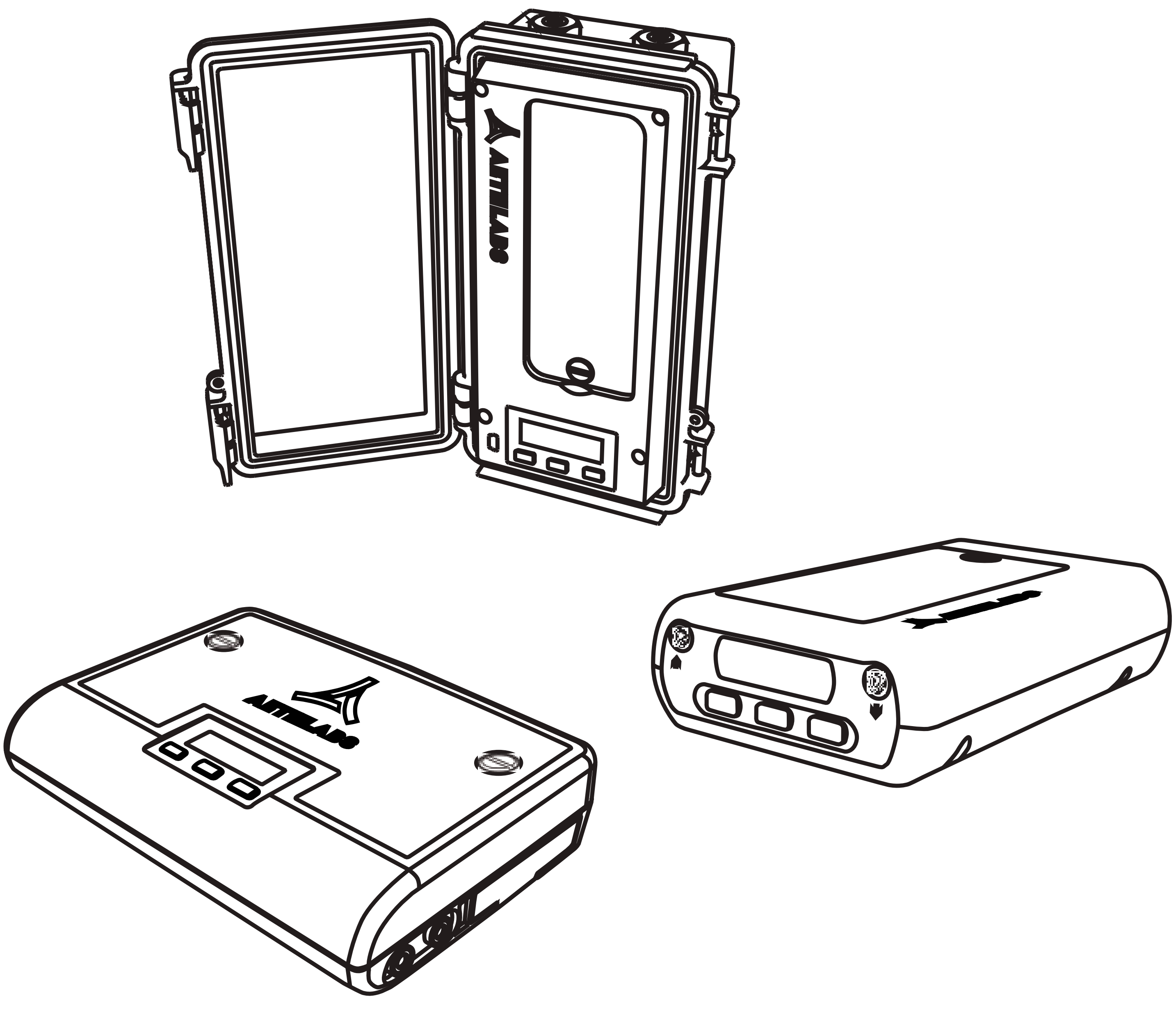
microAeth®

MA Series MA200, MA300, MA350

Operating Manual



AETHLABS

https://aethlabs.com
Firmware v1.12.5, microAeth Manager v1.6.0.208
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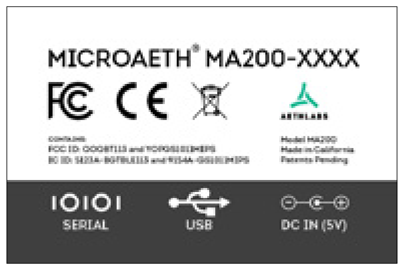
1. Introduction

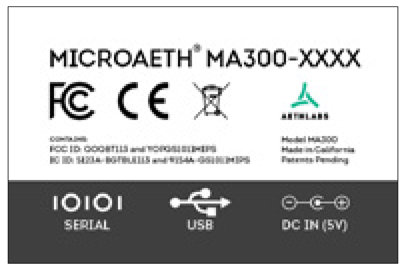
1.1. Serial Number

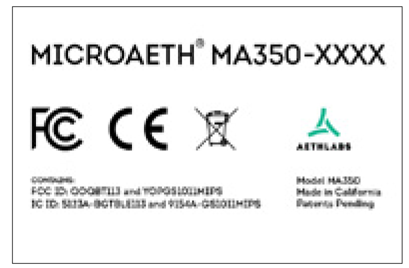
The model and serial number of the microAeth MA200 and microAeth MA300 are located on the bottom and back of the instruments adjacent to the USB port. The model and serial number of the microAeth MA350 is located on the inside of the main enclosure door of the instrument adjacent to the USB port. Record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

