



SL300 SNOW DEPTH SENSOR

Revision 1.1.2



User Manual

Table of Contents

1. Introduction 3

2. Operation 3

 2.1. Electrostatic Transducer.....4

 2.2. SL300 Analog Board4

 2.3. SL300 Digital Circuit Board.....4

 2.4. Calibration Procedure 6

3. Installation.....8

4. Maintenance9

5. Specifications.....11

6. Warranty12

1. Introduction

Felix Technology Inc SL300 Depth Sensor is an inexpensive solution for remotely measuring snow depth or water levels. The sensor measures the distance from the sensor to a target. The sensor works by measuring the time required for an ultrasonic pulse to travel to and from a target surface. An integrated digital temperature sensor inside a solar radiation shield provides an air temperature measurement for properly compensating the distance measured.

An embedded microcontroller calculates a temperature compensated distance and performs error checking. The distance is presented at the output as an analog signal between 0 to 5 Volts or 0 to 2.5V. An Optional digital RS232/485 output provides travel time in *ms*, distance in *mm* and air temperature in degree Centigrade. Accurate measurement of snow depth poses many difficult problems. The SL300 Snow Depth Sensor has proven very effective in measuring snow depth, which makes it well suited for the other various applications too.

2. Operation

The ultrasound waves are emitted in bursts and received back at the transducer as echoes. The instrument measures the time for the bursts to travel down to the reflecting surface and return. This time will be proportional to the distance from the transducer to the surface and can be used to determine the level of liquid or snow.

The simple ultrasonic echo ranging system included in the SL300 is composed of three main parts: the transducer, the electronics analog module, and the digital processor module. The transducer is an electrostatic type transducer used to both transmit the signal, and also receive the returning echoes. The electronic modules contain all of the necessary circuitry to generate the transmit signal, drive the transducer, receive the echoes, and process the information received by the transducer. The distance from the transducer to the target is then computed by the digital processor module, knowing the speed of sound in air, and the time interval between the transmit signal and the received echo. The SL300 operates over a distance range of 18 inches to 20 feet (0.45 to 6.10 meters), increasing the receiving amplifier gain and decreasing the bandwidth with time to compensate for signal losses over the distance range.

To minimize the system's susceptibility to noise pick-up, a signal integration scheme is employed before the system locks onto an echo. Once the threshold level of the integrator is reached, a signal is generated to indicate a received echo. The logic level outputs for the transmit signal and received echo can be used to perform control functions or calculate distance to the object.

2.1. Electrostatic Transducer

The key to the system is the unique electrostatic transducer. It is composed of a very thin, Kapton-film diaphragm vacuum coated with gold to form the negative electrode. The positive electrode is the coined aluminum back-plate which also provides the resonant structure for the diaphragm. Mechanical bias, as well as electrical contact is provided by a stainless steel leaf spring.

2.2. SL300 Analog Board

The analog module uses a single interface to connect to the main Digital Board. The module has an accurate ceramic resonator controlled 420 KHz time base generator that is being used with to provide the frequency of 49.4 KHz for the ultrasound transmission. Also a variable bandwidth amplifier with digital controlled gain with minimum noise used to receive the echoes with an accuracy of better than $\pm 1\%$. The transducer is driven with a 1 millisecond tone burst at 400 Volts peak-to-peak and 200 volts DC bias, producing an output sound pressure level at 50 kHz of approximately 110 dB SPL at 1 meter. The transmitting response is flat to beyond 100 KHz. This provides the transducer with very fast damping so that ranging at high gain can be achieved as quickly as possible after transmit. The very wide bandwidth and extremely high output allows the system to operate over a very wide distance range.

2.3. SL300 Digital Board

In the digital board a counter starts counting when a pulse is triggered by the processor. The same pulse is used to transmit an ultrasonic pulse towards a target. The output of the analog board which is an amplified received echo in response to transmit pulse is used to stop the counter. The count value represents the distance ultrasound wave traveled from the transducer to the snow surface and return back to the transducer. This count value and the temperature measured by the temperature chip are processed by the microprocessor to calculate the distance from the transducer to the object. The final measurement according to the full scale setting is fed to an analog to digital converter to produce the analog voltage output of 0 to 2.5V or 0 to 5V. In addition to analog output, a stream of real time digital data containing the maximum and minimum distance setting, temperature, travel time, and distance can be read through RS485 serial port.

