microAeth®

MA Series MA200, MA300, MA350

Operating Manual
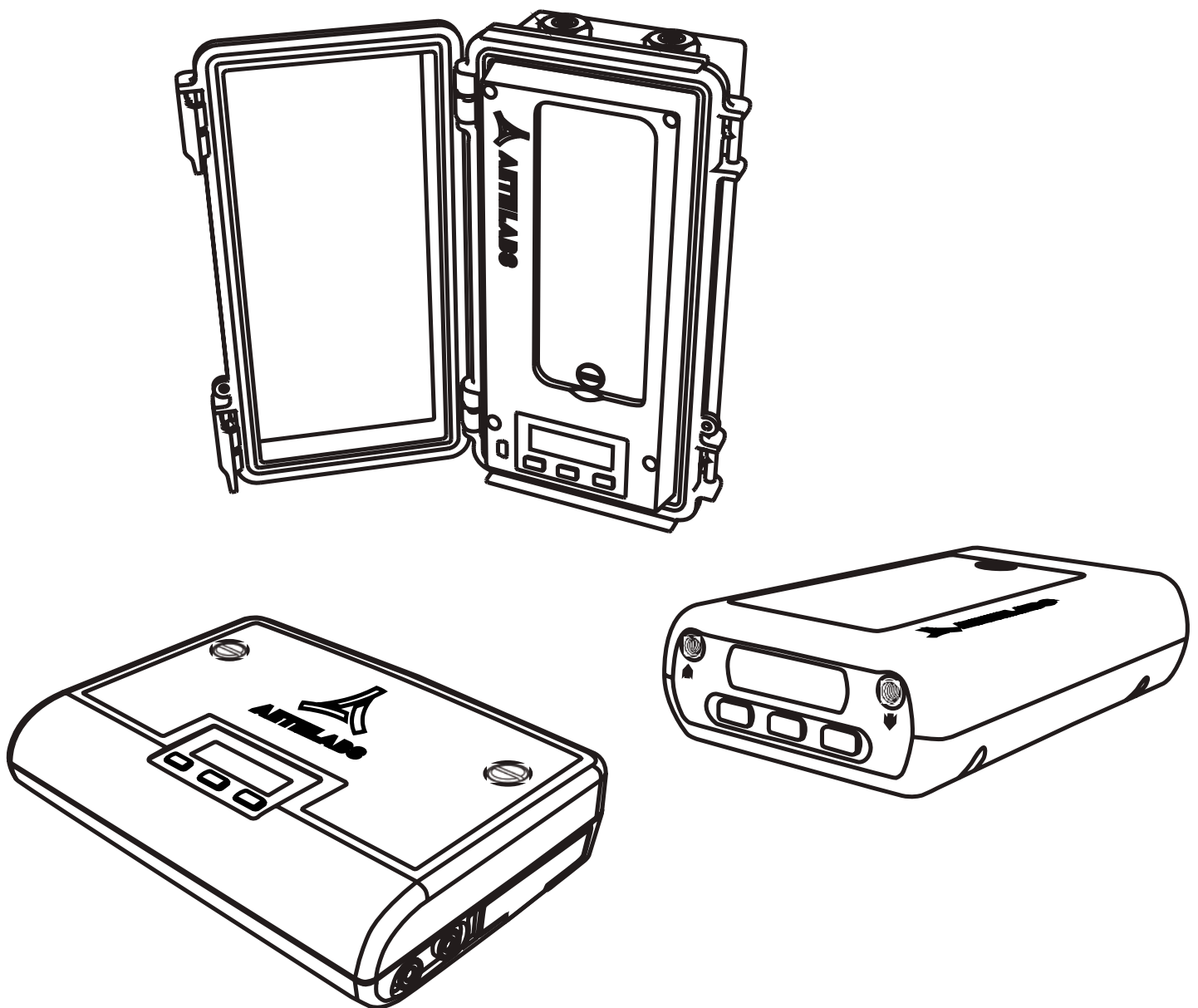
TABLE OF CONTENTS

1. Introduction

1.1. Serial Number

The model and serial number of the microAeth MA200 and microAeth MA300 are located on the bottom and back of the instruments adjacent to the USB port. The model and serial number of the microAeth MA350 is located on the inside of the main enclosure door of the instrument adjacent to the USB port. Record the serial number in the space provided below. Refer to these numbers whenever you contact AethLabs for service.

Model: microAeth® MA_____

Serial Number: MA_____-_____

1.2. Overview

Thank you for your purchase of the AethLabs microAeth® Black Carbon monitor. This product is the result of many years of research and development and represents a leap forward in mobile Black Carbon measurements. We hope that the features and capabilities of this product will enable new types of research and scientific inquiry. Please let us know how you use the instrument and if there is anything we can do to help.

The microAeth MA Series instruments are portable scientific instruments which measure the mass concentration of light absorbing carbonaceous particles in a sampled aerosol. The instruments have 5 analytical channels each operating at a different wavelength (880 nm, 625 nm, 528 nm, 470 nm, 375 nm). Measurement at 880 nm is interpreted as concentration of Black Carbon ('BC'). Measurement at 375 nm is interpreted as Ultraviolet Particulate Matter ('UVPM') indicative of organic sources such as woodsmoke, tobacco, and biomass burning. The MA Series instruments have a number of important advancements. The microAeth MA Series feature miniature cartridges that have a spool of filter material for particulate collection and on-board analysis. The instrument automatically controls the advance of the tape material, moving to a new unused spot when required. This allows the instrument to run continuously for multiple weeks or months without human intervention. The 5 wavelength optical engine enables discrimination between organic and elemental particles which is helpful in source identification when measuring different aerosols. The MA Series also features the DualSpot® loading compensation method, which in real-time measures and adjusts for differing optical properties of particles of varying age and composition.

1.3. Instrument Diagrams

1.3.1. MA200
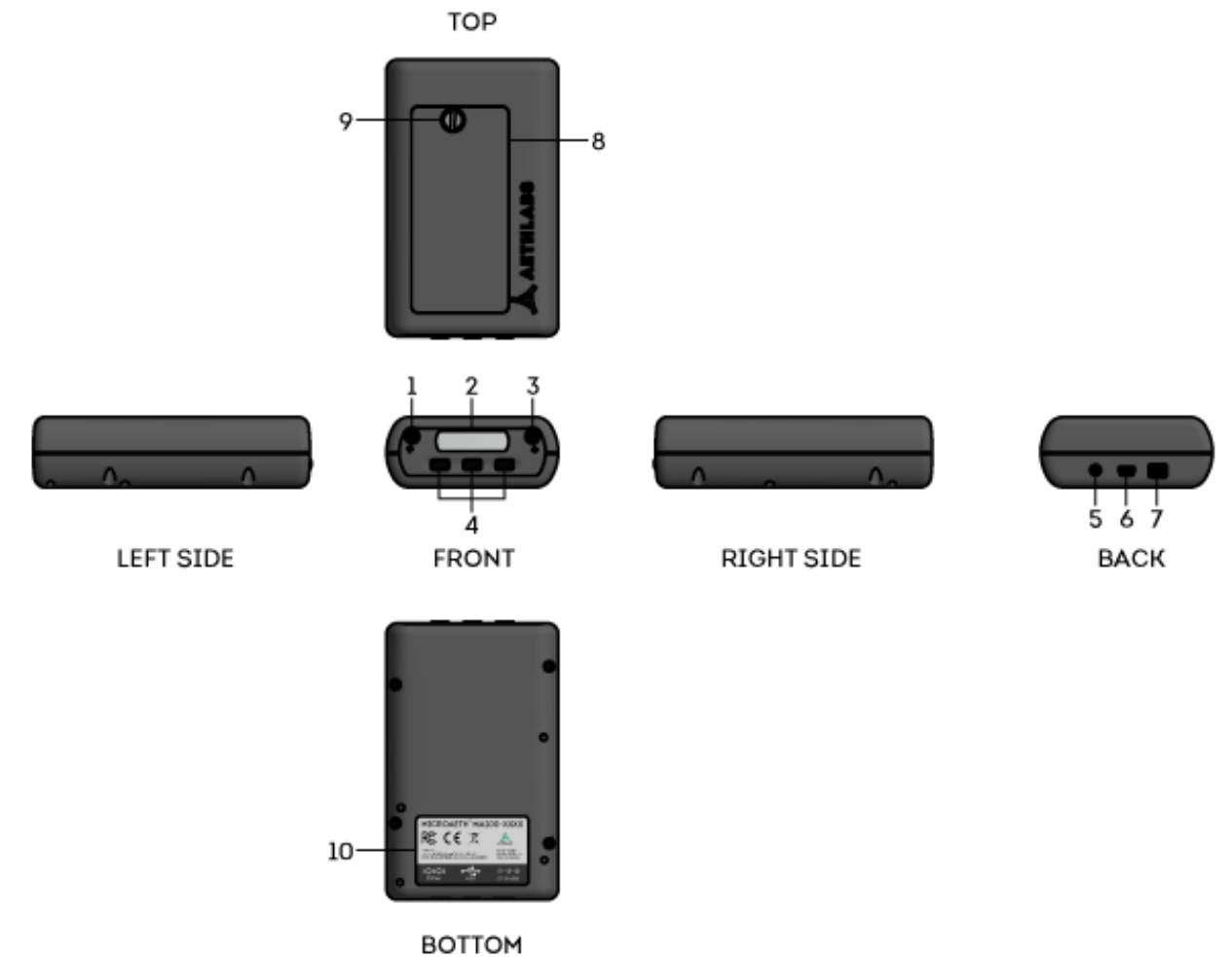
1. Inlet port
2. User interface screen
3. Outlet port
4. User interface buttons (3)
5. DC Barrel jack port
6. USB mini-B port
7. 4-pin 3.3V TTL serial port
8. Filter tape cartridge door
9. Flat head screw in filter tape cartridge door
10. Serial number label