Model: microAeth® MA_____

Serial Number: MA_____-______







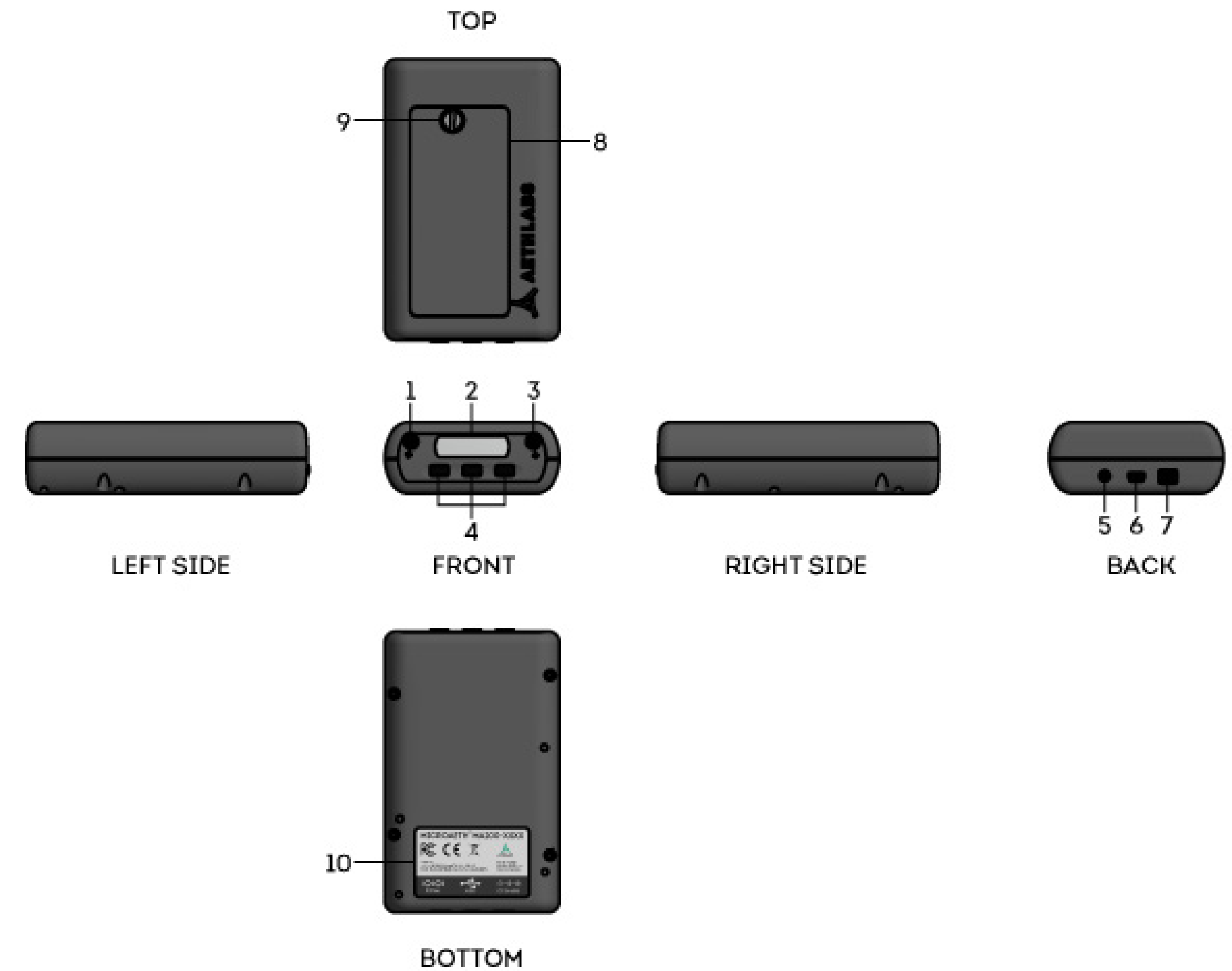
1.2. Overview

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 and stationary 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.

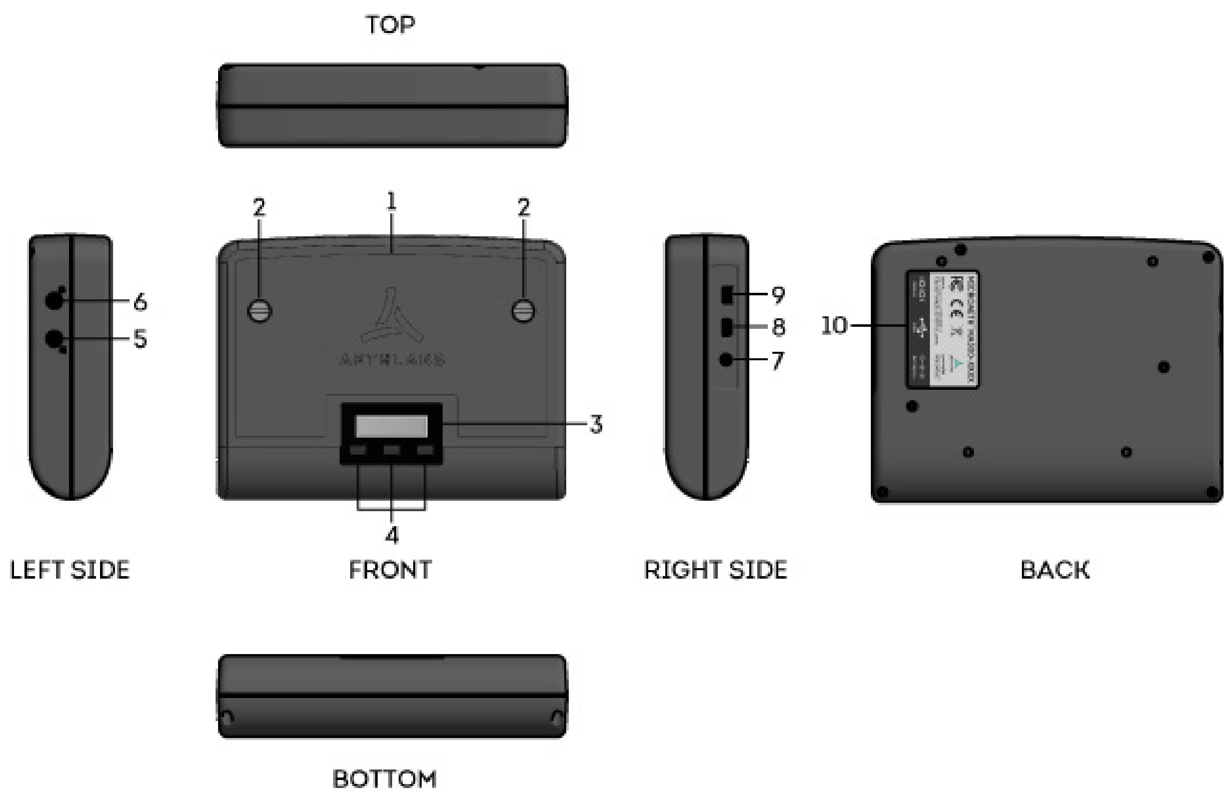
1.3. Instrument Diagrams

1.3.1. MA200



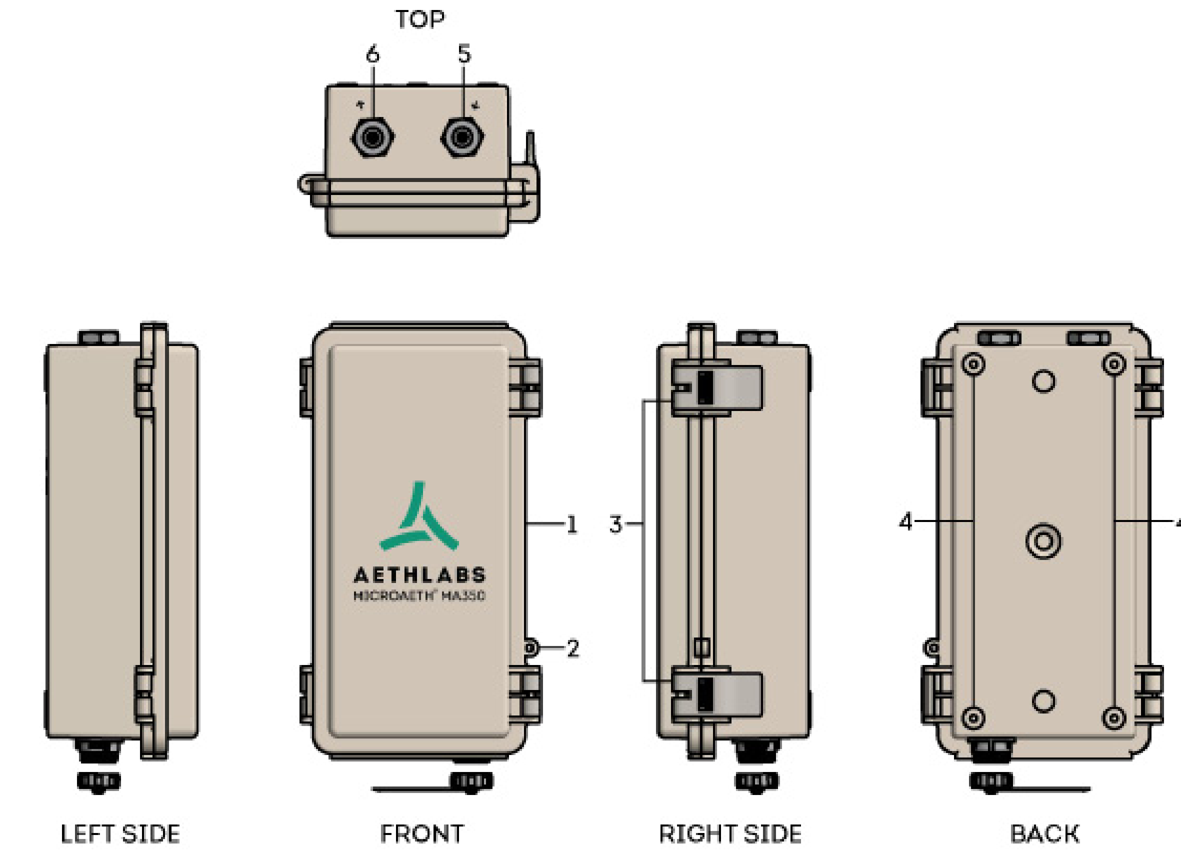
1. Inlet port
2. User interface screen
3. Outlet port
4. User interface buttons (3)
5. DC Barrel jack port
6. USB mini-B port
7. 4-pin 3.3V TTL serial port
8. Filter tape cartridge door
9. Flat head screw in filter tape cartridge door
10. Serial number label

