

microAeth®

MA Series MA200, MA300, MA350

Operating Manual

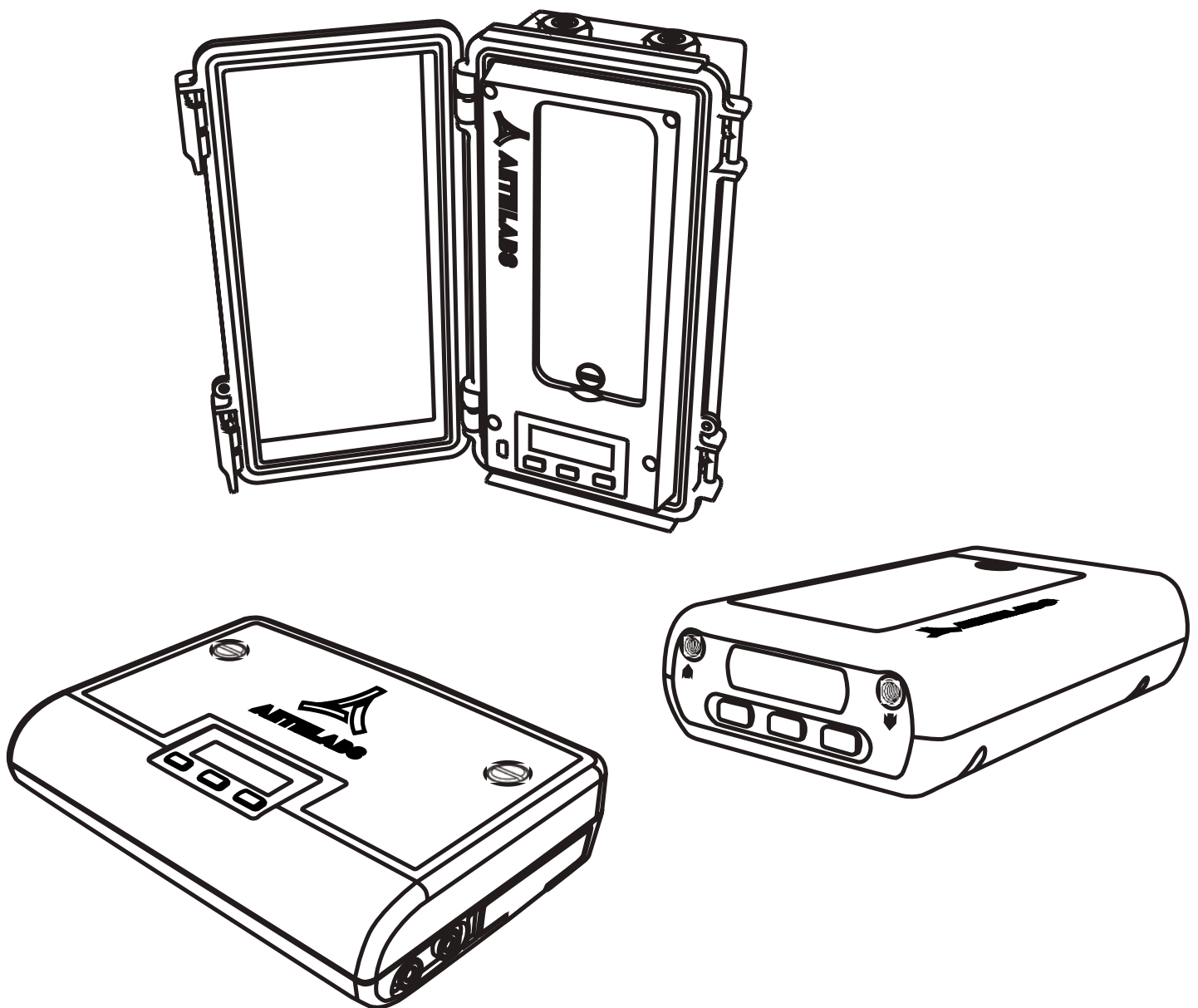


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1. Introduction

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_____ - _____



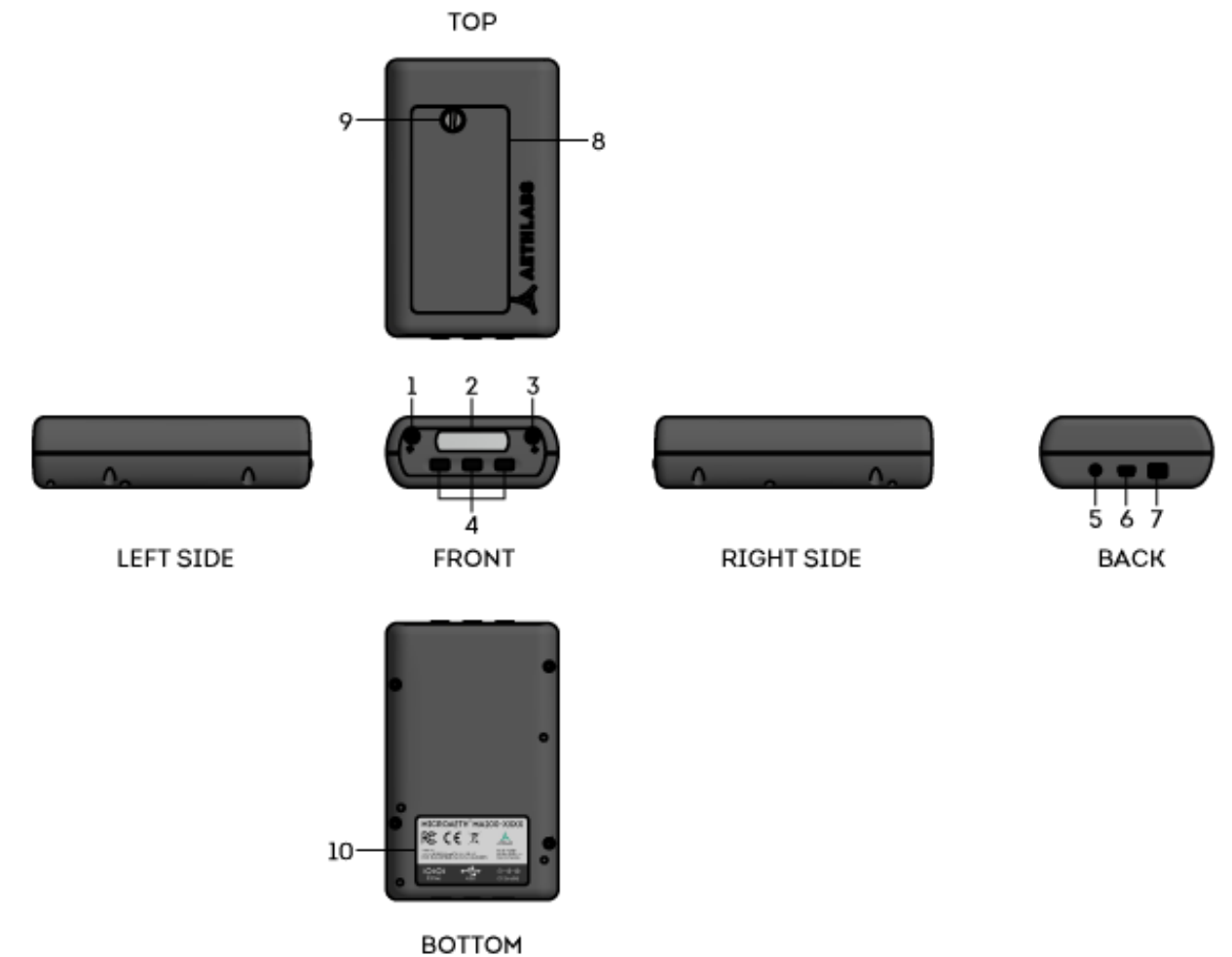
1.2. Overview

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.