1.3.2. MA300
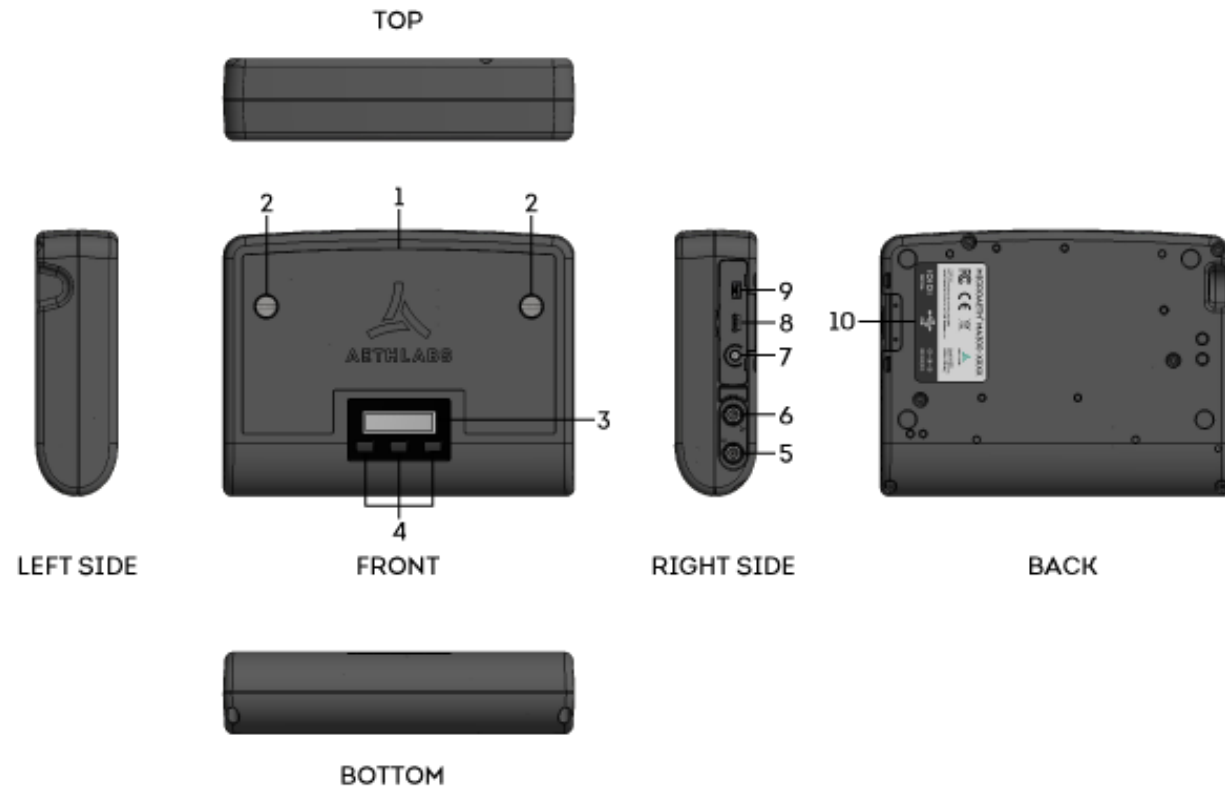
1. Filter tape cartridge door
2. Flat head screws (2) in filter tape cartridge door
3. User interface screen
4. User interface buttons (3)
5. Inlet port
6. Outlet port
7. DC Barrel jack port
8. USB mini-B port
9. 4-pin 3.3V TTL serial port
10. Serial number label

1.3.3. MA350
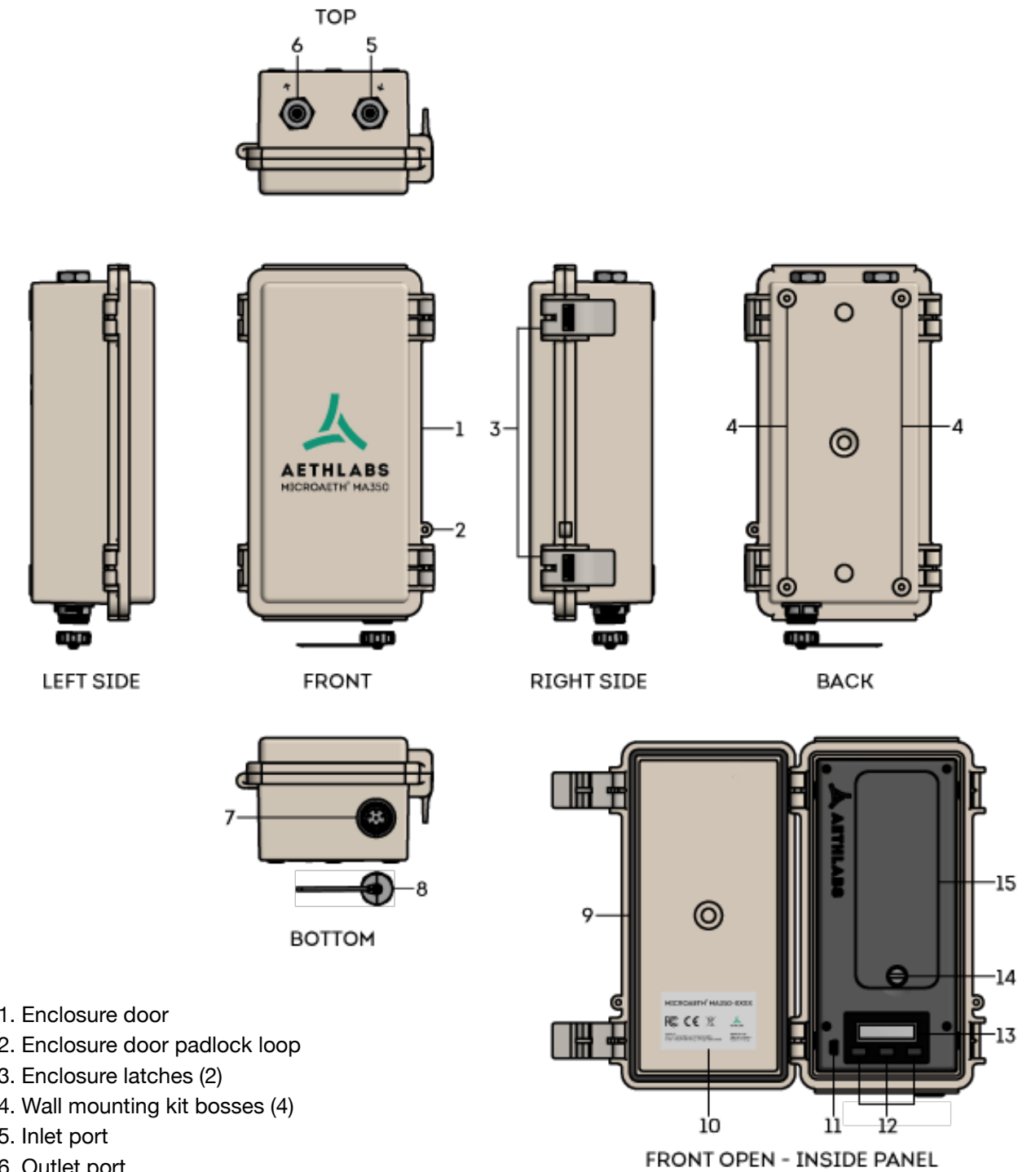
1. Enclosure door
2. Enclosure door padlock loop
3. Enclosure latches (2)
4. Wall mounting kit bosses (4)
5. Inlet port
6. Outlet port
7. Sealing circular connector for DC power in, 3.3V TTL serial comms
8. Cap for sealing circular connector
9. Enclosure door gasket
10. Serial number label
11. USB mini-B port
12. User interface buttons (3)
13. User interface screen
14. Flat head screw (1) in filter tape cartridge door
15. Filter tape cartridge door

2. Safety, Handling, and Support

2.1. Important Safety Information

WARNING: Correct operation of the microAeth is imperative for safe functioning. Failure to follow these safety instructions could result in fire, electric shock, injury, or damage to the microAeth, accessories, or other property. Only AethLabs authorized service personnel should remove covers except filter tape cartridge door. Never disassemble or make modifications to the microAeth as it may cause damage or hazard. Read all safety information and familiarize yourself with the contents of this user manual before using the microAeth.