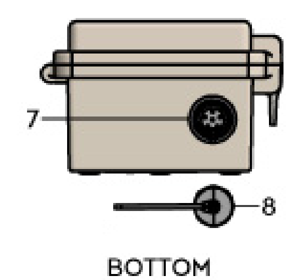
1.3.2. MA300

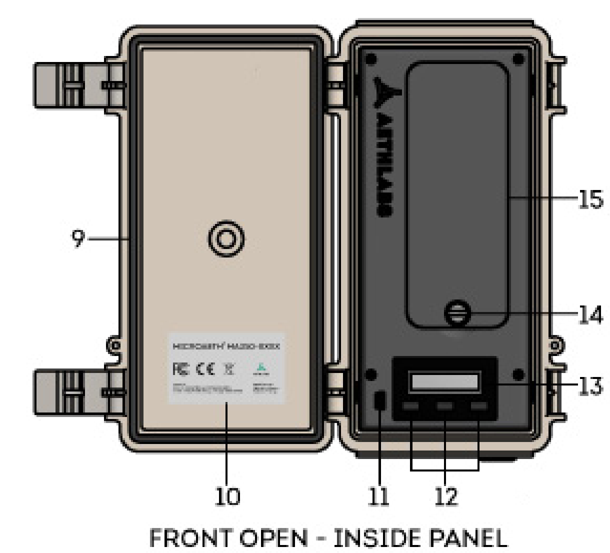


1. Filter tape cartridge door
2. Flat head screws (2) in filter tape cartridge door
3. User interface screen
4. User interface buttons (3)
5. Inlet port
6. Outlet port
7. DC Barrel jack port
8. USB mini-B port
9. 4-pin 3.3V TTL serial port
10. Serial number label

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

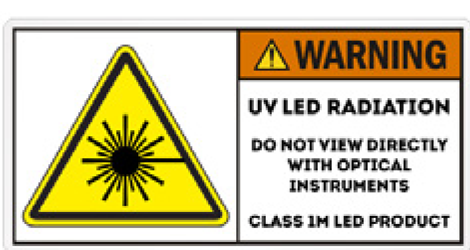
Please handle the microAeth with care. The microAeth has sensitive electronic and mechanical components inside that if disturbed or damaged can cause measurement issues and possible hazard. The microAeth and its lithium-ion battery can be damaged if dropped, impacted, burned, punctured, crushed, or exposed 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. The lithium-ion battery contained in the microAeth and therefore the microAeth must be packaged and shipped properly. Please see section 2.2.11. Shipping for more information. 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.

2.2.11. Shipping

The microAeth MA series instruments contain lithium-ion batteries and therefore must be packaged and shipped properly according to regulations for different shipping methods. Please refer to International Air Transport Association (IATA) regulations when shipping the microAeth as there are limits to how many microAeth can be shipped in a single box based on the battery size in each instrument. The microAeth MA200 contains a 3.6V, 3200mAh (11.52 Wh), 1 cell rechargeable lithium-ion battery. The microAeth MA300 contains a 3.6V, 12800mAh (46.08 Wh), 4 cell rechargeable lithium-ion battery. The microAeth MA350 contains a 3.6V, 12800mAh (46.08 Wh), 4 cell rechargeable lithium-ion battery. Please contact your shipping carrier for more information and for packing instructions.

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

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Agreement, Licensor and you agree to negotiate in good faith and undertake reasonable efforts to cooperate with one another in order to achieve a mutually satisfactory resolution. Licensor has no obligation to become involved in any dispute between you and any other person. This Agreement and any dispute arising in connection therewith shall be exclusively governed by and construed in accordance with the laws of the State of California without regard to its conflict of law principles. Licensor and you agree that all disputes arising under this Agreement shall be resolved by confidential binding arbitration administered by the American Arbitration Association ("AAA") in San Francisco, California, or another forum mutually agreed upon by you and Licensor, pursuant to the Commercial Arbitration Rules ("Rules") of the AAA by a sole arbitrator nominated by agreement of you and Licensor and confirmed in accordance with the Rules. If AAA is not hearing consumer commercial disputes at the time, Licensor may select another arbitral body in its sole discretion. The arbitrator's award shall be binding and may be entered as a judgment in a court of competent jurisdiction. You agree that Licensor is entitled to obtain preliminary injunctive relief to the extent allowed by law to enforce any of the terms of this Agreement pending a final arbitral decision.
Indemnification. You agree to defend, indemnify and hold harmless Licensor, and its affiliates, officers, directors, employees and contractors from any demands, claims, damages, liabilities, expenses or harms, including attorneys' fees, arising in connection with your use of the Software, breach of this Agreement, or dealings or transactions with other persons resulting from use of this Software.
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 1 territory-specific plug
USB communication cable
1 one 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
MA300/350 Filter Tape Cartridge (1 installed in instrument)
Barrel jack AC adapter with 1 territory-specific plug
USB communication cable
1 one 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
MA350/350 Filter Tape Cartridge (1 installed in instrument)
MA350 Sealed connector to DC barrel jack and serial port cable
Barrel jack AC adapter with 1 territory-specific plug
USB communication cable
2 one meter sampling hose with swivel tube connector
Cross-platform microAeth® Manager software (for download via AethLabs website)
Manual (for download via AethLabs website)

3.4. Consumables

MA200 Filter Tape Cartridge
The filter tape cartridges are custom designed for use in the microAeth® MA200. The filter tape cartridges have PTFE filter material for collecting a 3 mm sample spot. MAFT-L17 Cartridges each contain 17 sampling locations.

MA300 / MA350 Filter Tape Cartridge
The filter tape cartridges are custom designed for use in the microAeth® MA300 and MA350. The filter tape cartridges have PTFE filter material for collecting a 3 mm sample spot. MAFT-L85 Cartridges each contain 85 sampling locations.

3.5. Accessories

microCyclone™ 50, PM2.5 Size-selective inlet
The microCyclone is a miniature PM2.5 size-selective inlet for the microAeth. This sharp-cut cyclone has a size cut of 2.5 micron at 50 ml/min and 1.6 micron at 100 ml/min.

microCyclone™ 170, PM2.5 Size-selective inlet
The microCyclone is a miniature PM2.5 size-selective inlet for the microAeth. This sharp-cut cyclone has a size cut of 2.5 micron at 170 ml/min and 2.9 micron at 150 ml/min.

MA Series Flow Calibration Kit
The microAeth MA Series Flow Calibration Kit comes with all of the components necessary to reliably perform a flow calibration of the microAeth® MA Series instruments. This kit includes a custom designed external mass flowmeter and all necessary tubing, connectors, and cables to perform the simple and fully automated flow calibration. The only way to perform a flow calibration on the MA Series instruments is to use the AethLabs MA Series Flow Calibration Kit.

Portable Aerosol Dryer
A small, portable, passive nafion / dessicant aerosol dryer. Dessicant life of 72 liters before recharge or replacement. Dimensions (including fittings): L: 121.5 mm (4.78 in), W: 61.5 mm (2.42 in), D: 25.5 mm (1.00 in) Weight (including fittings): 128 grams (4.51 ounces)

Barb Fitting Swivel Connector
The barb fitting swivel connector allows the attachment of flexible hose that can swivel independently of the microAeth®. The barb fitting swivel connector joins a 1/8" inside diameter (ID) hose on one side with a 10-32 threaded fitting on the other - which fits into the inlet of outlet port on the microAeth.

1/8" Compression fitting connector
The 1/8" Compression Fitting Connector joins a 1/8" outside diameter (OD) metal tube on one side with a 10-32 threaded fitting on the other - which fits into the inlet or outlet port on the device. This fitting is made of 316 Stainless Steel.

1/4" Compression fitting connector
The 1/4" Compression Fitting Connector joins a 1/4" outside diameter (OD) metal tube on one side with a 10-32 threaded fitting on the other - which fits into the inlet or outlet port on the device. This fitting is made of 316 Stainless Steel.

Lapel Clip for Sampling Hose
The lapel clip allows the sampling hose to be securely situated near the target site of measurement - near the face, for instance.

Sampling Hose cut to length
Additional sampling hose with 1/8" inside diameter (ID) and 1/4" outside diameter (OD) in custom lengths can be acquired (in multiples of 10 feet) for various applications. This is a black static dissipative polyurethane hose.

