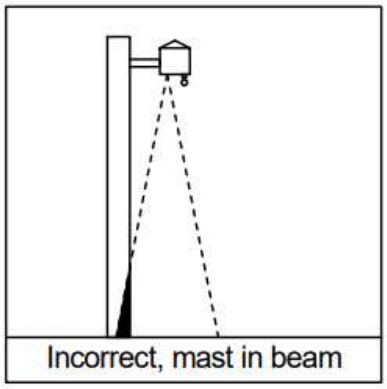
It is good practice to make reference marks on the support mast that are visible from a distance. These marks can be compared with the sensor readings to verify the operation of the sensor once snow has accumulated.

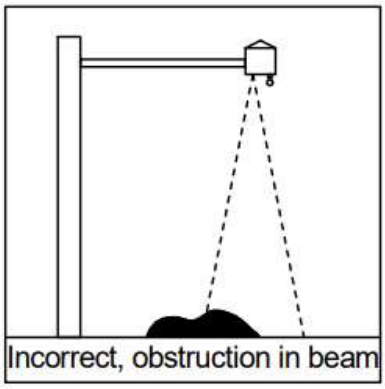
Good locations do not always remain obstruction free. Vegetation can grow quickly, changing an excellent exposure into a poor one. Sites should be inspected regularly in order to properly maintain the exposure of the sensor.

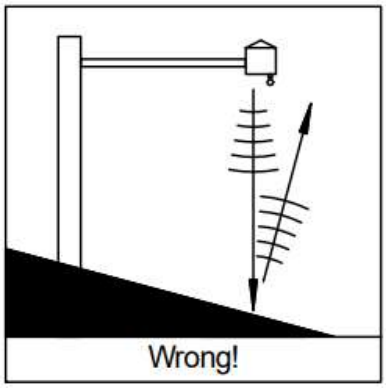
7 INSTALLATION

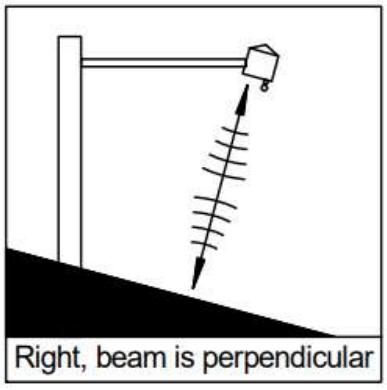
The support structure (tower or mast) must be sturdy to keep the sensor from vibrating when there are high winds. It must be tall enough for the expected snow accumulation, and the pipe extension that holds the sensor must be long enough so that the sound pulses do not reflect from the mast.



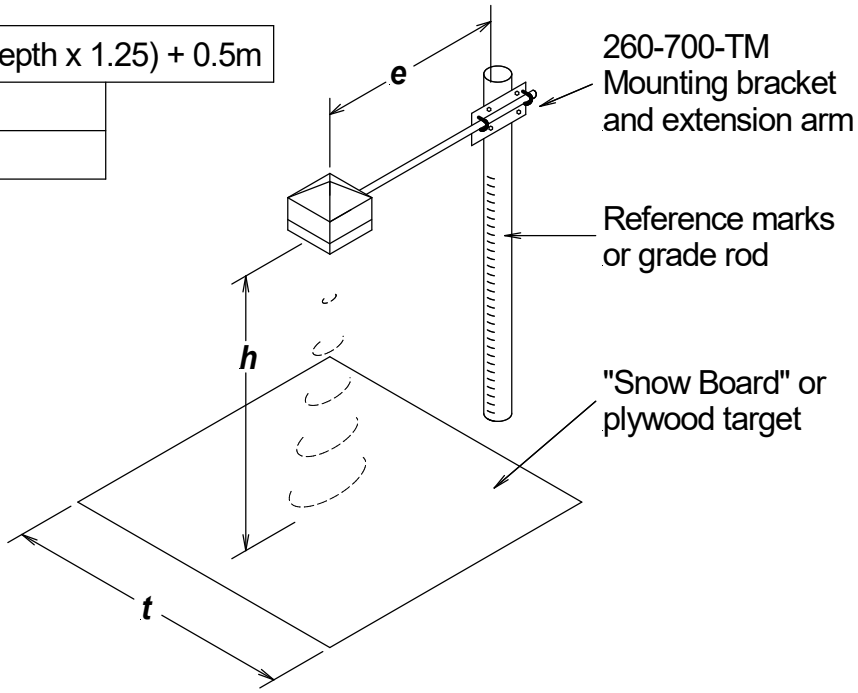








h = (maximum snow depth x 1.25) + 0.5m
t = ***h*** x 0.4
e = 0.194 x ***h***



not to scale

Determine the Sensor Height (*h*)

NOTE: The lower the sensor can be mounted the stronger the echo from the snow.

The sensor should be mounted at least 1.64 feet (0.5m) above the highest expected snow level, to a maximum of 32.8 feet (10m).

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

Determine the Extension Length (*e*)

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.