2.1.1 Handling

Please handle the microAeth with care. The microAeth has sensitive electronic and mechanical components inside that if disturbed or damaged can cause measurement issues and possible hazard. The microAeth and its lithium-ion battery can be damaged if dropped, impacted, burned, punctured, crushed, or exposed to liquid. If damage is noticed or suspected, discontinue use of the microAeth and any accessories until the instrument has been inspected or repaired by AethLabs authorized service personnel.

2.1.2. Repair

Only AethLabs authorized service personnel should repair or service the microAeth. Never disassemble the microAeth for any reason including repair. Never remove covers except for the filter tape cartridge door. Always make sure the filter tape cartridge door is reinstalled when the instrument is in use. Making modifications or repairs to the microAeth will void any warranty and may cause damage or hazard.

2.1.3. Light Sources

The microAeth contains components with emissions in both the visible (red, green, and blue) and invisible spectrums (infrared and ultraviolet). These components are covered during operation and not directly accessible but can cause injury and damage if unauthorized disassembly or repair is made to these sources or any of their mating components. Do not look directly at the light sources as it may be hazardous to do so with the naked eye or with the aid of optical instruments. The microAeth contains a Class 1M LED light source product. Do not directly view the light sources with optical instruments. Only AethLabs authorized service personnel should move, modify, service, or repair the light sources and mating components.
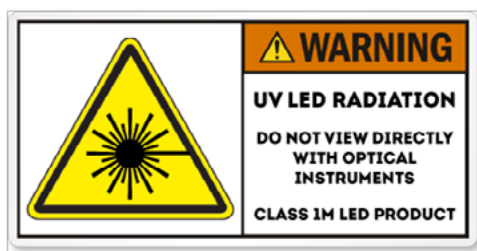
2.1.4. Battery

Do not attempt to disconnect, connect, or replace the lithium-ion battery in the microAeth. Do not expose the battery to sources of excessive heat. Only AethLabs authorized service personnel should service or replace the battery in the microAeth. Never remove covers except for the filter tape cartridge door. Always make sure the filter tape cartridge door is reinstalled while the instrument is in use. The lithium-ion battery in the microAeth must be recycled or disposed of properly and separately from general or household waste in compliance with local laws and regulations. Do not incinerate the battery. Do not handle damaged or leaking lithium-ion batteries. CAUTION RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE.

2.1.5. Charging / Power Source

The microAeth should only be operated and charged from the power source types indicated in the instrument specifications. Charge and operate the microAeth with the supplied power barrel jack for fast charging or the supplied USB cable for charging over USB. Only genuine cables and power chargers from AethLabs should be used. Do not use any cables, power chargers, or power sources with the microAeth that are not supplied by, or recommended by AethLabs, as they may cause damage or a hazard. Always inspect ports and cables before making any connection to the instrument. Damaged cables or chargers, or charging when moisture is present, can cause fire, electrical shock, other injury, or damage.

2.1.6. Heat Exposure

Do not expose the microAeth or its battery to sources of excessive heat such as direct, high intensity sunshine or fire. Always provide adequate ventilation, shelter, or protection for the instrument.

2.1.7. Radio Frequency Exposure

The microAeth uses radio signals for wireless communications with networks and other instruments.

2.1.8. Radio Frequency Interference (FCC and IC Compliance Statements)

The effect of electromagnetic fields from components and radios contained in the microAeth on other electronic devices is dependent on various factors and is unpredictable. The microAeth complies with Part 15 of the FCC Rules and with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Do not use near life critical systems. The electromagnetic fields from the instrument may interfere with other electronic devices. Follow all signs and notifications that prohibit or restrict the use of electronic devices and wireless transmitters.

Important: Changes or modifications to this product not authorized by AethLabs could void the electromagnetic compatibility (EMC) and wireless compliance and negate your authority to operate the product. This product has demonstrated EMC compliance under conditions that included the use of compliant peripheral devices and shielded cables between system components. It is important that you use compliant peripheral devices and shielded cables between system components to reduce the possibility of causing interference to radios, televisions, and other electronic devices.

2.1.9. Medical Device Interference

The effect of electromagnetic fields from components and radios contained in the microAeth on medical devices is dependent on various factors and is unpredictable. The electromagnetic fields from the instrument may interfere with medical devices.

2.1.10. Explosive Atmospheres

Never use, charge, or make connections to the microAeth in any area with a potentially explosive atmosphere or near fire or flammable substances.

2.1.11. High-consequence Activities

The microAeth is not intended for use where the failure of the microAeth could lead to death, personal injury, or severe environmental damage.

2.1.12. Choking Hazard

Some microAeth components and accessories may present a choking hazard to children. Keep these components and accessories away from children.

2.2. Important Handling Information

2.2.1. Moving Parts

The microAeth contains motorized moving parts. Be careful of moving parts when the filter tape cartridge door is open and or interacting with the filter tape cartridge advance and analysis chamber mechanisms.

2.2.2. Exposure to liquid, excessive dust, or foreign objects

Never expose the microAeth, ports, cables, or connections to the instrument to liquid or excessive dust. Never insert foreign objects into any opening or port. This instrument, ports, and air passageways should not be exposed to rain, moisture, objects filled with liquids, or any other sources or forms of liquid.

2.2.3. Using connectors, ports, and buttons

Never force any connector, cable, or foreign object into any port or opening in the instrument. Do not apply excessive pressure when inserting the filter tape cartridge into the instrument, pressing a button, or inserting or threading a cable or tubing connector into a port. Be careful to align threaded connectors correctly and to assure correct orientation while inserting all connectors. If the cable or tubing connector and port do not join with reasonable ease, they may not be compatible or there may be an obstruction. Always inspect ports and cables before making any connection to the instrument. If a port is obstructed or a cable is damaged or frayed, contact AethLabs or an authorized representative immediately for support and genuine AethLabs replacement components.

2.2.4. Operating Temperature

The microAeth is designed to operate in ambient temperatures and conditions of 0 ~ 40 °C, non-condensing. The microAeth can be damaged and battery life shortened if stored or operated outside of these conditions. For safety reasons the internal battery charger may disable battery charging if the instrument is operating at extreme temperatures. Avoid exposing the microAeth, connections, and tubing to rapid and dramatic changes in temperature or humidity. Care must be taken to identify installation and use conditions that might cause condensation of the sample aerosol stream or of the instrument itself. Such condensation can cause instrument damage, electrical shock, or hazard.

2.2.5. Consumables

Filter tape cartridges will require replacement on a regular basis depending on the measurement environment and the operating settings of the instrument. Only genuine AethLabs filter material and cartridges, supplied by AethLabs or authorized representative, should be used in the microAeth.

2.2.6. Cleaning

If the microAeth is exposed to any liquids or other damaging contaminants, immediately turn off the instrument, disconnect all cables, and remove any foreign substances in contact with the instrument. Do not use liquids or other cleaning products on the instrument. Wait until the microAeth is completely dry before charging or turning on the instrument. Only AethLabs authorized service personnel should clean the air passageways and internal components of the microAeth. Keeping the microAeth and its air passageways, internal components, and optical chambers clean is critical for maintaining the instrument and producing quality measurements. Contamination of the instrument can cause increased measurement noise, poor sealing of the analytical area and degraded operational lifetime of some components. AethLabs recommends sending your instrument for annual service, or more frequent service depending on use and operating conditions.

2.2.7. Replacement Parts

Only genuine AethLabs parts should be used in the microAeth. Only AethLabs authorized service personnel should make repairs, install replacement parts, or open the instrument except for the filter tape cartridge door. Always make sure the filter tape cartridge door is reinstalled when the instrument is in use.

2.2.8. Accessories

Only use genuine accessories from AethLabs or recommended by AethLabs. Do not use any accessories with the microAeth that are not supplied by or recommended by AethLabs, as they may cause damage or hazard.

2.2.9. Servicing

Only AethLabs authorized service personnel should service the microAeth. Never remove covers except for the filter tape cartridge door. Always make sure the filter tape cartridge door is reinstalled when the instrument is in use.

2.2.10. Disposal

The microAeth and/or its battery must be recycled or disposed of properly and separately from general or household waste in compliance with local laws and regulations. When this product reaches its end of life, take it to a collection point designated by local authorities. The separate collection and recycling of your product and/or its battery at the time of disposal will help conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment.