Serial to USB converter cable
This cable allows the microAeth MA Series instruments to send and receive serial data from the 4-pin serial port to the USB port of a computer. This cable is also used to upgrade the firmware of microAeth MA Series instruments. This cable is not included.

Serial to bare leads cable
This cable allows the microAeth MA Series instruments to send and receive 3.3v TTL serial data from the 4-pin serial port to and from other devices. This cable is not included.

MA350 Sealed connector to bare leads cable
This cable allows the microAeth MA350 to send and receive 3.3v TTL serial data to and from other devices. This cable also allows the MA350 to be powered from an external source. This cable is not included.

MA350 Pole kit
This stainless steel kit allows for mounting an MA350 directly to a 2-12" diameter pole by attaching it to the outdoor-rated enclosure.

17" Carrying case with foam
This black, protective carrying case for microAeth with Pick N Pluck Foam has exterior dimensions of 17" x 13.25", 4.5".

20" Carrying case with foam
This black, protective carrying case for microAeth with Pick N Pluck Foam has exterior dimensions of 20" x 14.75", 6".

Inlet Protection Kit
The Inlet Protection Kit for the microAeth is designed to help protect the instrument and data from moderate water and bug intrusion and in-line condensation throughout the sampling train. This kit includes a custom designed protection cone, water/bug trap, all necessary tubing and connectors, along with a custom mount and cable ties for installation.

3.6. Replacement Parts

MA Series AC Wall Adapter
The adapter is intended for use with the microAeth MA200, MA300, and MA350 instruments, comes with the appropriate region-specific plug, and both powers operation of the unit and charges the battery. We offer the following AC plug options: USA (Type A), Europe (Type C), UK (Type G), and Australia (Type I). This item is included with all MA Series instruments.

USB Power/Data Cable
The USB cable can be used to either connect the microAeth® to a computer for charging, settings changes, and data retrieval, or can connect to the AC Wall Adapter to charge the battery and power the unit. This cable is included with all MA Series instruments.

MA Series Flow Calibration Kit Communication cable
This cable allows the microAeth MA Series instruments to communicate with the custom designed external mass flowmeter in the microAeth MA Series Flow Calibration Kit. This cable is included in the MA Series Flow Calibration Kit.

MA Series Flow Calibration Kit Inlet filter
This low backpressure inline disc filter is used on the inlet of the external flowmeter of the microAeth MA Series Flow Calibration Kit to keep the external flowmeter clean and to keep the microAeth sampling filter clean during flow calibration. An inline filter isn't required but is recommended especially if a flow calibration is being completed outdoors or in a dirty environment. This item is included with the MA Series Flow Calibration Kit.

MA350 Sealed connector to DC barrel jack and serial port cable
This cable converts the microAeth MA350 sealed connector port to a DC barrel jack port and a 4-pin serial port. This cable is included with the MA350.

17" Carrying case replacement foam
This is the replacement Pick N Pluck foam for the above protective carrying case for microAeth with exterior dimensions of 17" x 13.25", 4.5". This item is included with the 17" Carrying case with foam.

20" Carrying case replacement foam
This is the replacement Pick N Pluck foam for the above protective carrying case for microAeth with exterior dimensions of 20" x 14.75", 6". This item is included with the 20" Carrying case with foam.

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.

4.1.1. DualSpot® Loading Compensation (beta)

The microAeth MA Series instruments include hardware and firmware that implement the patented DualSpot® Loading Compensation method. This method simultaneously collects aerosol samples on two analysis spots in parallel and at different face velocities while measuring the rate of change in absorption of transmitted light due to the particles loading on the filter. The use of this method is an optional user selectable feature. **A flow rate of 100, 125, 150 or 170 ml/min is highly recommended when using DualSpot® loading compensation.** Although DualSpot mode can be used in many sampling scenerios, for best results it should be used in stationary applications.

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 and Dewpoint

A relative humidity measurement of the sample air stream is made every Timebase. This sensor is coupled to measurement sample spot sense2. In SingleSpot™ mode there is no active flow through the humidity sensor, while in DualSpot® mode there is active flow through the humidity sensor. Therefore the measurement will be more accurate and more responsive in DualSpot® mode. 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 senors 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 flow measurements of the sample air stream and are recorded every Timebase. These sensor measurements are always recorded and represent the average flow through the timebase period (not instantaneous). 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 ± 5% FS 0-1 L/min (25 °C characteristic). The repeatability of the flow measurements is typically ±0.4% FS 0-1 L/min.

When the instrument has DualSpot loading compensation enabled, a flow calculation is made by the instrument every Timebase. This value is always calculated and recorded. In the data output, this value is recorded in the column labeled “Flow2 (mL/min).”

5. Configuration and Operation

5.1. Overview

The microAeth MA Series instruments are highly sensitive, portable, and miniature five-wavelength instruments designed for measuring the light absorbing carbon (‘LAC’) particles. The instruments have an 880 nm optical channel which is primarily interpreted as Black Carbon (‘BC’). The instruments also measure Ultraviolet Particulate Matter (‘UVPM’) and makes measurements at three other wavelengths which can be used to calculate the angstrom exponent for source apportionment or other investigations into the optical properties of light absorbing particles in the atmosphere. The instruments are based on the well-established Aethalometer® measurement principle used for over 30 years in laboratory-sized analyzers and incorporate the patented DualSpot® loading compensation method. The microAeth draws an air sample at a flow rate of 50, 75, 100, 125, 150, or 170 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 multiple sampling flow rate settings: 50, 75, 100, 125, 150 and 170 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. Due to the flow split between Spot 1 and Spot 2 the measurement sensitivity in DualSpot® mode will be lower than in SingleSpot™ mode for the same total flow rate. DualSpot mode may not be compatible with 50 ml/min flow rate unless measuring higher mass concentrations.

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. 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

5.2.4. 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.

5.2.5. 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. microAeth Recommended Cleaning & Maintenance Intervals

It is suggested to perform standard maintenance on the microAeth at least once per 12-18 months. Unique, dirtier and or higher concentration sampling environments and applications may require standard maintenance on more regular intervals. It is recommended that users plan standard maintenance schedules that best coincide with and allow for the best data quality during measurement campaigns.

5.2.9. microCyclone™ 50, PM2.5 Size-selective inlet

The microCyclone™ 50 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 cutpoint when the microAeth is set to a 50 ml/min flow rate. A 1.6 micron size cutpoint is provided by the microCyclone when connected to a microAeth with a 100 ml/min flow rate. The microCyclone 50 may not be appropriate for use with the microAeth MA200, MA300, or MA350 when using specific operating settings depending on flow rates and if DualSpot® loading compensation is enabled. The microCyclone can be used at 100 ml/min with a outpoint of 1.6 micron in DualSpot mode. While operation at 50 ml/min in DualSpot mode may be possible it has not yet been validated.

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.

5.2.10. microCyclone™ 170, PM2.5 Size-selective inlet

The microCyclone™ 170 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 cutpoint when the microAeth is set to a 170 ml/min flow rate. A 2.9 micron size cutpoint is provided by the microCyclone when connected to a microAeth with a 150 ml/min flow rate. The microCyclone may not be appropriate for use with the microAeth MA200, MA300, or MA350 when using specific operating settings depending on flow rates and if DualSpot® loading compensation is enabled.

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

The inlet port and all connections to the inlet port must be properly protected from the environment. There must be limited restriction to flow while protection from water, insects, bugs, and other objects that can block or infiltrate the instrument air pathway. Extra precaution must be taken as the internal pump of the instrument is pulling air into the instrument through this port.

It is always recommended to use the sampling tube assembly supplied with your microAeth, screwed into the instrument's inlet port. Using this sampling tube assembly allows for more targeted sampling, can provide basic protection to the instrument inlet, and prevents the possibility of light leakage into the instrument's sample chamber.

5.3.2. Outlet Port

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

The outlet port and all connections to the outlet port must be properly protected from the environment. There must be limited restriction to flow while protection from water, insects, bugs, and other objects that can block or infiltrate the instrument air pathway.

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 only one of the three buttons for 2 seconds. The screen and instrument will turn on and the instrument serial number will be displayed.