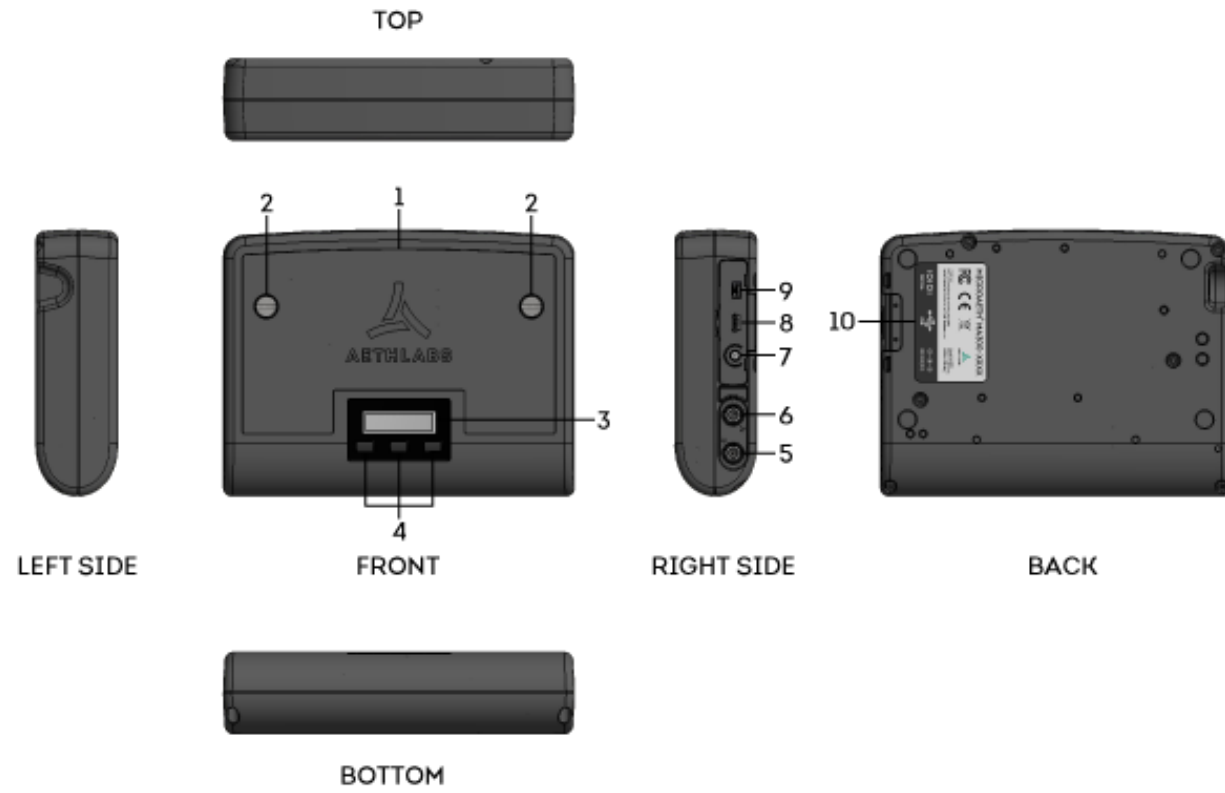
1.3. Instrument Diagrams

1.3.1. MA200



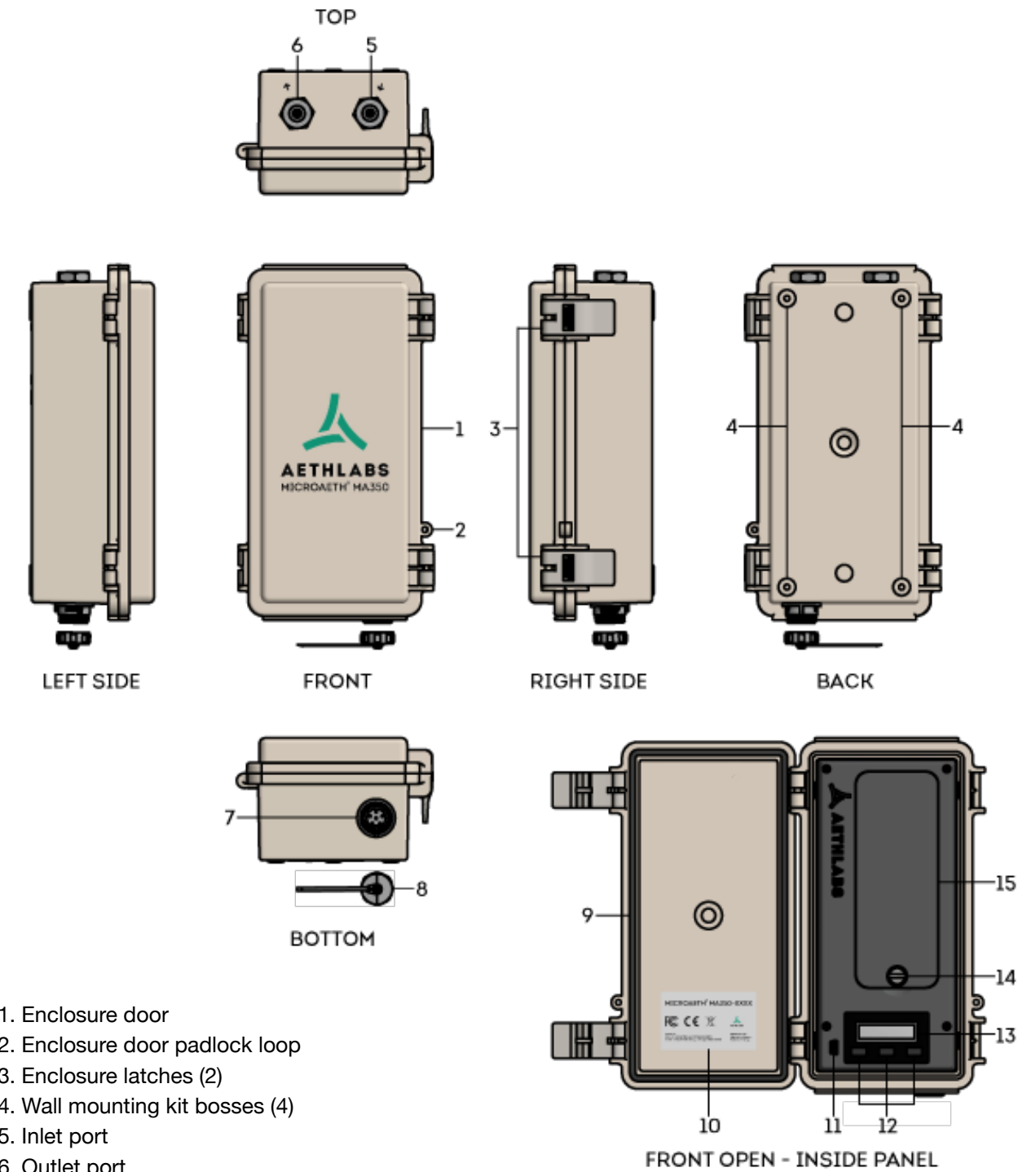
1. Inlet port
2. User interface screen
3. Outlet port
4. User interface buttons (3)
5. DC Barrel jack port
6. USB mini-B port
7. 4-pin 3.3V TTL serial port
8. Filter tape cartridge door
9. Flat head screw in filter tape cartridge door
10. Serial number label

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

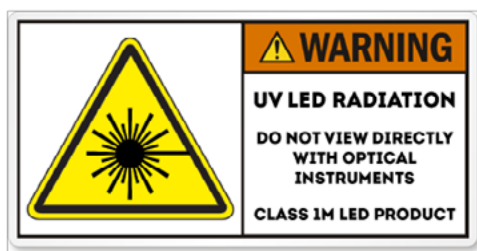
Please handle the microAeth with care. The microAeth has sensitive electronic and mechanical components inside that if disturbed or damaged can cause measurement issues and possible hazard. The microAeth and its lithium-ion battery can be damaged if dropped, impacted, burned, punctured, crushed, or exposed 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

If product(s) were not purchased directly from AethLabs, please check with your reseller for Warranty details.

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

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Entire Agreement. This Agreement constitutes the complete agreement between Licensor and you with respect to the subject matter hereof, and supersedes all prior agreements, oral or written, with respect to the subject matter hereof.

2.5. 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

MA200 / MA300 / MA350 Serial data cable to USB converter 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

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

MA350 circular connector to DC barrel jack and USB converter cable

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

4. Measurements

4.1. Particles

The microAeth MA Series instruments make real-time five wavelength optical analyses 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.

4.2. Temperature

A temperature measurement of the sample air stream is made every Timebase. The sensor value 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. This sensor value is always recorded. In the data output, this value is recorded in the column labeled "Sample temp (C)." The accuracy of the temperature measurement is typically ± 0.2 °C.

