Anemoment

ANEMOMENT LLC

TriSonica Mini Sensors

User Manual

TriSonica Mini Sensors: User Manual

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NOTES:

Sensor Unit Numbers: _____

Purchase Date: _____

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Chapter 1

Hello World!

Welcome to the User Manual for the TriSonica Mini (TSM) family of products from Anemoment.

We hope you find this information useful and wish you every success in your research. We welcome comments and questions about this manual by email at *info@anemoment.com*.

Guide to User Manual

This User Manual provides technical information to mount, connect, receive data, and configure the TSM Sensors. For specific information on **FUNCTIONALITY**, **CONFIGURATIONS**, plus **TECHNICAL DATA and DRAWINGS,** use the Table of Contents in this User Manual to find information you seek.

The TriSonica Mini Family of Products

1. **TSM-WS** *TriSonica Mini Wind Sensor* (discontinued)
2. **TSM-FB** *TriSonica Mini Wind and Weather Sensor – Flat Base*
3. **TSM-PM** *TriSonica Mini Wind and Weather Sensor – Pipe-Mount Base*
4. **USB-Interface** *TriSonica Mini USB Interface Module*
5. **TSM-FBSK** *TriSonica Mini Flat Base Starter Kit* includes one each: **TSM-FB, USB-Adapter,** and **USB A-to-B cable**.
6. **TSM-PMSK** *TriSonica Mini Pipe Mount Starter Kit* includes one each: **TSM-PM**, **USB-Adapter**, **USB A-to-B Cable**, and **2-meter single terminated cable**.

As used in this Manual, the term “TSM Sensor” means the information specified applies to both the TSM-WS *and* the TSM-PM.

Table 1: TSM SENSOR COMPARISON GUIDE

	MOUNT STYLE	CONNECTION TYPE	AVAILABLE COMMUNICATION PROTOCOLS	DATA OUTPUT	ON-BOARD SENSOR TYPES
TSM-WS (discontinued)	Flat Base	4 Wires	• EIA232	Configurable ASCII String	• Wind Direction & Velocity • Air Temp.
TSM-FB	Flat Base	4 Wires	• EIA232	Configurable ASCII String	• Wind Direction & Velocity • Air Temp. • Air Pressure • Humidity • Tilt • Compass
TSM-PM	Pipe-Mount with 3 Set Screws	12-pin Mating Connector	• EIA232 • EIA422 • EIA485 • LVTTL-UART • Modbus (future)	Configurable ASCII String	• Wind Direction & Velocity • Air Temp. • Air Pressure • Humidity • Tilt • Compass

Tell Us!

Did you spot a bug, a spelling error, or something that just didn't make sense to you? We'd love to hear about it. Please send feedback to info@anemoment.com, with a detailed explanation of your concern. Screenshots and photos can be extremely helpful!

Limitation Alerts

Anemoment wants you to get the best possible use from your TSM Sensor investment, and we understand that each User has a unique idea they want to create. You know best what you are trying to accomplish. We know the TSM Sensors can help you access essential and actionable wind and weather data in new places and new ways, but we cannot promise that they can do everything or go everywhere the human mind can think up. We want to alert you to these points up front, to empower your decisions as you plan your project.

Compact Fluorescent Lamps

Many compact florescent lamps operate at ultrasonic frequencies that interfere with the operation of a TSM Sensor. If the TSM Sensor is operated near compact florescent lamps, erroneous and erratic readings may result. Turning off the compact florescent lamps or moving the TSM Sensor away from the CFL should result in proper instrument operation.

Electro-Mechanical Motors and Magnetic Sensors

Electro-mechanical motors generate magnetic fields; the effect of the field on a magnetic sensor varies by distance of the sensor to the motor, and by the speed (and variations of speed) at which the motor is operated. The magnetic sensor aboard your TSM Sensor will be affected by the field generated by motors nearby. We recommend

that you consider the effects of magnetic fields arising from your unique use configuration in both your hardware and software design.

Ice and Snow

The small size and light weight that are the hallmark of the TSM-FB and TSM-PM leave no space for on-board heaters. These TSM Sensors are designed to function in outdoor conditions; however, if ice or snow accumulate *within* the Sensor the acoustic pathways between transducers can be blocked. While the dark coloring of the TSM-Sensors facilitates natural solar removal of ice and snow, the TSM Sensors may not be the best choice of sensor for sustained use in wintery weather.

Just the Facts, Ma'am

TSM Sensors combine powerful detection elements with a high-speed processor to produce near-realtime data facts about atmospheric conditions at the site of the sensor. The TSM Sensor transmits these collected data facts over wires in the form of a User-configurable ASCII data stream. It is up to the User, however, to interpret this data in the User's unique situational context, which may require combination with additional User-provided data or other post-processing. Anemoment is not responsible for such additional data or processing.

Sorry, No Apples Today

The data stream from the TSM Sensor can be received, stored, and interpreted by the User's choice of device so long as it is connected to the Sensor by the proper communications protocol. We recommend the use of a Terminal Emulator, such as Tera Term, to review the data stream and to communicate with or configure the sensor. Available for download at the Anemoment website is a rudimentary User interface app for use on Windows™ operating systems; this app is not suitable for data logging functions. The App's OS choice is simply a result of skill-set limitations; we do not presently have a timeline for developing an interface app for other operating systems.

Wind Tunnels & Ultrasonic Frequency

Ultrasonic anemometers operate by generating ultrasonic pulses and measuring the time of flight of those sound pulses between transducers. The time-of-flight measurements can be disturbed by external noise sources in or near the same frequency band used by the ultrasonic anemometer's transducers. (The TSM Sensors operate in the 60KHz ultrasonic frequency range) We have found that some wind tunnels generate ultrasonic noise that can cause erroneous readings from the anemometer. This is not an indication of failure of the anemometer, but an artifact of using the anemometer in what is to it an ultrasonically noisy environment.

Chapter 2

TSM Body, Drawings, & Mounting Specifications

TSM Sensor Body Composition

The bodies of the TSM Sensors are injection molded of DuPont Performance Polymer Zytel® glass reinforced nylon for long-term performance in outdoor environments. Over time the sensor acquires a weathered-gray patina, ideal for minimizing visual presence of the system. The connecting posts are carbon fiber tubes.

Figure 1: NORTH INDICATOR

Orientation

The TSM Sensors have a “north” arrow indicator “N” marked on one of the upper arms. Airflow passing directly *into* the “N” will return ZERO degrees for wind direction, regardless of the actual orientation of the TSM Sensor.