2.3. Warranty

Disclaimer of Warranties; Limitation of Liability. Seller warrants that the Products sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for the lesser of (i) twelve (12) months, or (ii) the length of time specified in the operator's manual, from the date of the shipment to the Buyer ("Warranty Period"). This Warranty Period is inclusive of any statutory warranty. Notwithstanding the foregoing, this limited warranty is subject to the following exclusions and exceptions: (i) air pumps are warranted only for ninety (90) days unless otherwise specified in the operator's manuals; (ii) parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for the later of (a) ninety (90) days from the date of shipment to the Buyer, or (b) the end of the Warranty Period; (iii) Seller does not provide any warranty on finished goods manufactured by others or on other consumable materials; and (iv) unless specifically authorized by separate writing by Seller, Seller makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller. Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with the published specifications thereof; provided that Buyer shall (i) promptly notify Seller in writing upon the discovery of any defect, which notice shall be provided during the Warranty Period and shall include the product model and serial number (if applicable) and details of the warranty claim, and (ii) prepay the shipment costs. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to customer of repaired or replacement Products shall be made in accordance with the delivery provisions set forth in these Terms. In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of: (i) normal wear and tear; (ii) accident, disaster or event of force majeure; (iii) misuse, fault or negligence of or by Buyer; (iv) use of the Products in a manner for which they were not designed; (v) causes external to the Products such as, but not limited to, water damage, impact damage from fall, power failure or electrical power surges, lack of maintenance; (vi) improper storage and handling of the Products; or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by this warranty, Buyer shall pay Seller therefore at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS. THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT OR OTHERWISE FOR BREACH OF THIS WARRANTY OR THESE TERMS. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT. SELLER MAKES NO OTHER REPRESENTATION OR WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, REGARDING THE PRODUCTS, INCLUDING, BUT NOT LIMITED TO, ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. IN NO EVENT SHALL SELLER BE LIABLE FOR COSTS OF PROCUREMENT OF SUBSTITUTE GOODS AND SERVICES, LOSS OF USE OR LOST PROFITS, OR ANY OTHER SPECIAL, INCIDENTAL, INDIRECT OR CONSEQUENTIAL DAMAGES, ARISING OUT OF OR RELATED TO ANY SALE OF THE PRODUCTS OR THE USE OR PERFORMANCE OF THE PRODUCTS, HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN AN ACTION FOR CONTRACT, TORT OR OTHERWISE, AND WHETHER OR NOT SELLER HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

2.4. Regulatory and Compliance Notices

This instrument meets the requirements of CE certification.
This device complies with Part 15 of the FCC Rules.
This Class A digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada. If changes are made to this instrument or it is opened without the authorization of the manufacturer, this declaration will be rendered invalid.
Regulatory information, certification, and compliance marks specific to microAeth are available on microAeth and within the microAeth manual.

3. Unpacking

Carefully unpack the instrument and accessories from their packaging. Check to identify that all items are present and that there is no damage. Retain original packaging for safe storage and shipping of the instrument.

3.1. MA200 Included Items

microAeth MA200

MA200 Filter Tape Cartridge (1 installed in instrument)

Barrel jack AC adapter with wall plug adapter

USB communication cable

1 meter sampling hose with swivel tube connector

Lapel clip for sampling hose

Cross-platform microAeth® Manager software (for download via AethLabs website)

Manual (for download via AethLabs website)

3.2. MA300 Included Items

microAeth MA300

MA300 Filter Tape Cartridge (1 installed in instrument)

Barrel jack AC adapter with wall plug adapter

USB communication cable

1 meter sampling hose with swivel tube connector

Lapel clip for sampling hose

Cross-platform microAeth® Manager software (for download via AethLabs website)

Manual (for download via AethLabs website)

3.3. MA350 Included Items

microAeth MA350

MA350 Filter Tape Cartridge (1 installed in instrument)

Barrel jack AC adapter with wall plug adapter

USB communication cable

1 meter sampling hose with swivel tube connector

Lapel clip for sampling hose

Cross-platform microAeth® Manager software (for download via AethLabs website)

Manual (for download via AethLabs website)

3.4. Accessories and Consumables

MA200 Filter Tape Cartridge

MA300 / MA350 Filter Tape Cartridge

MA Flow Calibration Kit

microCyclone™ PM2.5 Size-selective inlet at 50 ml/min, 1.6 micron cut point at 100 ml/min

MA200 / MA300 / MA350 Serial data cable to bare leads cable

MA200 / MA300 / MA350 Serial data cable to USB converter cable

MA350 circular connector to DC barrel jack and USB converter cable

MA350 circular connector to bare leads cable

MA350 circular connector to DC barrel jack and serial port cable

4. Measurements

4.1. Particles

The microAeth MA Series instruments make real-time five wavelength optical analysis by measuring the rate of decrease in transmitted light through the sample filter, due to continuous particle deposition on the filter. Measurement at 880 nm is interpreted as the concentration of Black Carbon ('BC'). Measurement at 375 nm is interpreted as Ultraviolet Particulate Matter ('UVPM') indicative of woodsmoke, tobacco, and or biomass burning. Measurements at 625 nm, 528 nm, and 470 nm wavelengths provide additional information about the aerosol, and allow for the calculation of the angstrom exponent which can be used for source apportionment and other atmospheric investigations.

4.1.1. DualSpot Loading Compensation

The microAeth MA Series instruments include hardware and firmware that implement the patented DualSpot® Loading Compensation method. This method simultaneously collects aerosol samples on two analysis spots in parallel and at different face velocities while measuring the rate of change in absorption of transmitted light due to the particles loading on the filter. The use of this method is an optional user selectable feature.

4.2. Temperature

A temperature measurement of the sample air stream is made every Timebase. The sensor for this measurement is very close to both the filter sampling locations and the internal mass flowmeters. The datastream from this sensor is representative of the internal temperature of the sample air and while it may track changes in external air temperature, it may have a temperature offset compared with actual external ambient air temperature due to internal heating or cooling of the instrument. The accuracy of the temperature measurement is typically ± 0.2 °C.

4.3. Relative Humidity

A relative humidity measurement of the sample air stream is made every Timebase. This sensor is always recorded. The accuracy of the relative humidity measurement is typically ± 1.8 %RH between 10-90 %RH at 25 °C.

4.4. Altimeter/Barometer

A pressure measurement of the internal chassis of the instrument is made every Timebase. This sensor is always recorded. The accuracy of the absolute pressure measurement is typically ± 0.4 kPa at test conditions of 50 to 110 kPa over −10 °C to 70 °C.

4.5. Accelerometer

A 3-axis acceleration measurement of the internal chassis of the instrument is made every Timebase. This sensor is always recorded.

5. Configuration and Operation

5.1. Overview

The microAeth MA Series instruments are highly sensitive, portable, and miniature five-wavelength instruments designed for measuring the light absorbing carbon ('LAC') particles. The instruments have an 880 nm optical channel which is primarily interpreted as Black Carbon ('BC'). The instruments also measure Ultraviolet Particulate Matter ('UVPM') and makes measurements at three other wavelengths which can be used to calculate the angstrom exponent for source apportionment or other investigations into the optical properties of light absorbing particles in the atmosphere. The instruments are based on the well-established Aethalometer® measurement principle used for over 30 years in laboratory-sized analyzers and incorporate the patented DualSpot® loading compensation method. The microAeth draws an air sample at a flow rate of 50, 100, or 150 ml/min through a 3 mm diameter portion of the filter media. Optical transmission through the 'Sensing' spot is illuminated by stabilized 880 nm (IR), 625 nm (Red), 528 nm (Green), 470 nm (Blue), and 375 nm (UV) LED light sources and measured by a detector. The optical attenuation (ATN) due to absorbance of particles collected on the spot is measured relative to an adjacent 'Reference' portion of the filter where no particles are accumulated. This change in ATN is derived using a starting measurement and an additional measurement at the end of the timebase period. The gradual accumulation of optically-absorbing particles leads to an increase in ATN from one period to the next. The air flow rate through the spot is measured by one or more mass flow sensor(s) which are also used to stabilize the pump. The electronics and microprocessor measure and store the data each timebase period to determine the ATN increment during each timebase. This is then converted to a mass concentration of BC expressed in nanograms per cubic meter (ng/m³) using the known optical absorbance per unit mass of Black Carbon material. The instrument's operating parameters are set up by an external software application or by the on-board interface. Operation is completely automatic after the instrument is turned on and sampling is started. During operation, the microprocessor performs the optical measurements, measures and stabilizes the air flow, calculates the BC mass concentration and records data to internal nonvolatile memory. The data may be downloaded at a later time by the same external software package or over serial. The microAeth derives its power from an internal rechargeable lithium-ion battery.

5.2. Recommendations for Best Use Practices

The small size and light weight of the microAeth® allow it to be used to gather data in a wide range of operational scenarios, not always possible using larger instruments. Optimization of performance across this breadth of applications requires an understanding of operational settings, precautions, and maintenance procedures. The following recommendations provide general guidelines.