2.4. Digital Board Connectors, Switches, and LEDs

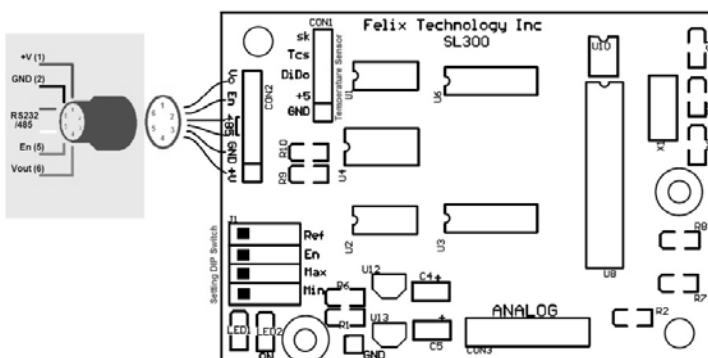


Figure 1 Digital Board connectors, Switches, and LEDs

There are three connectors on the digital board as follows:

- **CON1:** Temperature Sensor Connector
- **CON2 :** I/O Connecto (Power Input, Serial Interface, Enable, Analog Out)
- **CON3:** Interface to the analog Module

The unit setting is achieved using four DIP switches:

- **J1:** DIP Switches are for setting the Analog Output Range, Voltage Output Enable, and Maximum & Minimum Ranges.
 - SW1 Analog Output range selection:
 - ON:** 0 to 5 Volts DC Output
 - OFF:** 0 to 2.5 Volts DC Output
 - SW2 Enable
 - ON:** Free running, device does not need HIGH 'Enable' input.
 - OFF:** Device functions only when 'Enable' input is HIGH (TTL level).
 - SW3 Maximum range setting
 - SW4 Minimum range setting

SL300's operation can be monitored using 2 LEDs.

- **LED1:** Mode detection LED
 - Normal Operation mode: Flashing
 - Calibration mode (setting the maximum and minimum ranges of depth measurement): starts with OFF, and after a delay it blinks once to show the end of the calibration process (Refer to Calibration procedure).
- **LED2:** Power ON

2.5. SL300 wiring

It is recommended to power down your system before wiring the SL300. Never operate the sensor with the shield wire disconnected. The shield wire plays an important role in noise emissions and susceptibility as well as transient protection.

Pin #	Colour	Function	Connection
1	Red	+8 to 24V Power	12V Power Supply
2	Black	Ground	12V Power Supply
3	Blue	RS485 B	To RS-485 B terminal
4	White	RS485 A	To RS-485 A terminal
5	Brown	Enable	Digital Output of Datalogger
6	Green	Analog Output	Analog Input of Datalogger
7	Yellow	Analog Ground	Analog Input of Datlogger

2.6. Analog Output Calibration Procedure

To perform the calibration setting, it is required to open the enclosure of the sensor. Please refer to section (4) Maintenance.

1. Apply the DC power (8 to 24VDC) between Pin-1 (Red Cable as +V) and Pin-2 (Black cable as Ground or -V).
2. Connect a DC voltmeter (DVM) Plus (+) lead to the Analog Output (pin 6 or Green cable) and the DVM Minus (-) lead to Common (pin 2 or Black Cable).

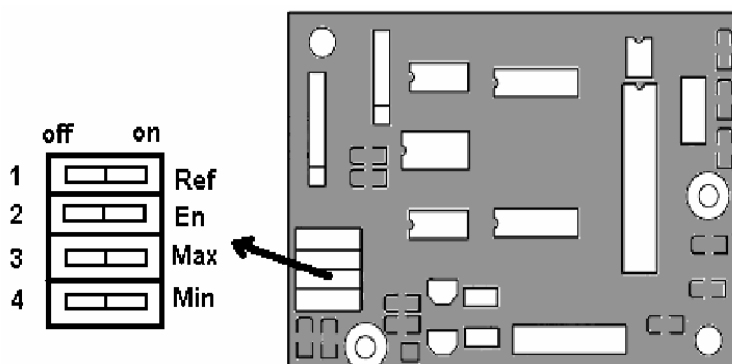


Figure 2 Maximum and Minimum calibration using Dip switched on the digital board

3. Place the target at the maximum desired distance for the full-scale voltage output. Switch the “MAX” Switch (DIP-SW3) to “ON” position, and wait for the detect LED1 indicator to blink once and then remain on. Then return the “MAX” Switch (DIP-SW3) to “OFF” position. The SL300 is now calibrated to your desired maximum target distance for full scale analog voltage output (5 or 2.5VDC).
4. Place the target at the desired minimum distance for the zero voltage output. Switch the “MIN” switch (DIP-SW4) to “ON” position, and wait for the detect LED1 indicator to blink once and then remain on. Then return the “MIN” Switch (DIP-SW4) to the original “OFF” position. The SL300 is now calibrated to your desired minimum target distance for zero analog voltage output.