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 though the 3.3V TTL serial port can be established to a computer through a terminal emulator using the custom AethLabs 4-pin Serial to USB converter cable. **AethLabs only supports Tera Term for Windows.** The default terminal emulator settings and terminal emulator settings required for updating firmware in the bootloader are as follows:

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

NOTE: The serial baud rate can be changed using the on-board LCD interface and the Change Serial Baud menu or using the microAeth Manager and the Baud rate setting under Serial and Communications. When installing firmware using the instrument bootloader, the baud rate is always 1000000 even if the baud rate setting has been changed.

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. WiFi

The microAeth has 802.11b WiFi with AES hardware encryption built-in. WiFi can be enabled and used to stream data to the AethLabs website using timebases of 60 seconds or greater and with Data transmission Output format greater than or equal to Version 2.

IMPORTANT: In order to complete initial setup of and enable WiFi, the user must be logged into the AethLabs website through the microAeth Manager Application. Please read section 7.6. WiFi Setup and Configuration before using this menu option.

5.5.5. Bluetooth Low Energy

The microAeth has Bluetooth Low Energy built-in. Bluetooth is not available for use.

5.6. Instrument Operating Parameters

5.6.1. Date/Time: GPS time synchronization (microAeth Manager only)

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

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

5.6.1. Date/Time: Application time synchronization (microAeth Manager only)

The time on the microAeth can be manually synchronized to the time on the computer. Time synchronization will occur between the microAeth and the computer when the button is clicked in the microAeth Manager. Time is ISO 8601 formatted.

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

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

The timezone offset setting permits the user to select a timezone offset from Coordinated Universal Time (UTC) to be used as part of the ISO 8601 time and date format in the instrument and recorded with instrument measurement data. Daylight savings time offsets are not automatically adjusted by the instrument or the microAeth Manager.

5.6.3. AutoSample

The AutoSample setting permits the user to select if the microAeth will automatically start sampling and measurements.

Off: Automatic start of sampling and measurements will not occur.

Resume after power loss (Resume): 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.

External power control (Ext Power): If the 5V barrel jack of the instrument is supplied with power, the instrument will automatically turn on and start sampling and measurements. If power is removed from the 5V barrel jack of the instrument, the instrument will automatically stop sampling and measurements and turn off.

5.6.4. Flow setpoint

The sampling flow setpoint setting permits the user to select a sampling flow rate setpoint of 50, 75, 100, 125, 150 or 170 ml/min. **A flow rate of 100, 125, 150 or 170 ml/min is highly recommended when using DualSpot® loading compensation.** 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.

5.6.5. Timebase

The timebase setting permits the user to select a measurement integrating time of 1, 5, 10, 30, 60, or 300 second(s). The date and time (timestamp) is recorded at the end of the sampling and measurement interval.

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.

5.6.6. Wavelengths (microAeth Manager only)

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

Only IR wavelength: IR (880 nm)
UV + IR wavelength: IR (880 nm), UV (375 nm)
Blue + IR wavelengths: IR (880 nm), Blue (470 nm)
Blue + IR + UV wavelength: IR (880 nm), Blue (470 nm), UV (375 nm)
5 wavelengths: IR (880 nm), Red (625 nm), Green (528 nm), Blue (470 nm), UV (375 nm)

5.6.7. Sampling mode (microAeth Manager only)

The sampling mode setting permits the user to select if the microAeth is in SingleSpot™ or DualSpot® loading compensation sampling mode. **A flow rate of 100, 125, 150, 170 ml/min is highly recommended when using DualSpot® loading compensation.** Although DualSpot mode can be used in many sampling scenerios, for best results it should be used in stationary applications.

5.6.8. Tape advance ATN threshold

The tape advance ATN threshold setting permits the user to enter the attenuation (ATN) threshold natural number 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.

5.6.9. GPS (microAeth Manager only)

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

5.6.10. Data transmission Mode

The serial data mode setting permits users to select the serial data mode of the serial port. The following three options are available:.

Off: No measurement data will be transmited via the serial port. On-board user interface data and the output of Display All Settings and Display FlowCal Info will still be transmitted when selected and at startup.

Streaming: Measurement data will be transmited via the serial port while sampling and measurements are occuring. On-board user interface data and the output of Display All Settings and Display FlowCal Info will still be transmitted when selected and at startup.

Polled: Measurement data and instrument status can be polled and the operating controls of the instrument can be controlled using the command line inferface (CLI) via the serial port. See section 5.9. Command Line Interface (CLI) for Polled Serial Data Mode for CLI commands. On-board user interface data and the output of Display All Settings and Display FlowCal Info will still be transmitted when selected and at startup.

5.6.11. Data transmission Output format (microAeth Manager only)

The serial data output format setting permits the user to select the serial data format of the measurement data sent through the serial port and over WiFi in streaming and polled serial data modes. Not all data formats are supported when sending measurement data over WiFi.

Three format options are available:

Version 3: Highly recommended. Compatible with WiFi steaming. New data format supported with Firmware version 1.12 and newer. Includes version 2 data format but has additional data for source apportionment and

Version 2 (previously "Verbose"): Compatible with WiFi steaming. Data format supported with Firmware v1.08 and newer.

Version 1 (previously "Minimal"): Not compatible with WiFi streaming.

For more information about serial output formating structures, see section 6.2. Serial Output Format Structures.

5.6.12. Data transmission Serial baud rate

The serial baud rate setting permits the user to select the serial baud rate of 57600, 115200, 230400, 460800, 921600, or 1000000 to use when measurement data is transmitted through the serial port.

NOTE: When installing firmware using the instrument bootloader, the baud rate is always 1000000 even if the baud rate setting has been changed.

5.6.13. Source Apportionment AAE Biomass (microAeth Manager only)

The source apportionment AAE Biomass setting permits the user to enter the AAE Biomass decimal number value of 1.5 to 100 that is used for calculating

5.6.14. Source Apportionment AAE Fossil Fuel (microAeth Manager only)

The source apportionment AAE Fossil Fuel setting permits the user to enter the AAE Fossil Fuel decimal number value of 0.5 to 100 that is used for calculating

5.6.15. Source Apportionment Cref (microAeth Manager only)

The source apportionment Cref setting permits the user to enter the Cref decimal number value of 0.8 to 100 that is used for calculating

5.6.16. WiFi

The WiFi setting in the on-board interface permits the user to select if WiFi data streaming is turned on or off. The WiFi settings in microAeth Manager permit the user to configure all WiFi settings and setup WiFi communication infrastructure on the instrument and the AethLabs website.

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.

Before installing or upgrading microAeth Manager, make sure to export and backup all data stored in the microAeth Manager local database.

5.7.1.1. Installation on macOS

1) Delete any previous versions of the microAeth Manager from the computer.
2) Download the microAeth Manager software to the computer running macOS®.
3) Locate and open the file 'microAeth_Manager_x.xx.dmg' on the computer.
4) The virtual disk image will be mounted and a window will open showing the 'microAeth Manager' application file.
5) 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.
6) 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

1) Delete any previous versions of the microAeth Manager from the computer.
2) Download the microAeth Manager software to the computer running Windows®.
3) Locate and open the file 'microAeth_Manager_x.xx.exe' on the computer.
4) A prompt may appear with the following message and verification request, 'Do you want to allow this app from an unkown publisher to make changes to your device?' Please confirm to start the installation wizard.
5) 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.
6) 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.
7) 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 and firmware, Notifications, and Device Section.

5.7.2.1.1. AethLabs Server Connectivity Status

The AethLabs Server Conectivity Status indicators and menu in the top right corner of the main application window display the current connectivity status of microAeth Manager application the AethLabs Server, the application user's Login Status to the AethLabs Server/Dashboard and the status dropdown menu that allows for expanded interaction:

1) Connectivity status of microAeth Manager application the AethLabs Server
2) Login Status to the AethLabs Server
3) Status dropdown menu which shows more information and actions
   a) Logged in status / Logged in as Name / Logged in as Email
   b) Log in / Log out button
   c) Reset Password button
   d) View Dashboard button

5.7.2.1.2. Manage application: Application settings and Local database

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.