5.2.1. Instrument Settings: Measurement Timebase and Flow Rate

In order to get the best data from the microAeth for a sampling campaign, we highly recommend that the instrument warm up for approximately 30 minutes so that it can equilibrate to its environment. The microAeth can acquire data on six timebase settings: 1, 5, 10, 30, 60, or 300 seconds. The 1 second timebase should only be used under special circumstances where a decreased signal-to-noise ratio is acceptable. At this setting, instrumental noise is larger and typically requires post-processing. The microAeth pump can operate at three sampling flow rate settings: 50, 100, and 150 ml/min. The choice of these parameters affects the operation and data. On a 1 second timebase, the instrument will acquire about 25 megabytes of data per day, which may be more challenging to handle and take longer to download.

5.2.2. Battery Runtime on Single Charge

Battery Runtime on Single Charge: Affected by flow rate and timebase settings.

NOTE: Battery life will gradually diminish after many cycles (~ 1 year of use). Runtimes vary based on individual microAeth instruments and specific environments.

5.2.3. Individual Data Point Noise

Individual Data Point Noise: At 150 ml/min, primarily affected by timebase setting.

5.2.4. Effects of Contamination

Effects of Contamination, Vibration, and Impact: Primarily affected by timebase setting.

1 second	5 seconds	10 seconds	30 seconds	60 seconds	300 seconds
very large	large	large	moderate	low	least

5.2.5. Recommended Settings for Different Scenarios

Different Black Carbon measurement scenarios require different operational settings for optimum performance. The 1 second timebase setting is a 'Data Acquisition Mode' intended for subsequent processing, and should NOT be used for routine monitoring. On a 1 second timebase, the instrument will acquire about 25 megabytes of data per day, which may be more challenging to handle and take longer to download. Data collected on a 1 second timebase should always be smoothed or averaged over longer periods, in order to optimize the signal-to-noise ratio at the desired time resolution.

5.2.6. Contamination, Maintenance, and Cleaning of Sample Chamber

If a loose particle of contamination enters the sample chamber of the microAeth or the instrument experiences vibration or impact, the data may be degraded. Shaking or tapping a "dirty" instrument may create data excursions that are far larger than those of a "clean" unit. These effects are amplified greatly at the shorter timebase settings. Our recommendations for cleaning are based upon the likelihood of contamination and the nature of use.

5.2.7. Contamination Probability for Various Use Scenarios

Sampling Scenario without use of microCyclone™	Contamination Probability
Dry, dusty environment	High
Occupational settings with combustion exhaust	High
Exposure to "oily" smokes such as biomass-burning plumes, 2-cycle engine exhaust	High
Presence of suspended fluff, fibers, pollen	High
Immediate vicinity of traffic and roadways	High
Outdoor urban environments	High
Outdoor rural environments (without dust, fluff, pollen)	High
Residential indoor environments	High

5.2.8. Recommended Hours of Operation Between Cleaning & Maintenance

Sampling Scenario	Contamination Probability		
	High	Medium	Low
Mobile sampling with impacts: on person or in vehicle	100	200	400
Mobile sampling on cushioned support	150	300	500
Stationary sampling, relocated during operation	500	800	1200
Stationary sampling, not moved during operation	800	1200	2000

5.2.9. microCyclone™ PM2.5 Size-selective inlet

The microCyclone™ may help to prevent contamination in dusty or dirty environments where larger diameter particles are present. The microCyclone PM2.5 Size-selective inlet can be connected to the inlet of the microAeth to provide a PM2.5 size cut point when the microAeth is set to a 50 ml/min flow rate. A 1.6 micron size cut point is provided by the microCyclone when connected to a microAeth with a 100 ml/min flow rate. The microCyclone may not be appropriate for use with the microAeth MA200, MA300, or MA350 when using specific operating settings depending on flow rates and if DualSpot® loading compensation is enabled.

IMPORTANT: If a microCyclone is being used with your microAeth, please clean it on a frequent basis, depending on sampling environment and concentrations.

5.3. Measurement Sampling Connections

5.3.1. Inlet Port

The inlet port is a 10-32 inch threaded port.

5.3.2. Outlet Port

The outlet port is a 10-32 inch threaded port.

5.4. Power

5.4.1. Charging

Input: 100~240 VAC 50/60Hz 0.4A, Output: 5VDC / 2A, with option for Type A, C, G, or I plug

It is highly recommended to use the DC barrel jack for charging and power. Power via USB may introduce additional noise to measurement data.

Charging times with instrument turned off:

MA200:

Fast charging DC via barrel jack AC adapter: ~3 hours
USB charging: ~6.5 hours

MA300:

Fast charging DC via barrel jack AC adapter: ~11.75 hours
USB charging: ~25.75 hours

MA350:

Sealed connector for fast charging DC via barrel jack AC adapter: ~11.75 hours
USB charging on inside panel: ~25.75 hours

5.4.2. Turn on

The on-board user interface on the front of the microAeth can be used to turn on the instrument.

1) To turn on the microAeth, press and hold any one of the three buttons for 2 seconds. The screen and instrument will turn on.

5.4.3. Turn off

The on-board user interface on the front of the microAeth can be used to turn off the instrument.

1) Use the left and right buttons to scroll through the top level menu options to 'Turn off'.

2) Press the center button to select the 'Turn off' option. The screen and instrument will turn off.

5.5. microAeth Manager Software Installation

The microAeth Manager is not yet available. Please contact AethLabs for more information.

5.6. Communication

5.6.1. On-board user interface

The microAeth has an on-board user interface with a backlit low power screen and three buttons.

5.6.2. USB 2.0

The microAeth has a USB 2.0 port for communication with the cross-platform microAeth® Manager software for configuring the instrument settings and downloading data.

The AethLabs provided mini-B to Type A USB cable can provide communication and power to and from the device, although it is not recommended for providing power to the microAeth while making measurements. A USB connection to a computer running the microAeth Manager software can be used to communicate with the device. Charging through the USB port is at a slower rate than the barrel jack AC adapter. It is highly recommended to use the DC barrel jack for charging and power while making measurements.

5.6.3. 3.3V TTL Serial

The microAeth has a 4-pin serial port for communication through 3.3V TTL Serial with external data acquisition systems or for direct integration into another system.

Communication though the 3.3V TTL Serial port can be established to a computer through a terminal emulator using the custom AethLabs 4-pin Serial to USB converter cable. The terminal emulator settings are as follows:

Baud Rate	Data	Parity	Stop	Flow control
1000000	8 bit	none	1 bit	none (Xon/Xoff for firmware update)

5.6.4. Wi-Fi

The microAeth has 802.11b Wi-Fi with AES hardware encryption built-in.

5.6.5. Bluetooth Low Energy

The microAeth has Bluetooth Low Energy built-in.

5.6.6. GPS

The microAeth has access to the Global Positioning System with a built-in antenna. The GPS is used for precise, automatic time synchronization and for optional location tracking.

5.7. Operation

Before starting a sampling run, it is recommended that the user verify all parameter settings. A description of each operating parameter and its configuration is described in section 5.9.3. Configuration of Instrument Operating Parameters. **IMPORTANT: When a new sampling and measurement session is started, the microAeth will automatically advance the filter tape cartridge to a new sampling location. If a filter tape cartridge is not installed or is not installed correctly, sampling and measurement will not start.**

5.7.1. Start Sampling and Measurements

The on-board user interface on the front of the microAeth is used to start sampling and measurements using the latest saved settings.

1) Use the left and right buttons to scroll through the top level menu options to the 'Start Measurement' option.

2) Press the center button to select the 'Start Measurement' option. The microAeth will automatically advance the filter tape cartridge to a new sampling location. Status information will be displayed on the screen and sampling and measurement will begin.

5.7.2. Start Sampling and Measurements with streaming data output

This option will provide a data stream via the serial port with a dataline being sent every timebase.

The on-board user interface on the front of the microAeth is used to start sampling and measurements with streaming data output using the latest saved settings.

1) Use the left and right buttons to scroll through the top level menu options to the 'Start Meas w/ output' option.

2) Press the center button to select the 'Start Meas w/ output' option. The microAeth will automatically advance the filter tape cartridge to a new sampling location. Status information will be displayed on the screen and sampling and measurement will begin.

5.7.3. Stop Sampling and Measurements

The on-board user interface on the front of the microAeth is used to stop sampling and measurements.

1) While the microAeth is sampling, press and hold the center button for 2 seconds to stop sampling and measurement. 'stop' will briefly be displayed on the screen and sampling and measurement will finish.

5.7.4. Advance Tape

The on-board user interface on the front of the microAeth can be used to advance the filter tape.

1) Use the left and right buttons to scroll through the top level menu options to the 'Advance Tape" option.

2) Press the center button to select the 'Advance Tape' option. The microAeth will advance the filter tape cartridge to a new sampling location.

5.7.5. Filter Tape Cartridge Removal and Installation

The on-board user interface on the front of the microAeth is used to remove and install the filter tape cartridge.