TSM-FB

The TSM-FB features a flat base with four mounting points for connecting to a User-supplied mounting platform.

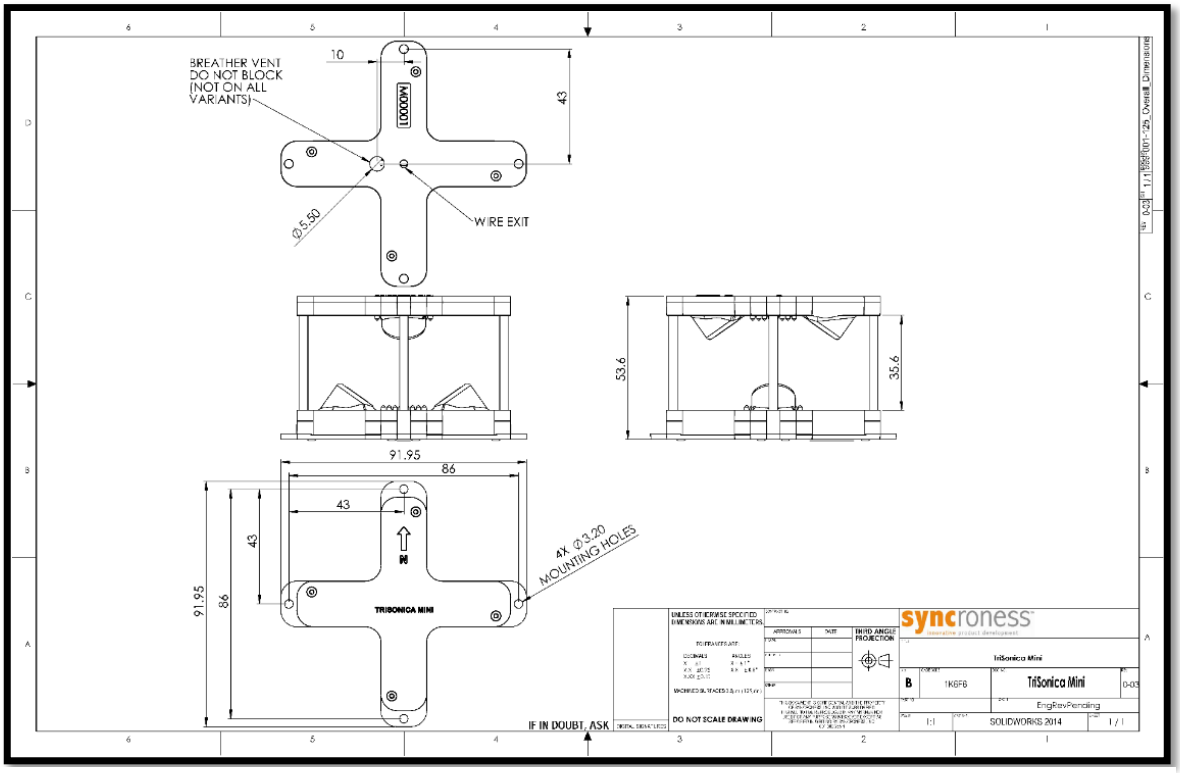


Figure 2: TSM-FB DRAWING

Considerations for User-Supplied Mounting Platform for TSM-FB

The User-supplied mounting platform should be a flat plate having a 5-mm hole in the center for the connecting wires, and 5.5-mm hole positioned at the Gore-Tex™ Vent to allow for water vapor and air pressure exchange.

TSM-FB Tripod Mounting Plate

Anemoment offers an optional 3d-printed mounting plate for attaching the TSM-FB to a standard platform or camera tripod. This mounting plate features a brass ¼-20 threaded insert.

TSM-PM

The TSM-PM has a circular connector to mount over a standard ½" DIN15 Schedule 10 pipe or 22-mm Carbon Fiber Tube. The pipe must be a thin wall type, as indicated by the Schedule 10 designation, to allow an inside diameter wide enough to let the mating cable connector pass through the pipe.

Before fitting the TSM-PM to the pipe, thread the mating cable through the pipe and snap the cable connector to the TSM-PM base connector. Then place the TSM-PM over the pipe and tighten the three set screws to secure. For a detailed description of the internal wiring of the connector and cable specifications please see Chapter 3: CONNECTING.