A temperature measurement of the internal chassis of the instrument is made every Timebase. This sensor value is always recorded. In the data output, this value is recorded in the column labeled "Internal temp (C)." The accuracy of the temperature measurement is typically ± 1 °C at 25 °C and typically ± 3 °C over the temperature measurement range of -40 to +85 °C.

4.3. Relative Humidity

A relative humidity measurement of the sample air stream is made every Timebase. This sensor value is always recorded. In the data output, this value is recorded in the column labeled "Sample RH (%)." The accuracy of the relative humidity measurement is typically ± 1.8 %RH between 10-90 %RH at 25 °C.

A dewpoint calculation is made by the instrument every Timebase. This value is always calculated and recorded using the temperature and relative humidity sensors measurements. In the data output, this value is recorded in the column labeled "Sample dewpoint (C)."

4.4. Altimeter/Barometer

A pressure measurement of the internal chassis of the instrument is made every Timebase. This sensor is always recorded. In the data output, this value is recorded in the column labeled "Internal pressure (Pa)" 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. In the data output, this value is recorded in the columns labeled "Accel X," "Accel Y," and "Accel Z."

4.6. 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.

4.7. Flow

Two separate mass flowmeters each make a flow measurement of the sample air stream every Timebase. These sensors are always recorded. In the data output, these values are recorded in the column labeled “Flow total (mL/min)” and “Flow1 (mL/min).” The accuracy of the flow measurements is typically $\pm 5\%$ FS (25 °C characteristic).

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. 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/m^3) 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 the breadth of applications requires an understanding of scientific objectives, operational settings, their impact on instrumental sensitivity and trade-offs, as well as proper maintenance of the instrument. 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. 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 (hours of operation)		
	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.

IMPORTANT: If a microCyclone is being used with your microAeth, please clean it on a frequent basis, depending on sampling environment and concentrations. Please see microCyclone manual and documentation for more information.

5.3. Measurement Sampling Connections

5.3.1. Inlet Port

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

5.3.2. Outlet Port

The outlet port is a 10-32 UNF 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. Communication

5.5.1. On-board user interface

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

5.5.2. USB 2.0

The microAeth has a USB 2.0 full speed 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.

5.5.3. 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 through 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)

Before using the AethLabs 4-pin Serial to USB converter cable, it may be required to install drivers from Future Technology Devices International Ltd. (FTDI) in order for the converter cable to be recognized by and used with the computer.

A bare leads serial cable is available from AethLabs for custom integration work.

CAUTION: Interfacing to the serial port for customization and integration requires care, a short of the power supply or improper grounding practices could cause additional instrument noise and / or in the case of a short circuit or over-voltage / over-current, damage to the instrument.

5.5.4. Wi-Fi

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

5.5.5. Bluetooth Low Energy

The microAeth has Bluetooth Low Energy built-in.

5.6. Instrument Operating Parameters

5.6.1. Date/Time: Timezone offset (microAeth Manager only)

The timezone offset setting permits the user to select a timezone 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.

5.6.2. Flow setpoint

The sampling 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.

5.6.3. Timebase

The timebase setting permits the user to select a measurement integrating time of 1, 5, 10, 30, 60, or 300 second(s).

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.

5.6.4. Wavelengths (microAeth Manager only)

The wavelengths setting permits the user to select the measurement wavelength(s) used for particle measurements.

1 Wavelength: IR (880 nm)

2 Wavelengths: IR (880 nm), UV (375 nm)

5 Wavelengths: IR (880 nm), Red (625 nm), Green (528 nm), Blue (470 nm), UV (375 nm)

5.6.5. Auto restart sampling (microAeth Manager only)

The auto restart sampling 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.

5.6.6. GPS (microAeth Manager only)

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

5.6.7. Serial data streaming (microAeth Manager only)

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

5.6.7.1. Serial data streaming output format (microAeth Manager only)

The serial data streaming output format setting permits the user to select the streaming serial data output format desired. Two format options are offered: Verbose and Minimal

For more information about serial data streaming output formatting structures, see section 6.2. Serial Data Streaming Structure.

5.6.8. Tape advance ATN threshold

The tape advance ATN threshold setting permits the user to enter the attenuation (ATN) threshold integer value of 1 to 100 that will trigger an automatic tape advance to a new filter sampling location during a sampling and measurement period. The attenuation (ATN) threshold value will trigger a tape advance when the first of the wavelength measurements reaches this threshold.

Note: The lowest wavelength light source enabled will typically trigger the attenuation (ATN) tape advance.

5.7. Using the microAeth Manager Software

5.7.1. microAeth Manager Software Installation

The microAeth Manager for macOS® and Windows® is available for download from the AethLabs website at <https://aethlabs.com/microaeth/software>. Before installation, check with the computer’s system administrator to make sure that the correct permissions have been granted on the computer to install and run a new application. Please visit the AethLabs website for more information and to sign up for software announcements and to receive notifications of software and firmware updates.

5.7.1.1. Installation on macOS

Download the microAeth Manager software to the computer running macOS®. Locate and open the file ‘microAeth_Manager_x.xx.dmg’ on the computer. The virtual disk image will be mounted and a window will open showing the ‘microAeth Manager’ application file. Drag the ‘microAeth Manager’ application file to the ‘Applications’ folder of the computer. The application is now installed and ready for use with the microAeth MA series instruments. When the microAeth Manager is first opened after installation on the computer, a prompt may appear with the following message and verification request, “‘microAeth Manager’ is an application downloaded from the Internet. Are you sure you want to open it?’ Please confirm to start using the application.