1) Make sure that the microAeth is not sampling. If the instrument is sampling, use the on-board interface to stop sampling and measurements.

2) Unscrew the large flat head slotted screw(s) in the filter tape cartridge door of the case. When the screw is completely free of its mating threaded hole, use the flat head slotted screw(s) to pull the filter tape cartridge door from the case.

3) The filter tape cartridge will now be exposed or if a filter tape cartridge is not currently installed, the cartridge holder area will be empty.

4) Use the left and right buttons to scroll through the top level menu options to 'Release Tape'.

5) Press the center button to select the 'Release Tape' option. The optical head of the instrument will move to its open position and stop in about 6 seconds.

6) Once the optical head stops moving, use the pull tab in the center of the filter tape cartridge to remove the cartridge straight out of the instrument.

7) Insert a new filter tape cartridge straight into the instrument, aligning the left and right holes in the cartridge with the two white capstans in the instrument.

8) Make sure that the new filter tape cartridge is fully inserted and sits flat in the instrument.

9) Use the left and right buttons to scroll through the top level menu options to 'Clamp Tape'.

10) Press the center button to select the 'Clamp Tape' option. The optical head of the instrument will move to its clamped position and stop in about 6 seconds.

11) Confirm that the filter tape cartridge is clamped by the optical head.

12) If the filter tape cartridge is correctly installed, replace the filter tape cartridge door to its closed position and completely screw the large flat head slotted screw(s) in place. Once the door is in its closed and locked position, the instrument is ready for further use

13) If the filter tape cartridge is not fully installed or seated properly in the instrument after clamping the tape, use the left and right buttons to scroll through the top level menu options to 'Release Tape'. Press the center button to select the 'Release Tape' option. If the instrument does not accept the release tape command, press and hold down the center button until the optical head moves up enough to remove the filter tape cartridge. Then remove the filter tape cartridge. Use the left and right buttons to scroll through the top level menu options to 'Clamp Tape'. Press the center button to select the 'Clamp Tape' option. The optical head of the instrument will move to its clamped position and stop, resetting the optical head position. Go to step 4 and try again to replace the filter tape cartridge.

5.7.6. Clear Data

The on-board user interface on the front of the microAeth can be used to clear all measurement data stored on the instrument.

1) Use the left and right buttons to scroll through the top level menu options to the 'Delete Data' option.

2) Press the center button to select the 'Delete Date' option and to enter the delete data confirmation screen.

3) To cancel and return to the top menu level, press the center button.

4) To confirm and delete all data, press either the left or right button.

5) All data will be deleted immediately. Press the center button to return to the top menu level.

5.8. Filter Media

The sample collection and analysis is performed on a roll of polytetrafluoroethylene (PTFE) filter tape that is housed in the filter tape cartridge. As the aerosol sample is drawn through the filter media by the instrument's integrated, internal sample pump, the aerosol sample collects gradually on the filter medium to create a gray spot 3mm in diameter. The microAeth determines the optical attenuation as the accumulated particles increase the optical density of the filter spot. After the optical density reaches a certain level, which is set by the ATN Tape Trigger setting, the filter spot must be replaced to maintain measurement integrity. The filter tape roll is automatically advanced to provide a new clean spot location for sampling.

5.9. Settings Configuration

5.9.1. Using the microAeth Manager

The microAeth Manager is not yet available. Please contact AethLabs for more information.

5.9.2. Using the on-board user interface

5.9.2.1. Change Timebase

The on-board user interface on the front of the microAeth can be used to change the measurement timebase setting of the instrument.

1) Use the left and right buttons to scroll through the top level menu options to the 'Change Timebase' option.

2) Press the center button to select the 'Change Timebase' option and to enter the change timebase submenu.

3) Use the left or right buttons to scroll through timebase value options.

4) Press the center button to select the current timebase value option. Once selected, '- Saving' will be displayed in the computer terminal emulator and the user interface menu is automatically returned to the top menu level.

5.9.2.2. Change Flow Rate

The on-board user interface on the front of the microAeth can be used to change the sampling airflow rate setting of the instrument.

1) Use the left and right buttons to scroll through the top level menu options to the 'Change Flow' option.

2) Press the center button to select the 'Change Flow' option and to enter the change flow submenu.

3) Use the left or right buttons to scroll through flow value options.

4) Press the center button to select the current flow value option. Once selected, '- Saving' will be displayed in the computer terminal emulator and the user interface menu is automatically returned to the top menu level.

5.9.2.3. Change ATN Tape Trigger

The on-board user interface on the front of the microAeth can be used to change the setting for the ATN value at which an automatic tape advance is triggered.

1) Use the left and right buttons to scroll through the top level menu options to the 'Change ATN Tape Trigger' option.

2) Press the center button to select the 'Change ATN Tape Trigger' option and to enter the change flow submenu.

3) Use the left or right buttons to scroll through ATN tape trigger value options.

4) Press the center button to select the current ATN tape trigger value option. Once selected, '- Saving' will be displayed in the computer terminal emulator and the user interface menu is automatically returned to the top menu level

5.9.3. Configuration of Instrument Operating Parameters

5.9.3.1. Time and Time Sync

The time on the microAeth is automatically synchronized to satellites using its on-board GPS unit. Time synchronization will automatically occur even if the GPS setting is turned off and location is not being recorded. Time is ISO 8601 formatted.

It is very important to confirm the date and time of the microAeth before a sampling campaign.

5.9.3.2. Date/Time Change Time Zone Offset

The Date/Time Change time zone offset setting permits the user to select a time zone offset from GMT to be used as part of the ISO 8601 time and date format in the instrument and recorded with instrument measurement data.

5.9.3.3. Flow Rate Setpoint

The Flow Setpoint setting permits the user to select a flow rate setpoint of 50, 100, or 150 ml/min.

It is recommended to use lower flow rates in areas with high BC concentrations, and higher flow rates when maximum sensitivity is required in areas of low BC concentrations. A lower flow rate should also be selected for longer run times and extended battery life. Please read section 5.2 Recommendations for Best Use Practices for more information.

5.9.3.4. Timebase

The Timebase setting permits the user to select an analysis timebase period of 1, 5, 10, 30, 60, or 300 seconds.

It is recommended to use a 30 or 60 second timebase for most 'human exposure' or 'ambient monitoring' measurements. Faster timebases will result in higher noise, and are most useful either for direct source monitoring (tailpipe analysis) or for other applications requiring extremely rapid data. A 300 second timebase can be selected for longer run times and extended battery life. Please read section 5.2 Recommendations for Best Use Practices for more information.

5.9.3.5. Wavelength(s)

The Wavelength(s) setting permits the user to select the measurement wavelength(s) used for particle measurements. Currently, only all 5 wavelengths are available.

1 Wavelength: IR,
2 Wavelengths: IR, UV
5 Wavelengths: IR, Red, Green, Blue, UV

5.9.3.6. Automatic Sampling Restart

The Automatic sampling restart setting permits the user to select if the microAeth will automatically start sampling and measurements if the instrument was previously sampling and experienced a power failure. If this setting is on, the instrument will automatically start sampling and measurements when it turns on from a loss of power or some other event that caused the instrument to turn off.

5.9.3.7. DualSpot® Loading Compensation

The DualSpot® setting permits the user to select if DualSpot® Loading Compensation is turned on or off. A flow rate of 100 or 150 ml/min is highly recommended when using DualSpot® Loading Compensation.

5.9.3.8. GPS

The GPS setting permits the user to select if GPS location recording is turned on or off.

5.9.3.9. Bluetooth Low Energy

The bluetooth low energy setting permits the user to select if bluetooth is turned on or off.

5.9.3.10. Wi-Fi

The Wi-Fi setting permits the user to select if Wi-Fi is turned on or off.

5.9.3.11. Serial Data Streaming

The serial data streaming setting permits the user to select if data streaming through the serial port is on or off.

5.9.3.11.1. Serial Data Streaming Output Format

The serial data streaming output format setting permits the user to select the streaming serial data output format desired. Currently one format is offered: Verbose Structure

5.9.3.12. Tape Advance ATN Threshold

This menu selects the Attenuation (ATN) value that will trigger the microAeth to automatically advance the filter tape cartridge to a new sampling location.

5.10. Downloading Data

5.10.1. Using the microAeth Manager

The microAeth Manager is not yet available. Please contact AethLabs for more information.

5.10.2. Over serial using the on-board user interface (not streaming)

The on-board user interface on the front of the microAeth can be used to download data stored on the instrument via the 4-pin serial port. Data can be downloaded to a computer through a terminal emulator, using an AethLabs 4-pin Serial to USB converter cable.

1) Plug in the AethLabs Serial to USB converter cable to the 4-pin serial port of the microAeth. Plug in the USB A plug of the cable into a computer where dat will be download.

2) Open a terminal emulator on the computer and use the following settings (as described in Section 5.6.3 3.3V TTL Serial):

Baud Rate	Data	Parity	Stop	Flow control
1000000	8 bit	none	1 bit	none

3) The terminal emulator should now display the on-board user interface options as the 3 button interface is used by the user. More information that is hidden on the microAeth screen will be displayed in the terminal emulator.