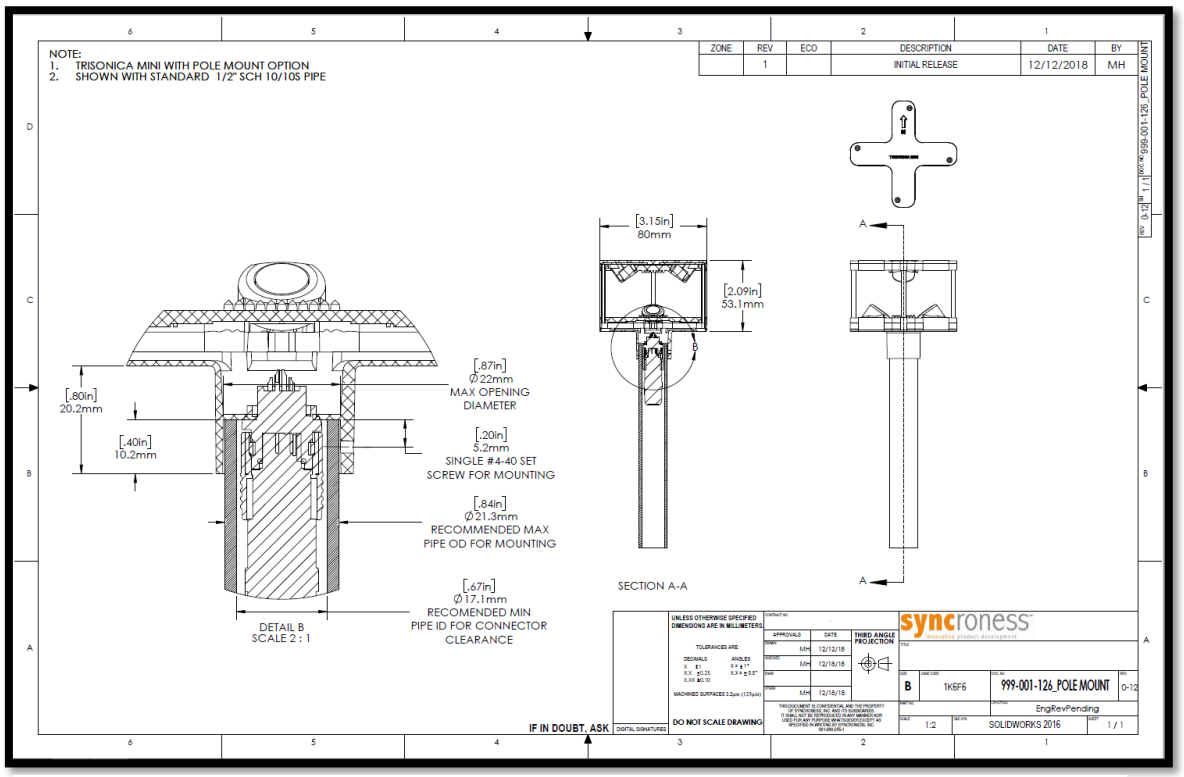


Figure 3: TSM-PM DRAWING

TSM-PM Tripod Adapter

As an optional accessory, Anemoment offers a 3d-printed pipe-simulating adapter for attaching the TSM-PM to a standard platform or camera tripod. This mounting adapter features a brass ¼-20 threaded insert.

Chapter 3

Connecting Up

Getting power in and data out – Your TSM Sensor will work best if you give careful attention to the information in this Chapter.

TSM-FB

Exiting the base of the TSM-FB are four unterminated wires for User hook-up. The wires are color coded to indicate the purpose of each.

Figure 4: TSM-FB WIRES

- **Yellow** is 9V to 36V.
- **Red** is RS-232 TxD (Serial Data Out of the TSM).
- **Green** is RS-232 RxD (Serial Data into the TSM).
- **Black** is Ground and the serial connection return.

Specially configured TSM-FB may have different color wires in the place of or in addition to these four. Please refer to instructions accompanying the specially configured TSM-FB for more information.

Connecting the TSM-FB to Other Anemoment Products

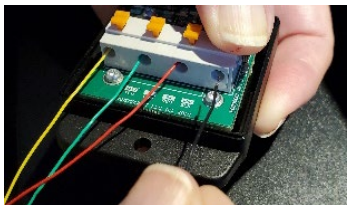


Figure 5: TSM-FB to USB ADAPTER INSERTION

- **USB ADAPTER:**

  Open the Adapter case, and insert the wires exiting the TSM-FB into the terminal block by color as labeled on the circuit board. Then connect the Adapter to a computer using the USB cable. A helpful video demonstrating this connection is available at Anemoment.com/resources/.

- **DATA LOGGER (Circuit Board Only):**

  The screw terminals on the Data Logger are labeled “A” and “B”. Use the “A” terminals to attach a single TSM-FB; use both “A” and “B” terminals to attach two TSM-FBs to the Data Logger board. Insert each wire into the appropriate screw terminal hole and tighten.

Table 2: TSM-FB to DATA LOGGER SCREW TERMINAL WIRING POSITIONS

	YELLOW Wire	**RED** Wire	**GREEN** Wire	**BLACK** WIRE
Single TSM-FB	A4	A6	A5	A3
Second TSM-FB	B4	B6	B5	B3

- **DATA LOGGER (in WEATHER-TIGHT BOX):**

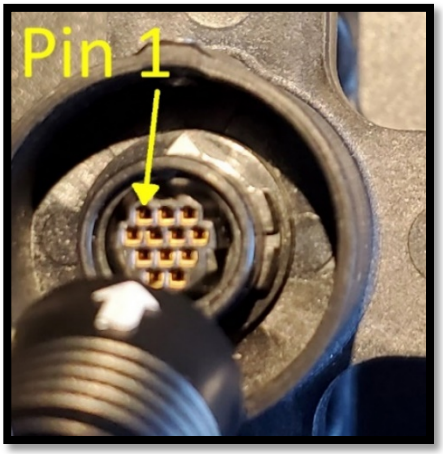
  Use a single terminated cable to connect the TSM-FB to a Data Logger in Weather Tight Box via the 12-pin Circular connector port on the outside of the box. Connect the wires exiting the TSM-FB to wires accessed in the blunt-cut end of the cable by carefully matching as follows:

Table 3: TSM-FB to BLUNT-CUT CABLE MATCHING

TSM-FB Wires→	**YELLOW** Wire	**RED** Wire	**GREEN** Wire	**BLACK** Wire
Cable Wire →	**BROWN** Wire	**YELLOW** Wire	**BLUE** Wire	**RED** Wire

TSM-PM

The TSM-PM contains a female 12 Pin circular connector that connects to a male 12 Pin Circular IP67 connector.



Cables with connectors may be purchased from Anemoment in 2m, 5m, 10m, and 20m lengths. Customized cables and mating connectors may be purchased directly from Samtec.com (see https://www.samtec.com/products/mcp for information about their line of products and customizability).

Table 4 shows the pin-out diagram for the signal connections and positions within the connector in reference to looking at the bottom of the connector, with Pin 1 at upper left.

The cable internal wire colors and pin description are given in Table 5.

1 - VIN	2 - GND	3 - Trigger	
4 - TX+	5 - TX-	6 - RX+	7 - RX-
8 - URX	9 - GND	10 - 232	
11 - UTX	12 - GND		

Table 4: TSM-PM PIN OUT DIAGRAM

Table 5: TSM-PIN DESCRIPTION & CABLE WIRE COLORS

Pin #	Wire Color	Signal Name	Description
1	BROWN	VIN	Voltage Input of 9V to 36V
2	RED	GND	Ground connection. Only one of the GND connections are required for proper operation. Multiple GND connections are provided as a convenience for system wiring.
3	ORANGE	Trigger	Synchronizing Trigger input. This input allows multiple instruments to synchronize their sampling to a common signal.
4	YELLOW	TX+	Serial Transmit data output in EIA232 Mode and TX+ data output in EIA422 mode.
5	GREEN	TX-	Serial Transmit data output TX- in EIA422 mode. Not used in EIA232 mode.
6	BLUE	RX+	Serial Receive data input in EIA232 Mode and TX+ data output in EIA422 mode.
7	VIOLET	RX-	Serial Receive data input RX- in EIA422 mode. Not used in EIA232 mode.
8	GRAY	URX	3.3V LVTTL UART Serial Data Input.
9	WHITE	GND	Ground connection. See the description for Pin #2
10	BLACK	232	Force Single Ended Serial mode. When this pin is connected to GND the TSM will start in EIA232 or LVTTL-UART mode with the settings of 115200,8,N,1 regardless of the software settings of the instrument.
11	LIGHT GREEN	UTX	3.3V LVTTL-UART Serial Data Output.
12	PINK	GND	Ground connection. See the description for Pin #2

Connecting the TSM-PM to Other Anemoment Products

- **USB ADAPTER:** Use the Single-Terminated blunt-cut cable to connect the TSM-PM to the USB Adapter. Separate out and strip 3mm of the ends from the **Yellow**, **Blue**, **Red**, **Black**, and **Brown** wires from the blunt-cut end of the cable.