The function of LED 1 during the Calibration procedure:

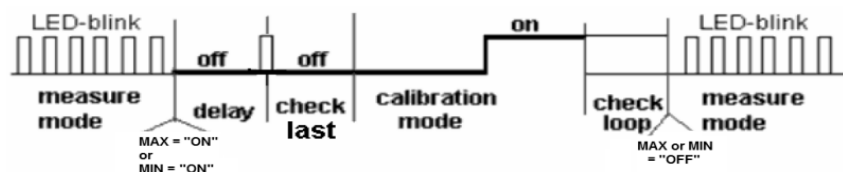


Figure 3 LED 1 function during the calibration procedure

Switching both MAX and MIN switches to “ON” position simultaneously and then switching back to “OFF” position, will reset the measurement range between Minimum=0.000 to Maximum=10.000 meters.

To determine the snow depth, first subtract the voltage recorded from the maximum voltage read on the voltmeter during the step3, then divide the result by 5 (if the full scale is set to 5V) or 2.5 (if the full scale is set to 2.5VDC). Finally, multiply the result of division by the maximum distance – minimum distance.

Note: Please always remember to return the MAX and MIN Switches back to “OFF” position for the normal operation of the device.

2.7. Serial Interface

There is an optional serial interface for digital data for a PC or Terminal Emulator with RS232 protocol. The serial connection is done using Pin 3 and 4 of I/O connector (White and Blue Cables).

When the unit is turned on, this uni-directional 2-wire interface, transmits the values of maximum and minimum adjusted distances (refer to Calibration Procedure) and after that continuously sends these data; Measured Distance, Travel time and Temperature.

At start:

'MAX='AAAA'mm' 'MIN='BBBB'mm'

Data Format

While working:

'X='CCCC'mm' 't=DD.DD'ms' 'T='EE.E

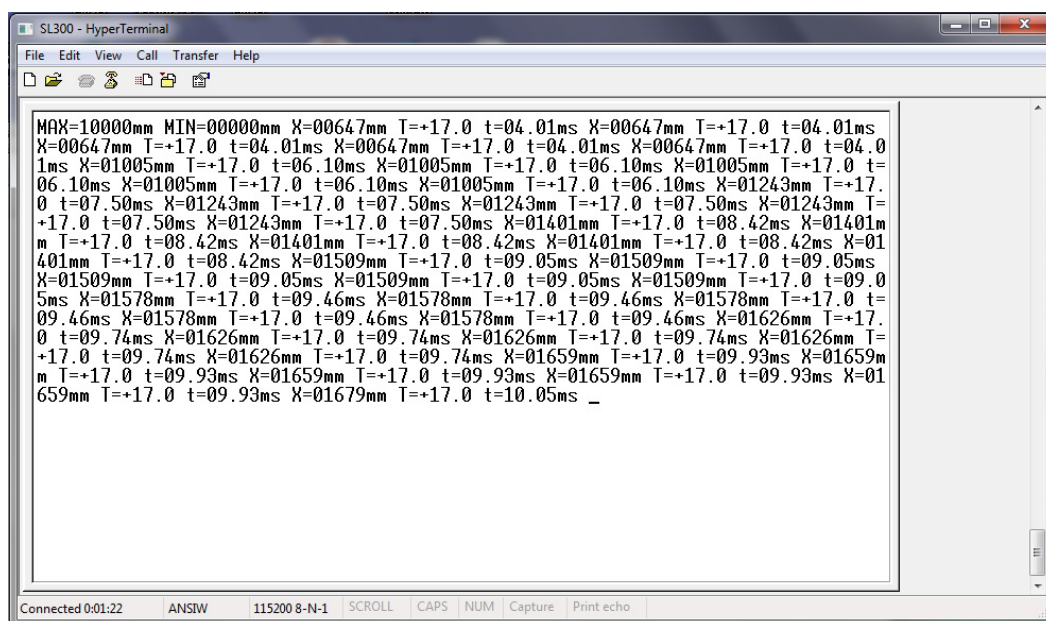


Figure 4 HyperTerminal display when SL300 connected to a PC through serial port

Installation

When mounting the sensor pay careful attention to the cone of the ultrasonic beam. The beam width is 15 degrees which means that the diameter of the beam will be 30% of the distance to the target. This means that after traveling 10 meters the beam diameter will be about 3 meters. In this example the sensor would need to be mounted at least half the distance of the beam diameter, or 1.50 meters, away from the mast. Be careful to avoid obstructed beam paths. To determine the minimum distance the sensor must be mounted away from the mast use this formula:

$$\text{Cross arm length} = 0.3 \times \text{Height}$$

The SL300 Depth Sensor must be mounted **perpendicular** to the target surface. Mounting the sensor at an angle will result in erratic and unreliable measurements. To improve the accuracy of the sensor measurements mount the sensor as close to the target as possible. This will minimize errors that are a percentage of the distance measured. However, the sensor cannot measure closer than 0.45 meters to the target, and for the best result it should be mounted at least 1 meter away from the target.

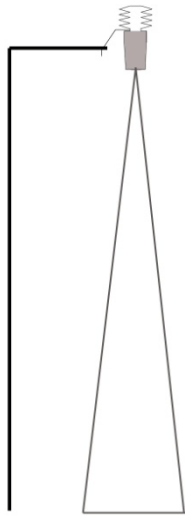


Figure 5 Correct mounting

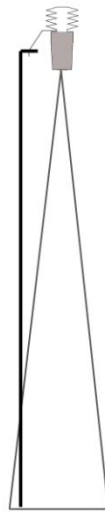


Figure 6 Incorrect mounting pole in the beam

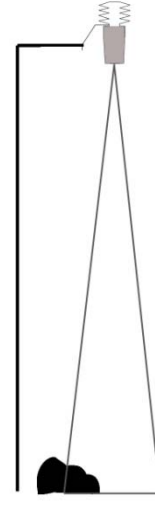


Figure 7 Incorrect mounting obstruction in beam

3. Maintenance

When properly installed, the Depth Sensor should require minimal maintenance. Disassembly is required for setting or calibration, to change the transducer, and inspect or replace the desiccant.

1. Disconnect the SL300 from the connector.
2. Dismount the sensor enclosure from the radiation shield by detaching the holder panel by removing two screws, and then un-tightening the throttle bolt/screw on the radiation shield.
3. Loosen the black gland to let the temperature sensor move and rotate freely inside the enclosure throttle.
4. Open the enclosure by rotating the enclosure cap anticlockwise.

Warning!

Make sure that during rotation, the temperature sensor and related cable stand still and do not turn together with the Cap.



Figure 6 Disassembling procedure for the maintenance

5. In order to access DIP switches, firmly pull out the Analog and Digital boards together with extra care in order to avoid any damage to the ribbon cable between the two boards and also the cable to the depth sensor. Continue pulling out the boards' assembly until the DIP switches are accessible for the required setting or calibration.



Figure 7 Dip switches are accessible for the required setting and calibration

The reverse procedure can be performed for assembling the unit back to the working status.

Warning!

After this reverse procedure, please make sure that both the enclosure cap and the black gland are securely tightened to prevent moisture getting inside the sensor enclosure.

6. Specifications

Distance Range:	0.45 - 6.10m (1.5'-20')
Accuracy (over entire range)	± 0.1%
Beam Pattern	Typically 15° nominal
Repetition Rate	2.5 Hz
Output Voltage (Analog)	0 to 2.5VDC or 0 to 5VDC
Load Current (maximum)	2 mA
Power Requirements	5 to 24 VDC (85 mA)
Operating Temperature:	-40 to +85°C (-40 to 185° F)
Weight	855 grams
Dimensions	L: 21cm, ϕ :13cm
Housing Material	Aluminum
Transducer Open Face	Stainless Steel

7. Warranty

The **SL300 Snow Depth Sensor** is warranted by Felix Technology Inc. to be free from defects in materials and workmanship under normal use and service for a year from date of shipment unless specified otherwise. Felix Technology Inc's obligation under this warranty is limited to repairing or replacing defective products . This warranty shall not apply to any Felix Technology Inc. products which have been subjected to modification, misuse, neglect, accidents of nature, or shipping damage. This warranty is in lieu of all other warranties, expressed or implied, including warranties of merchantability or fitness for a particular purpose. Felix Technology Inc. is not liable for special, indirect, incidental, or consequential damages.

Products may not be returned without prior authorization. To obtain a Return Materials Authorization, contact Felix Technology Inc. At:

**1-25 Edilcan Drive
Concord, ON L4K 3S4
Tel: (905) 760 0444
Fax: (905) 760 0044
Email: sales@felixtec.ca**

Non-warranty products returned for repair should be accompanied by a purchase order to cover the repair.