APPLICATION SETTINGS:
Application version and information: 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. **To check if updates of the microAeth Manager are available, click the 'Check for updates' button.** A web browser will open and take you to the AethLabs website for more information about the latest version available of the microAeth Manager.

Time format: The 'Show 24 hour format' toggle in the 'Application settings' section can be used to change the time formatting in the application.

Full notification log: The 'View full log' button in the 'Application settings' section will open a window with the full application log which can be reviewed and copied.

LOCAL DATABASE:
View database: The ‘View database’ button in the ‘Local database’ section in the top right allows the user to view all data previously downloaded from microAeth MA series instruments and is currently stored in the microAeth Manager application local database. Downloaded data will remain in the application local database until deleted.

If the ‘View database’ button is clicked, the 'Manage local database' window will appear and allows the user to view data session information and to export any data that was previously downloaded from microAeth to the microAeth Manager application local database on the computer. **A microAeth does not have to be connected to view and export previously downloaded data.** Data can be exported to .csv files. For more instructions on exporting data, see section 5.7.6. Exporting Data from the microAeth Manager local database.

Clear database: The ‘Clear database’ button in the ‘Local database’ section in the top right allows the user to delete all data previously downloaded to the microAeth Manager application local database on the computer.

If the ‘Clear database’ button is clicked, the 'Clear application database' window will appear to confirm if the user would like to delete all data in the application database. The user must confirm deletion 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 the microAeth Manager application local database does not delete data stored on a microAeth MA series instrument. This action only deletes the data that was previously downloaded and is currently stored in the microAeth Manager application local database on that specific computer.
AethLabs recommends regularly deleting the data in the microAeth Manager local database as the time it takes to access the microAeth Manager local data base through the 'Manage data' button will increase as the data base size increases.

5.7.2.1.3. Firmware updates button

Clicking the ‘Firmware updates' button in the top right of the main application window will open the 'Update firmware' window. Follow the on screen instructions to update firmware. Also see Section 7.5.1 Upgrading firmware using microAeth Manager v1.6.0 or newer.

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5.7.2.1.4. 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.

5.7.2.1.5. 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. Memory

The microAeth Manager displays the percentage of memory available in the microAeth. The microAeth has 16GB of memory which can store 31,250,000 data lines.
1 second timebase: 361 days of data
5 second timebase: 4.95 years of data
10 second timebase: 9.90 years of data
30 second timebase: 29.72 years of data
60 second timebase: 59.45 years of data
300 second timebase: 297.27 years of data

AethLabs recommends regularly deleting data on the microAeth as all unsynchronized data is downloaded together from the microAeth to the microAeth Manager local database on each different computer.

5.7.3.4. Firmware

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

5.7.3.5. 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.

5.7.3.5.1. GPS time synchronization

The GPS time synchronization toggle switch in the 'Change time options' window of the microAeth Manager (click the 'Time options' button on the main application window), can be used to turn GPS time synchronization on or off.

5.7.3.5.2. Application time synchronization

The application time synchronization 'Sync now' 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 manually synchronize the time of the microAeth and the computer. When time is synchronized, a confirmation notification will be displayed below the button in this window.

5.7.3.5.3. Timezone offset

The timezone offset dropdown and 'Set timezone offest' 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 Coordinated Universal Time (UTC) to be used as part of the ISO 8601 time and date format in the instrument and recorded with instrument measurement data. Daylight savings time offsets are not automatically adjusted by the instrument or the microAeth Manager. Select the desired value from the dropdown and click the button 'Set timezone offset' to save. When the timezone offset is saved, a confirmation notification will be displayed below the button in this window.

5.7.3.6. Operation Settings AutoSample

The AutoSample dropdown can be used to select the autosample mode. Select the desired value from the dropdown and click the checkmark to save and the 'x' to cancel.
Off: Automatic start of sampling and measurements will not occur.
Resume after power loss (Resume): 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.
External power control (Ext Power): If the 5V barrel jack of the instrument is supplied with power, the instrument will automatically turn on and start sampling and measurements. If power is removed from the 5V barrel jack of the instrument, the instrument will automatically stop sampling and measurements and turn off.

5.7.3.7. Tape advance triggers ATN threshold

The tape advance ATN threshold field can be used to enter the attenuation (ATN) threshold natural number 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.

5.7.3.8. Flow setpoint

The flow setpoint dropdown can be used to select a sampling flow setpoint of 50, 75, 100, 125, 150 or 170 ml/min. Select the desired value from the dropdown and click the checkmark to save and the 'x' to cancel. **A flow rate of 100, 125, 150 or 170 ml/min is highly recommended when using DualSpot® loading compensation.**

5.7.3.9. 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.

5.7.3.10. 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.
Only IR wavelength: IR (880 nm)
UV + IR wavelength: IR (880 nm), UV (375 nm)
Blue + IR wavelengths: IR (880 nm), Blue (470 nm)
Blue + IR + UV wavelength: IR (880 nm), Blue (470 nm), UV (375 nm)
5 wavelengths: IR (880 nm), Red (625 nm), Green (528 nm), Blue (470 nm), UV (375 nm)

5.7.3.11. Sampling mode

The sampling mode dropdown can be used to select if the instrument is in SingleSpot™ or DualSpot® loading compensation sampling mode. Select the desired value from the dropdown and click the checkmark to save and the ‘x’ to cancel. **A flow rate of 100, 125, 150 or 170 ml/min is highly recommended when using DualSpot® loading compensation.** Although DualSpot mode can be used in many sampling scenerios, for best results it should be used in stationary applications.

5.7.3.12. Source Apportionment AAE Biomass

The source apportionment AAE Biomass field can be used to enter the AAE Biomass decimal number value of 1.5 to 100 that is used for calculating

5.7.3.13. Source Apportionment AAE Fossil Fuel

The source apportionment AAE Fossil Fuel field can be used to enter the AAE Fossil Fuel decimal number value of 0.5 to 100 that is used for calculating

5.7.3.14. Source Apportionment Cref

The source apportionment Cref field can be used to enter the Cref decimal number value of 0.8 to 100 that is used for calculating

5.7.3.15. GPS

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

5.7.3.16. Data transmission Mode

The serial data mode dropdown can be used to select the serial mode of the serial port. Select the desired value from the dropdown and click the checkmark to save and the ‘x’ to cancel.

Off: No measurement data will be transmited via the serial port. On-board user interface data and the output of Display All Settings and Display FlowCal Info will still be transmitted when selected and at startup.

Streaming: Measurement data will be transmited via the serial port while sampling and measurements

are occuring. On-board user interface data and the output of Display All Settings and Display FlowCal Info will still be transmitted when selected and at startup.

Polled: Measurement data and instrument status can be polled and the operating controls of the instrument can be controlled using the command line inferface (CLI) via the serial port. See section 5.9. Command Line Interface (CLI) for Polled Serial Data Mode for CLI commands. On-board user interface data and the output of Display All Settings and Display FlowCal Info will still be transmitted when selected and at startup.

5.7.3.17. Data transmission Output format

The serial data format dropdown can be used to select the serial data format when serial data streaming or WiFi data streaming is turned on. Not all serial data formats are compatible with WiFi streaming. Select the desired value from the dropdown and click the checkmark to save and the ‘x’ to cancel.

Three format options are available:
Version 3: Highly recommended. Compatible with WiFi steaming. New data format supported with Firmware version 1.12 and newer. Includes version 2 data format but has additional data for source apportionment and

Version 2 (previously "Verbose"): Compatible with WiFi steaming. Data format supported with Firmware v1.08 and newer.

Version 1 (previously "Minimal"): Not compatible with WiFi streaming.

For more information about serial output formating structures, see section 6.2. Serial Output Format Structures.

5.7.3.18. Data transmission Serial baud rate

The serial baud rate dropdown can be used to select the serial baud rate for all data transmitted through the serial port. Select the desired value from the dropdown and click the checkmark to save and the ‘x’ to cancel.
NOTE: When installing firmware using the instrument bootloader, the baud rate is always 1000000 even if the baud rate setting has been changed.

5.7.3.19. WiFi

IMPORTANT: WiFi streaming is only compatible with timebases of 60 seconds or greater and with Data transmission Output format greater than or equal to Version 2.
The WiFi toggle switch can be used to turn WiFi streaming on or off.