5.7.1.2. Installation on Windows

Download the microAeth Manager software to the computer running Windows®. Locate and open the file ‘microAeth_Manager_x.xx.exe’ on the computer. A prompt may appear with the following message and verification request, ‘Do you want to allow this app from an unknown publisher to make changes to your device?’ Please confirm to start the installation wizard. The microAeth Manager installation wizard will guide the user through the process of choosing the application installation location, creating a desktop shortcut icon, and opening the Device Driver Installation Wizard for installing USB drivers required for the computer to communicate with the microAeth MA series instruments. A prompt may appear with a message and verification request to install the USB device software or drivers required. Please confirm and complete both installation wizards. The application is now installed and ready for use with the microAeth MA series instruments.

5.7.2. Overview

The microAeth Manager software is designed for use with microAeth MA series instruments only. The microAeth Manager is intended to help with the configuration and management of the microAeth MA series instruments and their collected data. Only one microAeth can be connected to the computer and microAeth Manager software at a time. Plug in the USB cable to the USB port of the microAeth. Plug in the USB A connector of the cable into a computer where the microAeth Manager is installed. Turn on the microAeth MA series instrument and open the microAeth Manager. The instrument serial number and name will appear in the microAeth Manager device section of the main application window and then the instrument can be configured and its data can be downloaded and managed through the application.

5.7.2.1. Main Application Window

The microAeth Manager main application window consists of three sections: Manage, Notifications, and Device Section.

5.7.2.1.1. Manage Application Button and Section

Clicking the 'Manage application' button in the top right of the main application window will toggle open and close the Manage application section where the user can manage general settings and find out more information about the application.

The 'Show tooltips' toggle switch in the top left of the 'Application settings' section is used to turn on and off the display of help information tooltips in the application.

The 'View full log' button below the 'Show tooltips' is used to open the 'Full public message log' window. This log show activity within the application that is useful for viewing application activity for debugging and troubleshooting issues. Clicking the 'Copy all text' button will select and copy all text in the log to the clipboard for pasting into an AethLabs support case communications.

The 'Info' button and the application version are in the top right of the 'Application settings' section. If the 'Info' button is clicked, a window will appear with more detailed information about the application, legal notices, a link for checking for available microAeth Manager updates, and a link to the AethLabs website.

The 'Clear database' button in the 'Local database' section in the top right allows the user to delete all data previously downloaded from microAeth MA series instruments and currently stored in the microAeth Manager application local database. If the 'Clear database' button is clicked, a window will appear to confirm if the user would like to delete all data in the application database. The user must confirm by typing in 'DELETE' and clicking the 'Delete all data in the application database' button.

ONCE THIS ACTION IS COMPLETED, IT IS NOT REVERSIBLE. Clearing and deleting the data in microAeth Manager local database does not delete data stored on a microAeth MA series instrument. It only deletes the data that was previously downloaded and stored in the microAeth Manager local database on that specific computer.

5.7.2.1.2. Notifications Section

The notifications section displays notifications in the expandable and collapsible log. Clicking the 'View all notifications' button on the right of the main application window will toggle open the notifications log. Clicking the same button labeled 'Collapse notifications' will collapse the notifications log to display the

single latest notification.

5.7.2.1.3. Device Section

The device section displays the interface for configuring settings, downloading data, and managing data from microAeth MA series instruments. This area will display 'Looking for connected devices' and a searching animation when no microAeth MA series instruments are connected and or communicating with the microAeth Manager.

When a microAeth MA series instrument is connected and communicating with the microAeth Manager, the section 'Local devices' and the instrument device pane for the specific connected microAeth MA series instrument will appear below.

The name and serial number of the instrument are displayed in the top left of the instrument device pane title bar. The name of the instrument can be edited by clicking on the name of the instrument in the device pane title bar.

The USB icon and device pane toggle button are displayed in the top right of the instrument device pane title bar. The USB icon will display green when the instrument is connected with the microAeth Manager. The device pane toggle button with the vertical arrow in it, located in the far right of the instrument device pane title bar, is used to expand and collapse the device pane. The device pane displays status, settings, and data information for the connected instrument.

5.7.3. Configuration and Status of Instrument and Operating Parameters

The microAeth Manager software can be used to only configure microAeth MA series instruments when the microAeth is connected to the computer. Only one microAeth can be connected to the computer and microAeth Manager software at a time. Plug in the USB cable to the USB port of the microAeth. Plug in the USB A plug of the cable into a computer where the microAeth Manager is installed. Turn on the microAeth MA series instrument and open the microAeth Manager. The instrument serial number and name will appear in the microAeth Manager device section of the main application window and then the instrument can be configured through the microAeth Manager device pane.

5.7.3.1. Battery

The microAeth Manager displays the percentage of battery remaining in the microAeth.

5.7.3.2. Status

The microAeth Manager displays the current status of the microAeth.

5.7.3.3. Date/Time

The microAeth Manager displays the current date, time, and timezone offset of the microAeth. Click the 'Time options' button to show the 'Change time options' window to modify date and time settings.

5.7.3.3.1. Timezone offset

The timezone offset dropdown and 'Set timezone offset' button in the 'Change time options' window of the microAeth Manager (click the 'Time options' button on the main application window), can be used to select and set a timezone 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. Select the desired value from the dropdown and click the button 'Set timezone offset' to save. To cancel, click the red 'x' in the top right of the window.

5.7.3.4. Memory

The microAeth Manager displays the percentage of memory available in the microAeth.

5.7.3.5. Firmware

The microAeth Manager displays the operating system firmware version running on the microAeth.