  NOTE: to some eyes the Brown wire appears mauve or lilac in color. If you find it difficult to identify the Brown wire because you see two purple-*ish* wires, the Brown wire is the lighter "not" rich-violet one.

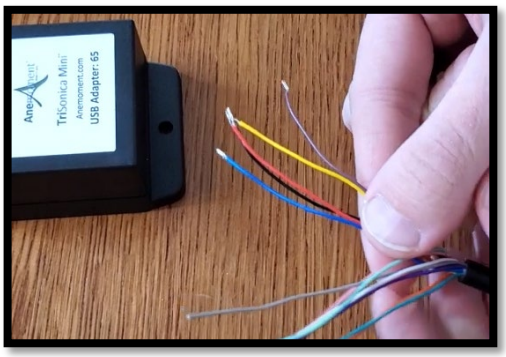
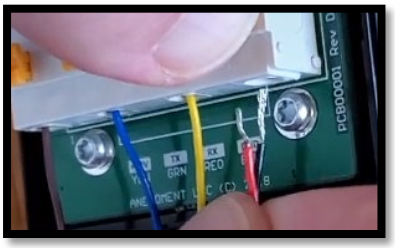


Figure 7: Separating the Wires

Open the adapter case and insert the wires into the terminal block holes as follows:

Table 6: TSM-FB to DATA LOGGER SCREW TERMINAL WIRING POSITIONS

1	2	3	4
BROWN	**BLUE**	**YELLOW**	**RED** & **BLACK**



CAUTION: Because the cable contains 12 wires designed to accommodate the multi-protocol capable TSM-PM, these color assignments ***do not match*** the labels printed on the USB Adapter circuit board.

A helpful video demonstrating this connection is available at Anemoment.com/resources/.

- **DATA LOGGER (Circuit Board Only):** Use a Single-Terminated blunt-cut cable to connect the TSM-PM to the USB Adapter. Separate out and strip 3mm of the ends from the **Red**, **Brown**, **Blue**, **Yellow**, **Orange**, and **Black** wires from the blunt-cut end of the cable.

  The screw terminals on the Data Logger are labeled "A" and "B". Use the "A" terminals to attach a single TSM-FB. Use both "A" and "B" terminals to attach two TSM-FBs to the Data Logger board.

  Insert each wire into the appropriate screw terminal hole and tighten.

Table 7: TSM-PM DATA LOGGER SCREW TERMINAL WIRING POSITIONS

	RED	**BROWN**	**BLUE**	**YELLOW**	**ORANGE**	**BLACK**
Single TSM-PM	A3	A4	A5	A6	A7	A8
Second TSM-PM	B3	B4	B5	B6	B7	B8

- **DATA LOGGER (in WEATHER-TIGHT BOX): Connect these items by snapping in** place the connectors at both ends of a Double-Terminated cable.

Chapter 4

Data Output

The TSM Sensor collects a wide variety of environmental data. This Chapter explains what you see in the data stream. Chapter 5 will tell you how to customize which variables should appear, how they should be labeled, and how often the information should arrive.

Viewing Serial Data Stream

With the TSM Sensor connected to a computer using the USB Adapter or similar User-designed device that both supplies power to the TSM Sensor and allows data pass-through, the Serial Data Stream from the TSM Sensor can be viewed by using a Terminal Emulator app such as Tera Term or with the TriSonica Mini User App downloadable at https://anemoment.com/resources/.

Serial Data Format

The TSM outputs data in an ASCII character string ending with carriage return and line feed characters.

Each line is a single record of all the measured parameters contained in a single sample. The parameters on an output line are separated by two spaces, or by a single space and a negative sign. The User may elect to use optional data tags to indicate the measurement associated with the value; the tags can be turned on or off for each individual type measurement. For more about tags, see ***Show, Hide, Tag, Untag,*** and ***Decimal*** Commands.

A sample of the output *without* tags:

05.2 112 -01.9 04.7 01.1 22.6
05.3 107 -01.5 04.9 01.3 22.2

The columns in this example in order are

Wind **S**peed - Wind **D**irection - **U**-Vector - **V**-Vector - **W**-Vector - **T**emperature.

A sample of the output data *with* tags:

S 05.2 D 112 U -01.9 V 04.7 W 01.1 T 22.6
S 05.3 D 107 U -01.5 V 04.9 W 01.3 T 22.2

S= Wind Speed
D= Wind Direction
U= U-Vector
V= V-Vector
W= W-Vector
T=Temperature

Custom Delimiters (New in 2.0)

The delimiters for the tags and parameters are customizable. In this example a colon is used after the tags in place of the space and a comma is added after the measurement value. The default values are a space character for both the tags and the parameters to be compatible with previous versions. Details on how to use this feature are given with the **paramdelim** and **tagdelim** commands.

S: 05.2,D: 112,U:-01.9,V: 04.7.W: 01.1,T: 22.6
S: 05.3,D: 107,U:-01.5,V: 04.9,W: 01.3,T: 22.2

Error Codes

When the TriSonica Mini firmware detects an error, it outputs an error code in the data stream in all the affected parameters. All error codes appear in the format of "-99.x". The decimal value of the error code varies with the error type.

When an error code is in the output, use the "diagnostic" command to get information about the error.

One of the most common reasons for an error is an ultrasonic pathway blockage. Ice, snow, or some other physical material is preventing the ultrasonic signal reception. Clearing the blockage returns the unit to normal operation.

Chapter 5

Customizing the TSM Sensor Configuration

The TSM Sensor collects a wide variety of environmental data. By connecting the TSM Sensor to a computer. This Chapter explains how to communicate to the TSM Sensor, which variables should appear, how they should be labeled, and how often the data packets should arrive.