IMPORTANT: In order to complete initial setup of and enable WiFi, the user must be logged into the AethLabs website through the microAeth Manager Application. IPlease read section 7.6. WiFi Setup and Configuration before using this menu option.

5.7.3.19.1. WiFi SSID

This field can be used to configure the SSID name of the WiFi network on the instrument.

5.7.3.19.2. WiFi Password
This password field can be used to configure the password of the WiFi network on the instrument.

5.7.3.19.3. WiFi Certificates
This button can be used to start the process of configuring WiFi certificates on the instrument. **A user must have an account with and be logged into the AethLabs website through the microAeth Manager application.**

If WiFi certificates are installed on the instrument, "Installed" will be displayed to the right of this setting title in microAeth Manager.

5.7.3.19.4. WiFi Connectivity test
This button can be used to start the WiFi connectivity test that tests the ability of the current instrument configuration to connect to the local WiFi network and to the AethLabs server. **A user must have an account with and be logged into the AethLabs website through the microAeth Manager application.**

5.7.3.19.5. WiFi Device reservation
This button can be used to claim the device reservation of the instrument on the AethLabs website. **A user must have an account with and be logged into the AethLabs website through the microAeth Manager application.**

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 for MAxxx-xxxx' window of the microAeth Manager for a connected microAeth. Data is downloaded from the instrument via the USB port and is stored in the microAeth Manager local database. Data previously downloaded from any microAeth to the microAeth Manager application local database, can be managed at any time with or without an instrument connected, through the 'Manage local database' window.

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 a microAeth via the USB port. Data can be downloaded to the application local database using the USB cable provided by AethLabs. Once the data stored on the microAeth is downloaded to the microAeth Manager application local 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 sesions from the instrument that are stored in microAeth Manager local database are displayed.
8) 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.
9) To download data from the instrument to the microAeth Manager local database, click the 'Download data from device (xxxx points)' button.
10) A window will appear with the title 'Downloading data progress for MAxxx-xxxx' and the 'Current Progress: xx%' progress bar.
11) 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. Data Export 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. There are two locations in the microAeth Manager to export data.

Option 1 - Data export from the local database for the connected microAeth:
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. This window displays all data files that were downloaded from the currently connected 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 sesions 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 sessons' 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 'Data file export location:'. The data file export directory can be opened and viewed in the computer operating system by clicking the 'Open' button.

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.

Option 2 - Data export from the local database for a disconnected microAeth:
1) Open microAeth Manager.
2) Click the 'Manage application' button in the top right of the main application window to toggle open the Manage application section.
3) Click the 'View database' button in the 'Local database' section to open the 'Manage local database' window. This window displays all the microAeth serial numbers along with information for data sessions for previously downloaded data from all microAeth that are stored in the microAeth Manager local database.
4) Click the 'Show sessions' button to the right of the microAeth serial number to toggle open the view of all data files for the instrument that were downloaded and are currently stored in the local microAeth Manager database on the computer.
5) Select the checkboxes of all data sessions to be export to .csv files.
6) 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.
7) To export the selected data sessions, click the 'Export selected sessons' button at the bottom of the section for the specific microAeth serial number.
8) 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 section for the specific microAeth serial number below the 'Export selected sessions' button and to the right of 'Data file export location:'. The data file export directory can be opened and viewed in the computer operating system by clicking the 'Open' button.

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.

5.7.7. Delete All Data on the microAeth

ONCE THIS ACTION IS COMPLETED, IT IS NOT REVERSIBLE. Deleting the data on the microAeth deletes all data stored on a microAeth.

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.
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 sesions from the instrument that are stored in microAeth Manager local database are displayed.
7) In the 'Data on device' section, click the 'Delete all data on device button'.
8) The 'Confirm deleting data' window will open. Type 'DELETE' into the text field.
9) **ONCE THIS ACTION IS COMPLETED, IT IS NOT REVERSIBLE.** Press the 'Delete all on the device' button to confirm.

10) All data on the microAeth is now erased.
11) Unplug the USB cable and once the microAeth information is unloaded from the microAeth Manager instrument device pane, plug the USB cable back in.

5.8. Using the on-board user interface

5.8.1. Overview

The on-board user interface of the microAeth MA Series instruments consitsts 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. Change Timebase

The on-board user interface on the front of the microAeth can be used to change the measurement timebase setting of the instrument.
1) Use the left and right buttons to scroll through the top level menu options to the 'Change Timebase' option.
2) Press the center button to select the 'Change Timebase' option and to enter the change timebase submenu.
3) Use the left or right buttons to scroll through timebase value options of 1, 5, 10, 30, 60, or 300 second(s).
4) Press the center button, 'OK' 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. Change Flow

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, 25, 50, 75, 100, 125, 150 or 170 ml/min.
4) Press the center button, 'OK' 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. Change Tape Adv. ATN

The on-board user interface on the front of the microAeth can be used to change the attenuation (ATN) threshold natural number 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 tigger values of 1 to 100 in incriments of 1.

4) Press the center button, 'OK' to select the current attenuation (ATN) threshold tigger 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 Measurement

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 sampling and measurement begins, the screen will display a "play" symbol in the top left cornter, 'Press Center to Stop' on line 2, the DualSpot (DS) or SingleSpot (SS) target total flow rate on line 3, and 'SAMPLING' on line 4.

To skip the automatic tape advance when starting measurements, in step 2 press and hold the center button for 6 seconds. While holding the center button, the microAeth screen will display 'SAMPLER PREPARING'. Once 'Skipped Tape Advance' flashes on the screen, the center button can be released. When sampling and measurement begins, the scren will display a "play" symbol in the top left cornter, 'Press Center to Stop' on line 2, the DualSpot (DS) or SingleSpot (SS) target total flow rate on line 3, and 'SAMPLING' on line 4.

NOT RECOMMENDED!
SKIPPING THE AUTOMATIC TAPE ADVANCE AT THE BEGINNING OF SAMPLING AND MEASUREMENTS SHOULD ONLY BE USED WHEN GOOD DATA QUALITY IS NOT NEEDED.
When the automatic tape advance is skipped, a status code is added to each data line that is collected during the sampling period where the automatic tape advance was skipped.

5.8.3.2. Stop Measurement

The on-board user interface on the front of the microAeth is used to stop sampling and measurements.
1) While the microAeth is sampling, the screen will display a "play" symbol in the top left cornter, 'Press Center to Stop' on line 2, the DualSpot (DS) or SingleSpot (SS) target total flow rate on line 3, and 'SAMPLING' on line 4.
2) Press and hold the center button for 2 seconds to stop sampling and measurement. The screen will display a "stop" symbol in the top left corner and '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 or optical 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. The screen will display '-Releasing Tape' then '-Advancing Tape' and then '-Clamping Tape' during the tape advance process.

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. '-Releasing Tape' and 'Tape Position @ <xx>' will be displayed on the screen where <xx> is the current tape position value. **IMPORTANT: It is recommended to record the displayed current tape position value so that this can be tracked and entered when the tape cartridge is installed again.** 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 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. '- Installed Tape Is:' and 'Old', 'New', 'None' options will be displayed on the screen.

> **OLD)** If installing an Old tape cartirdge that has been partially used before, press the left button that is under the on-screen 'Old' option.
>
> **NEW)** If installing a New tape cartridge that has never been used before, press the center button that is under the on-screen 'New' option.
>
> **NONE)** If reinstalling the same tape cartridge that was previously installed (no change to the tape cartridge was made - the tape cartridge was not removed after the tape clamp was released), press the right button that is under the on-screen 'None' option

11-OLD) If 'Old' was selected by pressing the left button, '- Position : <xx>' and '<<-', 'Done', and '+>' options will be displayed on screen where <xx> is the current tape position value of the tape cartridge being installed.
12-OLD) Use the left button under the on-screen '<<-' option and the right butto under the on-screen '+>' option to decrease or increase the current tape position value that is displayed on-screen.
13-OLD) When the correct current tape position value is displayed on-screen, press the center button under the 'DONE' option.
14-OLD) '-Clamping Tape' and 'Tape Position @ <xx>' where <xx> is the value entered as the current tape position will be displayed on-screen. The optical head of the instrument will move to its clamped position and stop in about 6 seconds.
15-NEW) If 'New' was selected by pressing the center button, '-Clamping Tape' and 'Tape Position @ 0' will be displayed on-screen since the tape cartridge is new and has never been used before. The optical head of the instrument will move to its clamped position and stop in about 6 seconds.
16-NONE) If 'None' was selected by pressing the right button, '-Clamping Tape' and 'Tape Position @ <xx>' where <xx> is the tape position value of the previouly installed tape cartridge will be displayed on-screen since no change to the tape cartridge was made (the tape cartridge was not removed after the tape clamp was released). The optical head of the instrument will move to its clamped position and stop in about 6 seconds.
17) Confirm that the filter tape cartridge is clamped by the optical head.
18) 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
19) 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

IMPORTANT: Please read section 7.3. Flow Calibration and section 7.3.5. 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.
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.