4) Use the left and right buttons to scroll through the top level menu options to the 'Download Session' option.

5) Press the center button to select the 'Download Session' option and to enter the download session submenu.

6) Use the left and right buttons to scroll through the data sessions stored on the microAeth. When you press the left or right button once, the device will search through its memory to find the beginning and end of a session. '<xxxx> <xxxx> … <xxxx>' will appear as it searches. When the device has found the beginning and end of a session, 'Session xx [xxx –xxx] YYYY-MM-DDTxx:xx:xx.xx' will appear and that session number with date and time labeled will be available for download.

7) Use the left or right buttons to continue to scroll to the next available saved session. Each time the left or right button is pressed, the device will need to search its memory to find the next session and the process in step 6 will occur again. When there are no more data sessions available to scroll to using the left or right button, 'Start of Data' or 'End of Data' will be displayed and you must use the opposite button to scroll back through data sessions.

8) When the data session desired for download is displayed, start a data logger in the computer terminal emulator.

9) Press the center button to begin the download of the displayed saved data session, 'Session xx [xxx –xxx] YYYY-MM-DDTxx:xx:xx.xx'. Each saved data line will be outputted for capture by the terminal or other data logging system. Press center button while the data session is being downloaded to cancel this process.

10) Once the data session is finished downloading, 'Exiting Function : Download Session' is displayed and the user interface menu is returned to the top level automatically.

5.11. Data Safety

AethLabs highly recommends keeping a presine backup of the original data collected on the instrument in an exported file.

5.12. Status Indications

5.12.1. microAeth Serial Number

The on-board screen displays the serial number of the microAeth in the top left corner.

5.12.2. Battery

The on-board screen displays the percentage battery remaining in the top right corner.

6. Viewing and Analyzing Measurement Data

6.1. Data File Structure

The data files downloaded through the microAeth Manager are plain text with the extension .dat or .csv. Each data file consists of a header containing descriptive information; a line identifying the data columns; and then a number of data lines with each item separated by a comma. As the microAeth is starting a new sampling and measurement session, the first few minutes of data do not contain the BC calculation; all subsequent lines of data show this value except during an automatic tape advance.

6.2. Streaming Data Structure

The structure of the streaming data that is output from the 4-pin serial port of the microAeth is as follows.

Verbose Structure:

Serial Number, Datum ID, Session ID, Firmware Version, Date Time, GPS Lat, GPS Long, GPS Alt, GPS Speed, Timebase, Status, Battery, Accel X, Accel Y, Accel Z, Tape Position, Flow Set, Flow Total, Flow 1, Flow 2, Air Temp, Air RH, Air DP, Int Pr, Int Temp, LEDs, UV Sen1, UV Sen2, UV Ref, UV ATN1, UV ATN2, UV K, Blue Sen1, Blue Sen2, Blue Ref, Blue ATN1, Blue ATN2, Blue K, Green Sen1, Green Sen2, Green Ref, Green ATN1, Green ATN2, Green K, Red Sen1, Red Sen2, Red Ref, Red ATN1, Red ATN2, Red K, IR Sen1, IR Sen2, IR Ref, IR ATN1, IR ATN2, IR K, UV BC1, UV BC2, UV BCc, Blue BC1, Blue BC2, Blue BCc, Green BC1, Green BC2, Green BCc, Red BC1, Red BC2, Red BCc, IR BC1, IR BC2, IR BCc, Checksum

7. Maintenance and Service

7.1. Cleaning

If the microAeth is exposed to any liquids or other damaging contaminants, immediately turn off the instrument, disconnect all cables, and remove any foreign substances in contact with the instrument. Do not use liquids or other cleaning products on the instrument. Wait until the microAeth is completely dry before charging or turning on the instrument. Only AethLabs authorized service personnel should clean the air passageways and internal components of the microAeth. Keeping the microAeth and its air passageways, internal components, and optical chambers clean is critical for maintaining the instrument and producing quality measurements. Contamination of the instrument can cause increased measurement noise, poor sealing of the analytical area and degraded operational lifetime of some components. **AethLabs recommends sending your instrument for annual service, or more frequent service depending on use and operating conditions.**

7.2. Flow Calibration Table

The flow calibration table stored in the microAeth is used to control and measure the instrument's flow system. The instrument's internal flow sensors and pump are calibrated to an accurate flow rate for each setpoint in the flow calibration table using an external mass flowmeter as a reference standard. Many commercial flowmeters are mass flowmeters. They calculate a flow rate by measuring the amount of gas molecules (or mass of the gas) moving through the device during a certain amount of time. However, because we commonly measure gases such as air as the volumes they occupy (as cc's or liters, for instance), usually at standard atmospheric pressure and temperature, flowmeters most often report flow rates not as a mass unit over time, but as a volume unit over time. The internal flow sensors are also measuring mass flow and converting these values to volumetric values using the flow calibration table. **Only the external mass flowmeter provided in the AethLabs MA Series Flow Calibration Kit is compatible with the MA200, MA300, and MA350.**

#	Ext	Meter1	Meter2	Pump
0	0.00	124.30	125.66	0.00
1	25.00	156.14	157.40	61.00
2	50.00	185.95	188.52	146.00
3	75.00	214.28	217.89	203.00
4	100.00	239.90	245.21	256.00
5	125.00	263.10	273.75	317.00
6	150.00	286.25	301.33	383.00
7	175.00	307.66	325.06	460.00
8	200.00	329.11	348.80	555.00
9	225.00	350.02	371.77	672.00

7.3. Flow Calibration Procedure

The on-board user interface on the front of the microAeth can be used to start the automatic flow calibration process. **IMPORTANT: Before starting the automatic flow calibration process, the filter tape cartridge must be at a new clean sampling location. The microAeth should be plugged into an external power source. The only way to perform a flow calibration on the MA200, MA300, and MA350 is to use a microAeth MA Series Flow Calibration Kit provided by AethLabs.**

1) Use the left and right buttons to scroll through the top level menu options to the 'Advance Tape" option.

2) Press the center button to select the 'Advance Tape' option. The microAeth will advance the filter tape cartridge to a new sampling location.

3) Plug in the microAeth to an external power source.

4) Plug in the MA Series Flow Calibration Kit flowmeter to an external power source. Make sure the flowmeter is turned on.

5) Use the left and right buttons of the microAeth to scroll through the top level menu options to the 'Calibrate Flow' option.

4) Press the center button of the microAeth to select the 'Calibrate Flow' option and to start the flow calibration process.

5) Connect the MA Series Flow Calibration Kit communication cable to the microAeth serial port and the flowmeter mini-din 8 port.

6) Connect the outlet port of the MA Series Flow Calibration Kit flowmeter to the inlet port of the microAeth. Make sure that all connections are tight and sealed so that no leaks are present.

7) Press the center button of the microAeth to start the automatic flow calibration of the microAeth.

7.4. Upgrading Operating System Firmware

The on-board user interface on the front of the microAeth can be used to upgrade the operating system firmware via the 4-pin serial port. Upgrading the operating system firmware of the microAeth can be accomplished through a terminal emulator using the AethLabs 4-pin Serial to USB converter cable.

1) Unplug the microAeth from all external power sources.

2) Plug in the AethLabs Serial to USB converter cable to the 4-pin serial port of the microAeth. Plug in the USB A plug of the cable into a computer where data will be download.

3) Open a terminal emulator (TeraTerm for Windows is highly recommended) on the computer and use the following settings (as described in Section 5.6.3

Baud Rate	Data	Parity	Stop	Flow control
1000000	8 bit	none	1 bit	Xon/Xoff

4) The terminal emulator should now display the on-board user interface options as the 3 button interface is used by the user. More information that is hidden on the microAeth on-board screen will be displayed in the terminal emulator.

5) Use the left and right buttons to scroll through the top level menu options to the 'Turn off' option.

6) Press the center button to select the 'Turn off' option.

7) Follow the instructions displayed in the terminal emulator to enter the bootloader.

8) 'Shutdown - Now (LEFT AND RIGHT) to enter Bootloader' is displayed. Press and hold down both the left and right buttons at the same time.

9) If successful in entering the bootloader, the microAeth will display more information. 'Serial Decrypting Bootloader Version x.xxL / Serial Number [MAxxx-xxxx] - 6F87' will be displayed.

10) If unsuccessful in entering the bootloader, the microAeth will turn off and nothing more will be displayed. To try again, turn on the microAeth and repeat steps 4-8.

11) Follow the instructions displayed in the terminal emulator and bootloader to upgrade the firmware.

12) 'Press CENTER button to start bootload process, Press LEFT or RIGHT buttons to CANCEL' Press either the left or right buttons to exit the bootloader and cancel the bootload process. The microAeth will shut off. If no further actions are taken within 30 seconds, the microAeth will automatically shut off. To try again, turn on the microAeth and repeat steps 4-11.