Serial Communication - Defaults

The TSM Sensor is configured by default to these serial parameters:

- Baud Rate: 115,200
- Data Bits: 8
- Parity: None
- Stop Bits: 1

The TSM Sensor starts generating data about one second after power up, and outputs data continuously when in sampling mode. You can tell the TSM Sensor is working by listening for a quiet rapid clicking sound made by the transducers. (This sound is a mechanical artifact from a transducer initiating an ultrasonic sound, not the ultrasonic sound itself).

Serial Communication – Access Methods

There are several access methods by which the User can enter configuration instructions for the TSM Sensor. The choice of method is largely up to User preference, though some higher level instructions are available only through more expert access methods. Each access method is explained.

Serial Menu (New in 2.0)

Pressing the ESC key brings up a serial menu for configuring basic settings. Please note that not all settings are accessible from this menu.

If no User input is received while the Serial Menu is inactive for one minute, the TSM returns to sampling mode and any changes made are not stored in the non-volatile memory.

Table 8: SERIAL MENU FUNCTIONS

MAIN MENU OPTION	FUNCTIONS AVAILABLE WITHIN MENU OPTION
A. Serial Setup	Serial Baud, Parity, and (TSM-PM only) Serial Protocol Selection
B. Data Output Setup	List of Output Parameters, indicating whether they are Enabled, how many Decimals are displayed, the Units for the parameters, and the data Tag. From this menu, press the menu letter key to access submenus that control these Output Parameters.
C. Instrument Setup	Data Output Rate, Orientation, and (TSM-PM only) Trigger parameters
D. Calibration	Walks the User through calibration steps for User-performed wind, level, and compass calibration. • To calibrate the wind sensor, the User places the instrument in a zero-airflow chamber equipped with a temperature sensor, and the User enters a value for local humidity. • The level sensor calibration requires a surface that is known to be level and that can support the TSM level to the surface. • Compass calibration requires the User to twist and rotate the sensor in a three-dimensional figure-eight fashion, in similar manner to how cell phones calibrate an internal compass.
E. Diagnostic	Runs built-in diagnostics and displays the results.
G. Instrument Reset	Resets the instrument, clearing all volatile memory, restoring to non-volatile memory settings.
X. Exit *without storing changes*	Exits the menu with the changes the User has made, allowing the User to apply the changes temporarily. These changes are not stored in the non-volatile memory and will be lost after a system reset/system power-down.
0. Exit	Exits the menu and stores changes in non-volatile memory. These changes are retained even after a system reset/system power-down

Command Line Interface - Basic

To enter command line interface (CLI) mode, press Ctl+C. The TSM Sensor stops sampling and provides a User prompt: “>”. New in 2.0, if no User input is given within one minute, the TSM Sensor returns to sampling mode.

Details of all available commands and their parameters are accessed within the Command Line interface by typing “help” at the User prompt. For reference, some of the commands are listed below. Parameters are indicated with “<” and “>” characters; you will replace the angle brackets and the text with the parameter value. Parameters shown within square brackets “[“ and “]” are optional.

NOTE: We attempt to make the TSM CLI self-documenting, so with future Firmware Releases, the detailed help for each command may be more current than appears in the following table.

Table 9: Serial Commands in the Command Line Interface

COMMAND	DESCRIPTION
help	Displays a list of CLI commands.
help <command>	The command word "help" followed by the name of another command displays detailed help for that command.
exit	Leave the CLI and return to sampling.
baudrate [<baud> [now]]	Show or set the current baud rate
calibrate <temp> [<rh>]	Start an anemometer calibration cycle. See the anemometer calibration Chapter of this document for more details about the anemometer calibration procedure.
compasscalibrate YES	Start a compass calibration cycle. (Not available on TSM-WS) See the compass calibration Chapter of this document for more details about the compass calibration procedure.
decimals [<param>]	Set the number of decimals places of a Display Parameter or a Group of Parameters. See the Show, Hide, Tag, Untag, and Decimal Commands section in this document.
declination [<value>]	Set/Read the true heading declination offset
Diagnostic [details|clear]	Performs a self-diagnostic and reports problems found with the TSM. The details parameter gives a more detailed diagnostic output. The clear parameter clears the error counts display of the details parameter
display	Show the current Display Mode settings. See the Display Commands section in this document.
expert enable|disable	Enable or Disable Expert Menu Command Items. See the section on Expert Mode
hide [<param>]	Hide Display Parameter Groups. See the Show, Hide, Tag, Untag, and Decimal Commands section in this document.
levelcalibrate YES	Start a level calibration cycle. (Not available on TSM-WS) See the compass calibration section of this document for more details about the compass calibration procedure.

COMMAND	DESCRIPTION
nvwrite	Writes parameter data to non-volatile memory. See the section about Non-Volatile Parameters.
outputrate [<value>]	Set or Show the data output rate of the sampled data
parity [odd|even|none [now]]	Set or Show the current parity setting
programupdate [YES]	Use the TriSonica Mini Program Update Utility provided by Anemoment.
show [<param>]	Show Display Parameter or Groups. See the Show, Hide, Tag, Untag, and Decimal Commands section in this document.
systemreset	Software Reset.
tag [<param>]	Display the ID Tag of a Display Parameter or a Group of Parameters. See the Show, Hide, Tag, Untag, and Decimal Commands section in this document.
triggertype [<type>]	Set or Get the sampling trigger type – TSM-PM Only
trisonicaid <id>	Set or Show TriSonica User Defined ID
units [<param> [units]]	Sets or Displays the units value for all adjustable parameters
untag [<param>]	Remove the ID Tag of a Display Parameter or a Group of Parameters. See the Show, Hide, Tag, Untag, and Decimal Commands section in this document.
version	Displays software version and build numbers
wd540 [<value>]	Set or Show the Wind Direction 540 Degree Mode

Command Line Interface - Expert Mode

When expert mode is enabled, these extra commands are present in the help menu. It is recommended that you understand the effects of these commands before you use them.

Table 10: Serial Commands In Expert Mode

COMMAND	DESCRIPTION
averagesize [<size>]	Set or Show the size of the average of samples. This command specifies the number of internal samples to average before generating an output, when combined with the samperate command below it affects the output data rate. For simplicity, it is better to use the outputrate command in the basic menu.
digitalgain [<gain>]	Get or Set the digital gain. Digital, or software, gain is set by the calibration command. Changing digitalgain can affect the stability of your output data.
distance [<value>] (x1 or x4)	Set or Show the distance between transducers. This is one of the calibration factors set during the calibration cycle. If you enter the value as a single number, it will be applied to all four distances. If you enter four values, they will be applied respectively to the four distance values. The mechanical distance between transducers of a TSM is 0.03486.
humiditycalibrate [slope <slope>|offset <offset>]	Gets or sets the slope and offset humidity calibration factors. This command allows the Users to add their own slope and offset values to the humidity senor output. Note that the humidity is transferred through the Gore-Tex Pvent on the bottom of the TSM and can take several minutes to equalized with there is a rapid change in humidity. Using the command without parameters returns the current slope and offset values. Providing the slope and offset parameter values sets these values for the humidity sensor.
lowpower	Sets or shows the low power configuration parameters. Low power mode can be woken internally, or externally. Do not use the external wake mode on a TSM-WWS.