5.7.3.6. Flow setpoint

The flow setpoint dropdown can be used to select a sampling flow setpoint of 50, 100, or 150 ml/min. Select the desired value from the dropdown and click the checkmark to save and the 'x' to cancel.

5.7.3.7. Timebase

The timebase dropdown can be used to select the measurement integrating time of 1, 5, 10, 30, 60, or 300 second(s). Select the desired value from the dropdown and click the checkmark to save and the 'x' to cancel.

5.7.3.8. Wavelengths

The wavelengths dropdown can be used to select the measurement wavelength(s) used for particle measurements. Select the desired value from the dropdown and click the checkmark to save and the 'x' to cancel.

1 Wavelength: IR (880 nm)

2 Wavelengths: IR (880 nm), UV (375 nm)

5 Wavelengths: IR (880 nm), Red (625 nm), Green (528 nm), Blue (470 nm), UV (375 nm)

5.7.3.9. Auto restart sampling

The auto restart sampling toggle switch can be used to turn auto restart sampling on or off.

5.7.3.10. GPS

The GPS toggle switch can be used to turn GPS recording on or off.

5.7.3.11. Serial data streaming

The serial data streaming toggle switch can be used to turn data streaming from the serial port on or off.

5.7.3.11.1. Serial data streaming output format

The serial data streaming output format dropdown can be used to select the serial data streaming output format when serial data streaming is turned on. Select the desired value from the dropdown and

click the checkmark to save and the 'x' to cancel.

5.7.3.12. Tape advance ATN threshold

The tape advance ATN threshold field can be used to enter the attenuation (ATN) threshold integer value of 1 to 100 that will trigger an automatic tape advance to a new filter sampling location during a sampling and measurement period. The attenuation (ATN) threshold value will trigger a tape advance when the first of the wavelength measurements reaches this threshold. Enter the desired value into the field and click the checkmark to save and the 'x' to cancel.

Note: The lowest wavelength light source enabled will typically trigger the attenuation (ATN) tape advance.

5.7.4. Data Sessions Management in the microAeth Manager

Management of data both stored on the microAeth and data stored in the microAeth Manager local database can be completed through the Manage data window of the microAeth Manager. Data is downloaded from the instrument via the USB port and is stored in the microAeth Manager local database.

The downloaded data is divided into data sessions in the microAeth Manager local database based on previous sampling and measurements completed with the instrument. A data session is created when the instrument starts sampling and measurements and the data session is closed when the instrument sampling and measurements are stopped. The downloaded data sessions can then be exported to one .csv file per session using the 'Data sessions in application' section of the Manage data window. Individual or multiple data sessions can be selected and exported. When exporting long data sessions that span multiple calendar days, the user can select to have the exported data session files split into multiple files based on the calendar days of that session.

Data session files are exported to a folder named with the instrument serial number (MAxxx-xxxx) in the directory shown at the bottom of the Manage data window below the 'Export selected sessions' button and to the right of the text 'Data file export location:' The data file export directory is located in the computer operating system user directory '/Documents/AethLabs_microAeth_Manager_Data'.

Session data files are exported as .csv files with the following naming system:

MAxxx-xxxx_Szzzz_yymmddhhmmss

xxx-xxxx is the serial number of the instrument

zzzz is the session ID number

yymmddhhmmss is the year, month, day, hour, minute, and second of when the session started

Session data files that are split into multiple files based on the calendar days of that session are exported as .csv files with the following naming system:

MAxxx-xxxx_Szzzz_Pv_yymmddhhmmss

xxx-xxxx is the serial number of the instrument

zzzz is the session ID number

v is the split session partial file number

yymmddhhmmss is the year, month, day, hour, minute, and second of when the split session partial file started within the session

5.7.5. Data Download in the microAeth Manager

The microAeth Manager can be used to download data stored on the instrument via the USB port. Data can be downloaded to the local database in the client application software using the USB cable provided by AethLabs. Once the data stored on the microAeth is downloaded to the local microAeth Manager database on the computer, the data can then be exported to .csv files. There are two locations in the microAeth Manager to download data from a microAeth.

Option 1:

- 1) Plug in the USB cable to the USB port of the microAeth. Plug in the USB A plug of the cable into a computer where the microAeth Manager is installed and where data will be downloaded.
- 2) Open microAeth Manager.
- 3) Turn on the microAeth.
- 4) The microAeth information will be loaded into the microAeth Manager instrument device pane.
- 5) If there is new data stored on the microAeth that has not been downloaded to the microAeth Manager local database, then the text 'There are xxxx points of new data available to download' and a 'Download now' button will appear below the instrument device pane title bar where the name and serial number of the instrument are displayed.
- 6) To download data from the instrument to the microAeth Manager local database, click the 'Download now' button.
- 7) A window will appear with the title 'Downloading data progress for MAxxx-xxxx' and the 'Current Progress: xx%' progress bar.
- 8) When the download is complete, the progress bar will change to 'Data download is complete (xxxx points)' and the 'Close' button can be clicked to return to the main application window.