13) Press the center button to start the firmware upgrade. More information and 'Waiting for download… (you have 30s)' will be display. The microAeth will wait 30 seconds for the user to send the firmware data file to the microAeth through the terminal emulator. If a file is not sent to the microAeth, the instrument will timeout and shut down. The microAeth no longer has a valid firmware loaded. Any time the instrument is turned on again, only the bootloader will start. To try again, turn on the microAeth and repeat steps 10-12

14) Use the terminal emulator to send the firmware file to the microAeth. Transfer will begin immediately and if the transfer successfully initiated, '*' star symbols will be displayed as the transfer progresses. Do not interrupt the data transfer and upgrade. Wait until the process is fully complete and 'SUCCESS' is displayed.

15) If the firmware transfer and upgrade fails, 'BAD LOAD' will be displayed. The microAeth no longer has a valid firmware loaded. Any time the instrument is turned on again, only the bootloader will start. To try again, turn on the microAeth and repeat steps 10-13

16) If the firmware transfer and upgrade are successful, the data transfer will finish, 'GOOD LOAD' will be displayed, self-checks will complete, 'SUCCESS' and 'Shut Down' will be displayed, and the microAeth will shut down.

17) The operating system firmware upgrade on the microAeth is now complete. Turn on the microAeth and check the flow calibration table. A flow calibration may be required after the operating system firmware is upgraded.

9. Technical Specifications

9.1. MA200

Measurement method
Real-time, 5 wavelength spectrum analysis by measuring the rate of change of transmitted light due to continuous particle deposition on filter. Measurement at 880 nm interpreted as concentration of Black Carbon ('BC'). Measurement at 375 nm interpreted as Ultraviolet Particulate Matter ('UVPM') indicative of woodsmoke, tobacco, and biomass burning.

Measurement wavelengths
880 nm, 625 nm, 528 nm, 470 nm, 375 nm

DualSpot® Loading Compensation
Real-time analysis by measuring the rate of change in absorption of transmitted light due to the continuous collection of aerosol on filter. Simultaneous collection on two spots in parallel at different flow rates.

Timebases
1, 5, 10, 30, 60, or 300 seconds

Flow Rates
Internal pump provides 50, 100, or 150 ml/min, DualSpot® compensation not compatible with all settings

Pump Options
Standard internal diaphragm pump, Optional internal rotary vane pump

Flow Control
Internal mass flowmeters with closed-loop control

Filter Material
Polytetrafluoroethylene (PTFE)

Filter Capacity
MA200 Filter Tape Cartridge with PTFE material (15 sampling locations)

Sensors
Accelerometer, Relative Humidity, Temperature, Altimeter/Barometer

Dimensions
L: 136.75 mm (5.38 in), W: 85 mm (3.35 in), D: 35.75 mm (1.41 in)

Weight
400 grams (14.1 ounces)

Memory
16 GB internal flash memory, providing multiple years of data storage

On-board user interface
Low Power Screen, 3 Buttons

Location services
GPS with Internal Antenna

Date/Time format
ISO 8601 with satellite synchronization

Wireless
802.11b Wi-Fi with AES hardware encryption, Bluetooth Low Energy

Connections
USB 2.0, 3.3V TTL Serial, DC input via barrel jack

Communications
USB and wireless connectivity to cross-platform microAeth® Manager software available on macOS® and Windows®. microAeth Manager software is included and facilitates settings configuration, calibration routines, downloading data, and uploading new instrument firmware.

Battery
Internal 3.6V 3200 mAh rechargeable lithium-ion battery

Recharging
Fast charging DC via barrel jack AC adapter (~3 hours to full charge, instrument turned off) or USB charging (~6.5 hours to full charge, instrument turned off)

Power Supply Adapter
Input: 100~240 VAC 50/60Hz 0.4A, Output: 5VDC / 2A, with option for Type A, C, G, or I plug

Operating Environment
0 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

9.2. MA300

Measurement method
Real-time, 5 wavelength spectrum analysis by measuring the rate of change of transmitted light due to continuous particle deposition on filter. Measurement at 880 nm interpreted as concentration of Black Carbon ('BC'). Measurement at 375 nm interpreted as Ultraviolet Particulate Matter ('UVPM') indicative of woodsmoke, tobacco, and biomass burning.

Measurement wavelengths
880 nm, 625 nm, 528 nm, 470 nm, 375 nm

DualSpot® Loading Compensation
Real-time analysis by measuring the rate of change in absorption of transmitted light due to the continuous collection of aerosol on filter. Simultaneous collection on two spots in parallel at different flow rates.

Timebases
1, 5, 10, 30, 60, or 300 seconds

Flow Rates
Internal pump provides 50, 100, or 150 ml/min, DualSpot® compensation not compatible with all settings

Pump Options
Standard internal diaphragm pump, Optional internal rotary vane pump

Flow Control
Internal mass flowmeters with closed-loop control

Filter Material
Polytetrafluoroethylene (PTFE)

Filter Capacity
MA300 Filter Tape Cartridge with PTFE material (85 sampling locations)

Sensors
Accelerometer, Relative Humidity, Temperature, Altimeter/Barometer

Dimensions
L: 165.20 mm (6.50 in), W: 125.20 mm (4.93 in), D: 39.70 mm (1.56 in)

Weight
700 grams (24.7 ounces)

Memory
16 GB internal flash memory, providing multiple years of data storage

On-board user interface
Low Power Screen, 3 Buttons

Location services
GPS with Internal Antenna

Date/Time format
ISO 8601 with satellite synchronization

Wireless
802.11b Wi-Fi with AES hardware encryption, Bluetooth Low Energy

Connections
USB 2.0, 3.3V TTL Serial, DC input via barrel jack

Communications
USB and wireless connectivity to cross-platform microAeth® Manager software available on macOS® and Windows®. microAeth Manager software is included and facilitates settings configuration, calibration routines, downloading data, and uploading new instrument firmware.

Battery
Internal 3.6V 12800 mAh rechargeable lithium-ion battery

Recharging
Fast charging DC via barrel jack AC adapter (~11.75 hours to full charge, instrument turned off) or USB charging (~25.75 hours to full charge, instrument turned off)

Power Supply Adapter
Input: 100~240 VAC 50/60Hz 0.4A, Output: 5VDC / 2A, with option for Type A, C, G, or I plug

Operating Environment
0 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

9.3. MA350

Measurement method
Real-time, 5 wavelength spectrum analysis by measuring the rate of change of transmitted light due to continuous particle deposition on filter. Measurement at 880 nm interpreted as concentration of Black Carbon ('BC'). Measurement at 375 nm interpreted as Ultraviolet Particulate Matter ('UVPM') indicative of woodsmoke, tobacco, and biomass burning.

Measurement wavelengths
880 nm, 625 nm, 528 nm, 470 nm, 375 nm

DualSpot® Loading Compensation
Real-time analysis by measuring the rate of change in absorption of transmitted light due to the continuous collection of aerosol on filter. Simultaneous collection on two spots in parallel at different flow rates.

Timebases
1, 5, 10, 30, 60, or 300 seconds

Flow Rates
Internal pump provides 50, 100, or 150 ml/min, DualSpot® compensation not compatible with all settings

Pump Options
Standard internal diaphragm pump, Optional internal brushless diaphragm pump.
Flow Control
Internal mass flowmeters with closed-loop control

Filter Material
Polytetrafluoroethylene (PTFE)

Filter Capacity
MA350 Filter Tape Cartridge with PTFE material (85 sampling locations)

Sensors
Accelerometer, Relative Humidity, Temperature, Altimeter/Barometer

Dimensions
L: 199.90 mm (7.87 in), W: 99.82 mm (3.93 in), D: 69.85 mm (2.75 in)

Weight
1100 grams (38.8 ounces)

Memory
16 GB internal flash memory, providing multiple years of data storage

On-board user interface
Low Power Screen, 3 Buttons

Location services
GPS with Internal Antenna

Date/Time format
ISO 8601 with satellite synchronization

Wireless
802.11b Wi-Fi with AES hardware encryption, Bluetooth Low Energy

Connections
Via sealed connector for 3.3V TTL Serial and DC power input, USB 2.0 on inside panel

Communications
USB and wireless connectivity to cross-platform microAeth® Manager software available on macOS® and Windows®. microAeth Manager software is included and facilitates settings configuration, calibration routines, downloading data, and uploading new instrument firmware.

Battery
Internal 3.6V 12800 mAh rechargeable lithium-ion battery

Recharging
Sealed connector for fast charging DC via barrel jack AC adapter (~11.75 hours to full charge, instrument turned off) or USB charging on inside panel (~25.75 hours to full charge, instrument turned off)

Power Supply Adapter
Input: 100~240 VAC 50/60Hz 0.4A, Output: 5VDC / 2A, with option for Type A, C, G, or I plug

Operating Environment
0 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.