COMMAND	DESCRIPTION
offset [<value>] (x1 or x4)	Set or Show the offset value for all paths. This is one of the calibration factors set during the calibration cycle. If you enter the value as a single number, it will be applied to all four distances. If you enter four values, they will be applied respectively to the four distance values. The offset value compensates for variations in manufacturing.
orientuv [std | ati | otsm]	Set or View the UV Wind Vector Output coordinate system. There are some different definitions for the meanings of the U and V axis. The “std” setting defines positive U as being from the West, and positive V as being from the South. The “ati” setting defines the positive U as being from the North, and positive V as being from the West. The “otsm” setting matches the original TriSonica Mini output definition of positive U as being form the North, and positive V as being from the East.
paramdelim [<delim> | space]	Get or Set the Parameter delimiter for all Display Parameters
pressurecalibrate [slope <slope>|offset <offset>]	Gets or sets the slope and offset pressure calibration factors. This command allows the Users to add their own slope and offset values to the pressure senor output. Note that the pressure is transferred through the GorTex vent on the bottom of the TSM and can take several seconds to equalized with there is a rapid change in pressure. Using the command without parameters returns the current slope and offset values. Providing the slope and offset parameter values sets these values for the pressure sensor.
protocol [232|422 [now]]	Show or set the current serial protocol setting. The command only works for the TSM-PM, where the EIA422 signals are brought out to the connector. This is the software command to select between EIA232 and EIA422 modes. The “now” parameters makes the change immediately, otherwise the change happens after a system reset. – TSM-PM Only

COMMAND	DESCRIPTION
samplerate [<Hz>]	Set or Get the internal sample frequency. This command changes the internal sampling rate and when combined with the averagesize command above affects the output data rate. For simplicity, it is better to use the outputrate command in the basic menu.
shadowcorrect [0|1]	Enable or disable the shadow correction calculations of the TSM. 1 = enable, 0 = disable. It is not recommended that the User turn off the shadow correction.
tagdelim [<delim> | space]	Get or Set the tag delimiter for all Display Parameters
tagid <param> <id>	Set the tag id to <id> in the specified parameter <param>
triggertype [<type>]	Get or set the trigger parameters. See the section on triggering.

Application Programming Interface (New in 1.9)

The TSM provides a method to simplify computer command automation. It is a variation on the CLI interface and uses the same commands as the CLI interface. The API commands are sent to the TSM during sampling mode. The command is enclosed in curly braces "{" and "}" without a carriage return or line feed character. One command per set of curly braces. The open curly brace "{" instructs the TSM that a API command is starting, and the close curly brace "}" indicates the end of the command. When the close curly brace "}" is received the command is executed and the results returned within the curly braces. **This is not compatible with the JSON protocol.**

Triggering – TSM-PM Only

The TSM-PM includes a trigger line. Triggering can be internal or external and can be adjusted to trigger on the rising or falling edge of the external signal. The parameters "posedge" and "negedge" for the **triggertype** command make this selection.

The three trigger modes are:

1. **Internal Trigger:** The TSM uses its own internal timer for sample triggering and runs asynchronous to other instruments. (NOTE: The TSM-FB only has Internal Triggering.)
2. **External Trigger:** When an external trigger is received the TSM-PM takes the number of samples specified in the **averagesize** command at the configured **samplerate**. When this sampling is complete the output is generated and transferred over the serial port. The TSM-PM then waits until the next trigger before sampling again. If the trigger is too fast to complete all the samples, the TSM-PM will shorten the number of samples taken to maintain the external trigger rate.

3. **Sync**: The sync trigger mode adjusts the internal trigger sampling to align with the sync trigger, otherwise the TSM-PM operates on its internal trigger. For instance, this is useful for aligning samples to a GPS Pulse Per Second clock so multiple instruments can trigger simultaneously without being connected to the same trigger. Sync pulses can have a very long time between pulses.

Display Command

The **'display'** command prints a table indicating the name and description of each signal available, whether it is tagged or not, what the tag value is, how many decimals are displayed, whether the signal is enabled to be added to the serial output string, and the units for each measurement.

```
> display
Display Value List:

┌──────┬──────────────────────┬────────┬──────┬──────────┬─────────┬─────────┐
│ Name │ Description          │ Tagged │ Tag  │ Decimals │ Enabled │ Units   │
├──────┼──────────────────────┼────────┼──────┼──────────┼─────────┼─────────┤
│    S │ Wind Speed 3D        │        │    S │        1 │ Yes     │ m/s     │
│   S2D│ Wind Speed 2D        │        │   S2 │        1 │         │ m/s     │
│    D │ Horiz Wind Direction │        │    D │          │ Yes     │ Degrees │
│   DV │ Vert Wind Direction  │        │   DV │          │         │ Degrees │
│    U │ U Vector             │        │    U │        1 │ Yes     │ m/s     │
│    V │ V Vector             │        │    V │        1 │ Yes     │ m/s     │
│    W │ W Vector             │        │    W │        1 │ Yes     │ m/s     │
│    T │ Temperature          │        │    T │          │ Yes     │ C       │
│   Cs │ Speed of Sound       │        │    C │        1 │         │ m/s     │
└──────┴──────────────────────┴────────┴──────┴──────────┴─────────┴─────────┘
```

Figure 8: Display Command Output Example

Show, Hide, Tag, Untag, and Decimal Commands

The '**show**', '**hide**', '**tag**', '**untag**', and '**decimal**' commands operate similarly. They enable a measurement, disable a measurement, display the tag for a measurement, remove the tag for a measurement, or adjust the number of decimals for an output; respectively.

When invoked without a parameter, they display the options available. The '**show**' command only lists the values that are available to be shown, similarly the '**hide**' command only lists the values that can be hidden. (The '**hide**' command provides a convenient list of all values currently being displayed.) The '**tag**' and '**untag**' commands show only the values available to be tagged and untagged, and the '**decimal**' command only lists the values that allow changing their decimal resolution.