Option 2:

- 1) Plug in the USB cable to the USB port of the microAeth. Plug in the USB A plug of the cable into a computer where the microAeth Manager is installed and where data will be downloaded.
- 2) Open microAeth Manager.
- 3) Turn on the microAeth.
- 4) The microAeth information will be loaded into the microAeth Manager instrument device pane.
- 5) If there is new data stored on the microAeth that has not been downloaded to the microAeth Manager local database, then the text 'There are xxxx points of new data available to download' and a 'Download now' button will appear below the instrument device pane title bar where the name and serial number of the instrument are displayed.
- 6) Click the 'Manage data' button to open the 'Manage data for MAxxx-xxxx' window.
- 7) At the top of this window is the 'Data on device' section to manage the data for this microAeth that is stored on the instrument. At the bottom of this window is the 'Data sessions in application local database' section where previously downloaded data sessions from the instrument that are stored in microAeth Manager local database are displayed.
- 7) If there is new data stored on the microAeth that has not been downloaded to the microAeth Manager local database, then in the 'Data on device' section at the top of the 'Manage data for MAxxx-xxxx' window, the 'Download data from device (xxxx points)' button will appear.
- 8) To download data from the instrument to the microAeth Manager local database, click the 'Download data from device (xxxx points)' button.
- 7) A window will appear with the title 'Downloading data progress for MAxxx-xxxx' and the 'Current Progress: xx%' progress bar.

- 8) When the download is complete, the progress bar will change to 'Data download is complete (xxxx points)' and the 'Close' button can be clicked to return to the main application window.

5.7.6. Exporting Data from the microAeth Manager local database

Once the data stored on the microAeth is downloaded to the local microAeth Manager database on the computer, the data can then be exported to .csv files.

- 1) Plug in the USB cable to the USB port of the microAeth. Plug in the USB A plug of the cable into a computer where the microAeth Manager is installed and where data will be downloaded.
- 2) Open microAeth Manager.
- 3) Turn on the microAeth.
- 4) The microAeth information will be loaded into the microAeth Manager instrument device pane.
- 5) Click the 'Manage data' button to open the 'Manage data for MAxxx-xxxx' window. A new window will open that shows all data files that were downloaded from the microAeth and are currently stored in the local microAeth Manager database on the computer.
- 6) At the top of this window is the 'Data on device' section to manage the data for this microAeth that is stored on the instrument. At the bottom of this window is the 'Data sessions in application local database' section where previously downloaded data sessions from the instrument that are stored in microAeth Manager local database are displayed.
- 7) Select the checkboxes of all data sessions to be export to .csv files.
- 8) The 'Split sessions into calendar days on export' toggle switch can be used to split exported data sessions that span multiple calendar days into multiple files based on the calendar days of that session.
- 9) To export the selected data sessions, click the 'Export selected sessions' button at the bottom of the window.
- 10) Data session files are exported to the to a folder named with the instrument serial number (MAxxx-xxxx) in the directory shown at the bottom of the Manage data window below the 'Export selected sessions' button and to the right of the text 'Data file export location:' The data file export directory is located in the computer operating system user directory '/Documents/AethLabs_microAeth_Manager_Data'.

For more information about data file naming, see section 5.7.4. Data Sessions Management in the microAeth Manager.

For more information about data file structures, see section 6.1. Data File Structure.

5.8. Using the on-board user interface

5.8.1. Overview

The on-board user interface of the microAeth MA Series instruments consists of a backlight screen and three buttons. This interface can be used to configure specific settings and operate the instrument.

5.8.2. Configuration of Instrument Operating Parameters

5.8.2.1. 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 of 1, 5, 10, 30, 60, or 300 second(s).
- 4) Press the center button to select the current timebase value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.2.2. Flow setpoint

The on-board user interface on the front of the microAeth can be used to change the sampling flow setpoint 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 of 0, 50, 100, or 150 ml/min.
- 4) Press the center button to select the current flow value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.2.3. Tape advance ATN threshold

The on-board user interface on the front of the microAeth can be used to change the attenuation (ATN) threshold integer value of 1 to 100 that will trigger an automatic tape advance to a new filter sampling location during a sampling and measurement period. The attenuation (ATN) threshold value will trigger a tape advance when the first of the wavelength measurements reaches this threshold.

Note: The lowest wavelength light source enabled will typically trigger the attenuation (ATN) tape advance.

- 1) Use the left and right buttons to scroll through the top level menu options to the 'Change Tape Adv. ATN' option.
- 2) Press the center button to select the 'Change Tape Adv. ATN' option and to enter the change submenu.
- 3) Use the left or right buttons to scroll through attenuation (ATN) threshold trigger values of 1 to 100 in increments of 1.
- 4) Press the center button to select the current attenuation (ATN) threshold trigger value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.3. Operation and Status

Before starting measurements, it is recommended that the user verify all parameter settings. A description of each operating parameter and its configuration is described in section 5.6. Instrument Operating Parameters. Instrument settings can be viewed through the microAeth Manager software, or through the serial terminal emulator interface using the Display All Settings menu. **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.**

5.8.3.1. 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 screen will display "SAMPLER PREPARING". The microAeth will automatically advance the filter tape cartridge to a new sampling location and run its start up routine. When the measurement period begins, the screen will display "SAMPLING" and sampling and measurement will begin.

5.8.3.2. 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. 'STOPPED' will be displayed on the screen and sampling and measurement will finish.

5.8.3.3. Advance Tape

The on-board user interface on the front of the microAeth can be used to manually advance the filter tape. **IMPORTANT: Manually advance the filter tape before a flow calibration to ensure minimal loading of the sample spots.**

- 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.

5.8.3.4. 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 of the on-board user interface 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 of the on-board user interface 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.

5.8.3.5. Calibrate Flow

Please read section 7.2. Flow Calibration Table and section 7.3. Flow Calibration Procedure before using this menu option. 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.

5.8.3.6. Display All Settings (terminal emulator interface only)

The on-board user interface on the front of the microAeth is used to send all settings information of the instrument via the 4-pin serial port. Displaying all settings of the microAeth can be accomplished through the serial port to a terminal emulator on a computer using the AethLabs 4-pin Serial to USB converter cable.