Calculate the minimum extension length using this simple formula:

Extension length = 0.194 x Sensor height

Mounting Hardware

The 260-705-TM kit (sold separately) contains parts for mounting the sensor to a mast or tower. The extension arm is 5 feet long and has a threaded fitting on one end for attaching the snow depth sensor. The sensor cable is threaded through the extension arm, and the arm itself is held by a bracket which is

then clamped to your mast. The standard kit includes U-bolts that fit a 1.25" diameter mast. Larger U-bolts (not supplied) can be substituted for masts up to 2.5" diameter.

A suitable mounting structure can be made with parts from a local hardware store. The 260-700 Ultrasonic Snow Depth Sensor is provided with a 1/2" NPT female coupler so that it is easily installed on a threaded 1/2" galvanized pipe of suitable length. A reducer may be used to adapt to larger pipe if needed for rigidity. Apply Teflon tape to the pipe threads, feed the cable through the pipe and then screw the pipe into the coupler on the sensor, taking 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.

8 WIRING

CAUTION: Make sure the power is turned off before connecting to your logger.

Color	Function	Data Logger Connection
Red	Power	+12 to +24 Vdc
Black	Ground	Ground
Clear	Shield	Ground
Green	Sensor Enable	+2.5 to +24V Control Port*
White	Output High	Signal or Differential Input High
Brown	Output Low	Differential Input Low**

* Free Run Mode: Connect green Sensor Enable wire to red Power wire
** Single Ended Input: Brown not connected (insulate)

The Red wire connects power to the sensor.

The Black wire connects power supply ground to the sensor.

The Clear (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 electricity.

The Green wire must be connected to the red Power wire to operate in free run mode, which outputs distance information only. Some loggers are capable of toggling Sensor Enable to start a measurement cycle, and can then read the temperature and distance measurement on the output wire(s).

The White wire is the analog output signal that is proportional to distance (free run mode). If free run mode is disabled and Sensor Enable is toggled, the temperature signal will be output, followed by the distance measurement.

The Brown wire is not used for single-ended inputs (insulate the brown wire). For differential inputs, connect to the low input.

9 CALIBRATION

The 260-700 Ultrasonic Snow Depth Sensor outputs temperature and distance measurements that are usually read by a logger or other device. Some loggers use slope/intercept calibration factors to scale the readings, while others use minimum/maximum settings. The following charts includes both sets of parameters, in various units, for your convenience.

NOTE: The temperature signal is available only if Free Run Mode and Fast Free Run Mode are disabled and the logger is programmed to read the temperature signal within the time slot specified by the setting of DIP Switch 4.

Output Range	**0 - 2.5 Volt Output**				**0-5 Volt Output**			
Distance Scale Factor	500 cm/volt				250 cm/volt			
	Min	**Max**	**Slope (m)**	**Offset (b)**	**Min**	**Max**	**Slope (m)**	**Offset (b)**
Volts	0	2.5	-	-	0	5	-	-
mm	0	12500	5000	0	0	12500	2500	0
cm	0	1250	500	0	0	1250	250	0
meters	0	12.5	5	0	0	12.5	2.5	0
inches	0	492.13	196.85	0	0	492.13	98.425	0

Output Range	**0 - 2.5 Volt Output**				**0-5 Volt Output**			
Temperature Scale Factor	200 °K / volt				100 °K / volt			
	Min	**Max**	**Slope (m)**	**Offset (b)**	**Min**	**Max**	**Slope (m)**	**Offset (b)**
Volts	0	2.5	-	-	0	5	-	-
Degrees K	0	500	200	0	0	500	100	0
Degrees C	-273.15	226.85	200	-273.15	-273.15	226.85	100	-273.15
Degrees F	-459.67	440.33	360.00	-459.67	-459.67	440.33	180	-459.67

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), it is often more useful to program the logger to reverse the readings to show actual snow depth. For loggers that use the slope/intercept method, simply multiply the slope by -1 and use the Max value as the offset. For loggers that use the minimum/maximum settings, swap the maximum and minimum parameters.

One more refinement is needed to normalize the readings. Unless the sensor is mounted at its maximum height the offset from zero needs to be accounted for. The easiest way to get a good zero reading when there is no snow on the target is to run the sensor and check the readings from the logger. Take an average of a few readings to calculate how much to adjust the zero offset. For slope/intercept loggers, adjust the offset only. For minimum/maximum loggers, if there is a zero calibration term apply the correction there.

It is a good idea to test your results by checking two points at least. One point can be ground level, where you should get a zero reading. To measure another point, place a stool with a piece of plywood on top under the sensor and take another reading. Compare this reading with the height of the plywood target.

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, drain it and let it dry before sealing up any openings.
2. If the sensor must be opened for any reason, check the condition of the desiccant pack and replace it as required.
3. Secure the cable so that it does not whip around in the wind. Check for signs of wear.
4. 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. Also check the PVC tee where the temperature sensor is mounted, and clear out any insect nests.
5. 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.
6. Aim the sensor perpendicular to the target.
7. Verify the calibration by checking the readings at two points at least.

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 then 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.

12 REFERENCES

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