Tag and Parameter Delimiters (New in 2.0)

The display output can be modified by changing the delimiters between the tag and the parameter value, and between measurement values. The tag delimiter is a single character display immediately after the parameter tag and is controlled by the **tagdelim** command. The delimiter between measurement values is a single character displayed immediately after the parameter value is displayed. This value is controlled by the **paramdelim** command. The default value for both delimiters is a space character.

Chapter 6

Calibration Procedures and System Memory

Every TSM Sensor is tested and calibrated prior to shipping.

However, the User can re-calibrate the sensor to acclimate to unique use cases or local conditions by following these directions.

Anemometer Calibration

Place the TSM inside a small container to reduce the airflow to as close to zero as possible. Care must be taken to eliminate acoustic reflections from hard sides and to not block the acoustic pathways. There should be some sound absorbing material on any flat walls that could reflect sound back towards the TSM. A small box with acoustic absorption foam is ideal. However, in a pinch you can successfully calibrate a TSM by loosely wrapping a coat or towel around it. The main thing is to provide a zero-wind environment, and to know the temperature, and ideally the humidity, of the air volume where the TSM is enclosed.

Type “calibrate <temp> [<rh>]”

Where the <temp> = xx.x in °C temperature and <rh> = xx.x in % relative humidity. If humidity is not supplied, then 50% is assumed.

The calibration cycle takes ten seconds. You will see dots printed on the serial console indicating progress, and the serial prompt will return when the calibration is completed. Enter “**nvwrite**” to store the new calibration values in non-volatile memory.

Level Calibration

The calibration function of the level is simply an offset adjustment for the accelerometer contained in the TSM. Place the TSM on a known level surface such that the bottom surface of the TSM is parallel with the level surface. The wires of the TSM will prevent placing the TSM directly on the level surface. With the TSM in a known level configuration execute the “**levelcalibrate**” command. Enter “**nvwrite**” to store the values in non-volatile memory.

Compass Calibration

The compass calibration acclimates the compass module in the TSM to the local magnetic field. Start the compass calibration by using the “**compasscalibrate**” command. The compass calibration is active for fifteen seconds, during this time tilt and rotate the TSM into as many orientations as possible using a three-dimensional figure eight pattern. Enter “**nvwrite**” to store the values in non-volatile memory.

Let's talk Calibration – It's all in the Math and Physics

Inside each TriSonica Mini sensor a high-speed processor running custom software applies principles of math and physics to extract atmospheric data from the tiny changes in how quickly soundwaves travel along paths between pairs of transducers.* By sending and detecting sound waves along multiple acoustic paths (TriSonica products use 4 acoustic paths intersecting the three spatial axes), three-dimensional information about atmospheric conditions at the site of the sensor can be obtained.

Our custom software results from decades of experience in sonic anemometry software design (including creation of the software currently featured in Applied Technologies, Inc. products). Our software also reflects years of testing and refinement for the unique geometry of the TriSonica Mini sensor through fluid dynamic modeling, digital signal processing, and wind-tunnel based shadow-correction verification.

This software enables the sensor to identify precisely how long it takes for sound to pass between two transducers. As a result, the only calibration measurement of importance is knowing the **exact distance of the acoustic paths** between the pairs of transducers.

Before leaving our facility, each TriSonica Mini undergoes calibration to identify that exact distance for each acoustic path. We do this by locking down the TriSonica Mini in a zero-airflow chamber fitted with an independent temperature and humidity sensor. After an appropriate time for the chamber conditions to settle, the calibration routine of our software runs the math and physics equations backwards, in a sense, to calculate the exact distance between pairs of transducers, down to the micron level. These results are stored in the TriSonica Mini sensor's memory to supply the known distance from which time-of-flight changes are detected. Packed in the box with each TriSonica Mini sensor you will find a certification that the sensor passed this power-up and calibration testing, and the distance values were stored.

The TriSonica Mini sensor is resilient, functioning well under many adverse conditions. However, if your sensor has been knocked about, or was skewed during attachment to your custom mounting device, the distance between pairs of transducers may have changed slightly. If you believe this has been the case, you can re-calibrate your sensor in the field using the Calibrate command. You will need to create a zero-air condition around your sensor, and to enter in the temperature and humidity values for your location. This will allow your sensor to find the precise lengths of the acoustic paths for improved data accuracy.

*For a brief and elegant explanation of the math and physics of sonic anemometry, see Section II of "A Martian Acoustic Anemometer", D. Banfield, *et al*., THE JOURNAL OF THE ACOUSTICAL SOCIETY OF AMERICA 140, 1420-1428 (2016) https://doi.org/10.1121/1.4960737. The truly curious may enjoy Dr. J. Chandran Kaimal's history of the science, in "Advances in Meteorology and the Evolution of Sonic Anemometry", available at https://www.apptech.com/wp-content/uploads/2016/08/Evolution-of-Sonic-Anemometry.pdf.

Wind Direction Scale Command (wd540)

Wind direction can be displayed in a 0-to-360-degree format or in a 0-to-540-degree format for strip chart type displays. The 540-degree mode prevents full scale shifting of data when the wind direction is around 0, where it moves from 359 to 0 to 359. Otherwise, the data makes a single large transition once at 540 degrees and again at 180 degrees to display data.

Non-Volatile Parameters

The TriSonica Mini operates with a copy of its configuration parameters in volatile memory (RAM). When changes are made using the CLI, the parameters are updated in the volatile memory. These changes will be lost when the unit restarts and pulls the parameters out of Non-Volatile Memory (Flash). To copy the parameter changes made in volatile memory to the non-volatile memory use the "**nvwrite**" command. The changes will then be remembered during a restart.

Chapter 7

TSM Sensor Meteorological Data Collection

The TSM Sensor detects humidity, absolute pressure, accelerometer (tilt), and magnetometer (compass) conditions at the location of the sensor.

Humidity

The humidity sensor is located inside the TriSonica Mini and depends on the water vapor transfer membrane (white Gortex dot) to keep the humidity inside the same as outside the unit. This causes a delay in the humidity reading when the humidity change. This delay can be up to an hour for very large humidity changes, such as moving the unit from a 90% environment to a 30% environment. Normal environmental humidity changes that happen more slowly experience a shorter latency.

The Humidity is determined by calculating the dew point inside the anemometer, it is assumed then that the dew point is the same inside and out. The average of the ultrasonic temperature is used to calculate the humidity from the dew point.