Before using the AethLabs 4-pin Serial to USB converter cable, it may be required to install drivers from Future Technology Devices International Ltd. (FTDI) in order for the converter cable to be recognized by and used with the computer.

- 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 5.5.3):

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

- 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 'Display All Settings' option.
- 6) Press the center button to select the 'Display All Settings' option.
- 7) All settings and status information will be displayed in the terminal emulator.

5.8.3.7. 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.

5.8.4. On-board Status Indications

5.8.4.1. Serial Number

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

5.8.4.2. Battery

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

5.8.4.3. Charging

When the instrument is connected to an external power source using the 5V barrel jack port and the battery is charging, the on-board screen displays "P" to the right of the percentage battery remaining in the top right corner. While the USB port can be used to charge the instrument, the charging indicator will not be displayed.

5.9. 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. **IMPORTANT: Do not rewind the filter tape cartridge, or use previously sampled filter tape sampling locations.**

5.10. Data Safety

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

6. Viewing and Analyzing Measurement Data

6.1. Data File Structure

The data files exported through the microAeth Manager are plain text with the extension .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.

Exported Data File Structure:

Serial Number, Datum ID, Session ID, Data format version, Firmware version, Date / time, Timezone Offset (mins), Date (yyyy/MM/dd), Time (hh:mm:ss), GPS lat (ddmm.mmmmm), GPS long (dddmm.mmmmm), GPS altitude (m), GPS speed (km/h), GPS sat count, Timebase, Status, Battery remaining (%), Accel X, Accel Y, Accel Z, Tape position, Flow setpoint (mL/min), Flow total (mL/min), Flow1 (mL/min), Flow2 (mL/min), Sample temp (C), Sample RH (%), Sample dewpoint (C), Internal pressure (Pa), Internal temp (C), Optical config, 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

6.2. Serial Data Streaming Structure

The structure of the serial data streaming that is output from the 4-pin serial port of the microAeth are 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, Act Comp, 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, CRC

Minimal Structure:

Preamble, Date Time, Status, Battery, Tape Position, Flow Total, Flow 1, Flow 2, UV BC1, UV BC2, IR BC1, IR BC2, CRC

6.3. Status Codes

Code Value	Status Description
1	No status notifications
2	Instrument in sampling and measurement startup
4	Tape advance occurring during sampling and measurement period
8	N/A
16	Optical saturation
32	Sample timing error
64	Sampling spot 2 of DualSpot® loading compensation is active
128	Flow unstable during sampling and measurement period. Flow deviates from target flow setpoint by more than +/- 5%.
256	Flow out of range during sampling and measurement period

If more than one status code is active simultaneously, the resulting code written to the data file is the sum of the error codes shown in the table above. For example, if the instrument is starting up (status code = 2) and the sampling spot 2 of DualSpot® loading compensation is active (status code = 64), the status code shown in the data file will be 66.

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 in the AethLabs MA Series Flow Calibration Kit is compatible with the MA200, MA300, and MA350.** The flow calibrator is a custom unit made for AethLabs specifically for the microAeth MA Series. The flow calibration process requires multiple calibration passes and the calibration of multiple flowmeters as well as other process controls. The process must be automated and thus the microAeth firmware has been developed to work with a specific custom flowmeter.

#	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. Please note that the flow calibration must calibrate two flowmeters and therefore similar information may be displayed on screen during the calibration of flowmeter one and two.

IMPORTANT: Before starting the automatic flow calibration process, the filter tape cartridge must be at a new clean filter 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) If the microAeth is not already at a new clean filter sampling location, use the left and right buttons to scroll through the top level menu options to the 'Advance Tape' option. Otherwise skip to step 3.
- 2) Press the center button to select the 'Advance Tape' option. The microAeth will advance the filter tape cartridge to a new clean filter 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) 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.
- 7) Make sure that all connections are tight and sealed so that no leaks are present.
- 8) Use the left and right buttons of the microAeth to scroll through the top level menu options to the 'Calibrate Flow' option.
- 9) Press the center button of the microAeth to select the 'Calibrate Flow' option. The screen will display 'Switch to CAL CABLE. Press any button.'
- 10) Press any button to start the automatic flow calibration of the microAeth.
- 11) The microAeth will check flow and communications.
- 12) The screen will display 'Assessing Top Flow.'
- 13) If there is a communications issue, the screen will display 'NO COMMS DETECTED.' The screen will then display 'Switch to DATA CABLE Press any button.' Press any button to return to the top level menu and return to step 3.
- 14) If there is a flow issue, the screen will display 'NO FLOW DETECTED.' 'Switch to DATA CABLE Press any button.' Press any button to return to the top level menu and return to step 3.
- 15) If there are no issues, the screen will display the max flow that can be reached and will then begin the flow calibration.
- 16) To cancel the flow calibration at any point, press the center button. The screen will display, 'Switch to DATA CABLE Press any button.' Press any button to return to the top level menu.
- 17) When the automatic flow calibration is complete, the screen will display 'Switch to DATA CABLE Press any button.' Press any button to return to the top level menu.

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.

Before using the AethLabs 4-pin Serial to USB converter cable, it may be required to install drivers from Future Technology Devices International Ltd. (FTDI) in order for the converter cable to be recognized by and used with the computer.

- 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 5.5.3):

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

420 grams (14.82 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 (11.52 Wh) 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

715 grams (25.22 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 (46.08 Wh) 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

965 grams (34.04 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 (46.08 Wh) 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.

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microAeth® MA Series MA200, MA300, MA350 Operating Manual, October 2017, rev01*