An issue seen during testing occurred when the TriSonica Mini was removed from a warm 90% humidity environment to a cooler 30% environment. The quick change caused condensation inside the unit and it displayed humidity greater than 100% until the condensation evaporated and equalized through the vent.

Absolute Pressure

The absolute pressure sensor is located inside the TriSonica Mini and depends on the water vapor transfer membrane to keep the pressure inside the same as outside the unit. A slight delay is noticed with rapid pressure changes.

Tilt

An accelerometer is located inside the TriSonica Mini. Since the mounting of the TriSonica Mini affects the tilt measurement, the offsets have not been set during manufacturing. The "**levelcalibrate**" command is provided to record the accelerometer values and use them to offset the measurement for level. The raw accelerometer outputs are also available.

Compass

A magnetic sensor, or compass, is located inside the TriSonica Mini. Since the heading reading of the magnetic sensor is very dependent on the magnetic effects of the environment around it, the heading is not calibrated during manufacturing. The "**compasscalibrate**" command is provided for the User to calibrate the compass in the environment where it will be used. The raw magnetometer outputs are also available.

To calibrate the heading, the User invokes the "**compasscalibrate**" command, then rotates and tilts the unit in a three-dimensional figure eight, like how you calibrate the compass of other handheld devices.

Chapter 8

TROUBLESHOOTING your TriSonica Mini Sensor

Common Set-up Errors

Figure 9: Listen for TSM Sensor Operation

Symptom: The TSM Sensor doesn't seem to be doing anything.

Action: Place the TSM Sensor near your ear and listen for a **quiet fast ticking sound**.

- If you hear no sound, confirm the device the TSM Sensor is connected to has power.
- If the device has power, check that the USB port is providing power, and the TSM Sensor has been assigned an appropriate COM Port.
- If the connected system is powered, check the TSM Sensor's VIN and Ground connections. Refer to the CONNECTION Chapter for specific details. Note that VIN line is the only line that can handle voltages exceeding 5 volts.
- If you've checked this twice and you still hear no sound, please contact us at info@anemoment.com for further steps.

Symptom: There is no serial data coming from the TSM Sensor.

Action: Refer to the CONNECTION Chapter to check to see whether you've swapped the Transmit and Receive data lines. If those are correct, check to see whether you've connected RS-232 wire to a UART input (such as on a Raspberry-PI, Arduino, BeagleBone or the like). Fix any mis-wired connections you have found.

Symptom: The TSM Sensor sends garbled data.

Action: Check your power supply and your receiving unit to make sure there is a ground connection between the power supply, the serial port receiving data, and the TSM Sensor. If those are correct, check your baud rate and parity settings on your receiver; the TSM Sensor default transmission settings are 115200,8,n,1.

Updating TSM Sensor Firmware

Download the latest Firmware release at Anemoment.com/resources/ and save in the Download directory. Connect the TSM Sensor that computer. From here, choose a method of command access. (TeraTerm is offered as the Terminal Emulator example):

If using the **TriSonica User APP**

- In the Settings Tab click "Browse…"
- Navigate to the downloaded file.
- Click "Update Software."
- The TSM Sensor updates and the new version number will register on screen.

If using **TeraTerm (Terminal Emulator)**

- With the TSM Sensor connected and streaming data, press CTRL+C.
- Type "**programupdate YES"**
- From the TeraTerm menu select the following: File → Transfer → YModem → Send.
- Select the file to upload, and press "Enter."

Updating TSM Sensor Bootloader (New in 2.0)

In the TriSonica Mini program memory are two programs, the TriSonica Sensor application, and a bootloader. During a reset or power on, the bootloader checks to determine if the sensor application is valid. If the sensor application is valid the bootloader turns over control to the sensor application. If the sensor application is not valid, the bootloader presents a command line interface with a limited set of commands: **help**, **programupdate**, **systemreset**, and **factoryreset**. These commands perform the same functions described in Chapter 5 above.

Version 2.0 of the sensor application has a command to update the bootloader to the current version. After updating the sensor application, enter the command line and enter the expert mode with the command "**expert enable**". Then use the command "**bootloadupdate YES**" to update the bootloader.

Chapter 9

WARRANTY AND DISCLAIMER

Limited Warranty

Anemoment warrants to the purchaser that each Anemoment Product will be free from defects in materials and workmanship for 90 (ninety) days from the date of sale. The Warranty shall not apply

(i) to any Product that is abused, damaged by external causes, altered or misused; or
(ii) to any Product damaged due to improper installation or use.

Anemoment's sole obligation under this Warranty shall be to repair, replace, or refund purchase price of the applicable Product, at its sole option, provided that Anemoment is given timely notice of the defect.

THE LIMITED WARRANTY REFERRED TO IN THIS SECTION IS THE ONLY WARRANTY, EXPRESS OR IMPLIED, THAT ANEMOMENT MAKES WITH RESPECT TO THE PRODUCTS. ANEMOMENT SPECIFICALLY DISCLAIMS ALL OTHER IMPLIED WARRANTIES, INCLUDING, WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT. NO ADDITIONAL REPRESENTATION OF WARRANTY, INCLUDING BUT NOT LIMITED TO: STATEMENTS OF CAPACITY, SUITABILITY FOR USE OR PERFORMANCE, WHETHER MADE BY ANEMOMENT EMPLOYEES OR OTHERS SHALL BE CONSIDERED TO BE A WARRANTY BY ANEMOMENT FOR ANY PURPOSE OR GIVE RISE TO ANY LIABILITY OF ANEMOMENT WHATSOEVER.

Warranty Returns

For defective Products, please contact us at +1 (720) 600-7241 or info@anemoment.com to make appropriate arrangements.

Limitation of Liability

ANEMOMENT SHALL NOT BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, SPECIAL, GENERAL, DIRECT, INDIRECT OR ANY OTHER DAMAGES SUSTAINED BY ANY PERSON OR ENTITY FROM THE USE OF THE PRODUCTS.

THIS LIMITATION OF LIABILITY SECTION APPLIES WHETHER THE ALLEGED LIABILITY IS BASED ON CONTRACT, TORT, NEGLIGENCE, STRICT LIABILITY, OR ANY OTHER BASIS, EVEN IF ANEMOMENT HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE. THE FOREGOING LIMITATION OF LIABILITY WILL APPLY TO THE FULLEST EXTENT PERMITTED BY LAW IN THE APPLICABLE JURISDICTION.

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