5.8.3.6. Test Flow

IMPORTANT: Please read section 7.3.3. Test Flow Procedure before using this menu option. This menu allows the user to change flow setpoint target to 50, 75, 100, 125, 150 or 170 ml/min and to have the measured flow of the internal flowmeter displayed as a comparison to check the quality of the current FlowCal table calibration of the instrument.

5.8.3.7. Calibrate Optics

IMPORTANT: Please read section 7.4. Optical Calibration Procedure before using this menu option. Before starting the automatic optical 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 optical calibration should be run only when the filter tape cartridge door is installed and closed. The optical calibration CANNOT be cancelled once it is started.**

5.8.3.8. WiFi

IMPORTANT: WiFi streaming is only compatible with timebases of 60 seconds or greater. If WiFi is turned on and the existing timebase setting is set to less than 60 seconds and measurements are started, the instrument will automatically use a timebase of 60 seconds.
The on-board user interface on the front of the microAeth can be used to change the WiFi enabled setting of the instrument.
1) Use the left and right buttons to scroll through the top level menu options to the 'WiFi' option.
2) Press the center button to select the 'WiFi' option and to enter the change WiFi enable submenu.
3) Use the left or right buttons to scroll through WiFi enable value options of Off or On.
4) Press the center button, 'OK' to select the current WiFi enable value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.3.9. Change Data Mode

The on-board user interface on the front of the microAeth can be used to change the serial mode setting of the instrument.
1) Use the left and right buttons to scroll through the top level menu options to the 'Change Serial Mode' option.
2) Press the center button to select the 'Change Serial Mode' option and to enter the change serial mode submenu.
3) Use the left or right buttons to scroll through serial mode value options of Off, Streaming, or Polled.
4) Press the center button, 'OK' to select the current serial mode value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.3.10. Change Serial Baud

The on-board user interface on the front of the microAeth can be used to change the serial baud rate setting of the instrument serial port.
1) Use the left and right buttons to scroll through the top level menu options to the 'Change Serial Baud' option.
2) Press the center button to select the 'Change Serial Baud' option and to enter the change serial baud submenu.
3) Use the left or right buttons to scroll through serial baud value options of 57600, 115200, 230400, 460800, 921600, or 1000000.
4) Press the center button, 'OK' to select the current serial baud value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.3.11. Change AutoSample

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

1) Use the left and right buttons to scroll through the top level menu options to the 'Change AutoSample' option.
2) Press the center button to select the 'Change AutoSample' option and to enter the change autosample submenu.
3) Use the left or right buttons to scroll through autosample value options of Off, After power fail, or External control.
4) Press the center button, 'OK' to select the current autosample value option. Once selected, the value is saved and the user interface menu is automatically returned to the top menu level.

5.8.3.12. 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 including the FlowCal 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. The serial output of Display All Settings is shown and described in setion 7.2. Display and Check All Settings.

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.

AethLabs only supports CoolTerm for macOS and Tera Term for Windows for transmitting display all settings.

5.8.3.12.1. macOS using CoolTerm

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 downloaded.
3) Open CoolTerm on the computer and use the following default settings (as described in section 5.5.3. 3.3V TTL Serial) or the serial baud rate setting as has been changed by the user:

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

4) When Cool Term opens, a window with the title 'Untitled_0' will appear.
5) In the main window menu, click the 'Options' button.
6) In the menu on the left, select 'Serial Port' to display the 'Serial Port Options' menu on the right.
7) Use the 'Port:' dropdown menu to select the COM port that the microAeth is connected to through the AethLabs 4-pin Serial to USB converter cable.
8) Use the 'Baudrate:' dropdown menu to select the baud rate or if not listed, select 'Custom...'
9) If 'Custom...' baud rate is selected, a pop-up window will open and a custom baud rate like the default 1000000 can be entered. Click OK
10) Use the 'Data Bits:' dropdown menu to select '8'.
11) Use the 'Parity' dropdown menu to select 'None'.
12) Use the 'Stop Bits:' dropdown menu to select '1'.
13) Use the 'Flow Control:' radio buttons to select 'XON'
14) Un the menu on the left, select 'Data Handling' to display the 'Special Character Handling' menu on the right.

15) Click the checkbox labeled 'Format TAB separated text and enter '8' into the 'Column width:' field
16) Press the 'OK' button in the button right corner.
17) In the main window menu, click the 'Connect' button.
12) 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.
13) Use the left and right buttons to scroll through the top level menu options to 'Display All Settings'.
14) Press the center button to select the 'Display All Settings' option.
15) 'Sent via Serial Port' will display on the screen and all settings, status, and flow calibration table information will be displayed in the terminal emulator.

5.8.3.12.2. Windows using Tera Term

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 downloaded.
3) Open Tera Term on the computer and use the following default settings (as described in section 5.5.3. 3.3V TTL Serial) or the serial baud rate setting as has been changed by the user:

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

4) When Tera Term opens, a window with the title 'Tera Term: New connection' will appear.
5) Select the 'Serial' radio button.
6) Use the 'Port:' dropdown menu to select the COM port that the microAeth is connected to through the AethLabs 4-pin Serial to USB converter cable.
7) Press 'OK'.
8) The main window will remain and the window title will now be the COM port number.
9) Select the 'Setup' menu and select 'Serial port...'.
10) In the 'Tera Term: Serial port setup' window, change the settings to match the communication settings in Step 3.
11) Press 'OK'.
12) 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.
13) Use the left and right buttons to scroll through the top level menu options to 'Display All Settings'.
14) Press the center button to select the 'Display All Settings' option.
15) 'Sent via Serial Port' will display on the screen and all settings, status, and flow calibration table information will be displayed in the terminal emulator.

5.8.3.13. 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. Status

The on-board screen always displays the current status of the microAeth in the top left corner.
A "play" symbol will be shown if the instrument is sampling and making measurements.
A "stop" symbol will be shown if the instrument is idle.

5.8.4.2. Serial Number

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

5.8.4.3. Battery

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

5.8.4.4. 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 "lightning bolt" symbol to the left of the battery remaining symbol in the top right corner of the screen. While the USB port can be used to charge the instrument, the charging indicator will not be displayed.

5.8.4.5. Current Attenuation (ATN) value

The on-board screen displays the current attenuation (ATN) symbol and the current attenuation value out of the tape advance ATN threshold trigger value for the lowest enabled wavelength that will trigger an automatic tape advance in the top middle of the screen.

5.8.4.6. Tape position

The on-board screen displays the tape position symbol next to the current tape position value in the top middle of the screen.

5.8.4.7. Instrument UTC Date / Time

The on-board screen displays the instrument UTC data and time in the top middle of the screen.

5.8.4.8. During Startup

The on-board screen displays additional status indications at startup when the instrument is turned on.
During startup, the following information is temporarily displayed:
AethLabs Logo
Version: x.xx <Displays the firmware version>
Serial Baud: xxxxxxx <Displays the current serial baud rate value>
AutoSample:xxx <Displays the current AutoSample setting value>

5.8.4.9. When Idle

When the instrument is idle (not sampling and making measurements), a "stop" symbol is displayed in the top left corner of the screen.

5.8.4.10. During Sampling

The on-board screen displays additional status indications during sampling. When the instrument is sampling and making measurements, During sampling and measurements, the following information is displayed:

On line 2: Press Center to Stop

On line 3: <XX> Target <FFF.FF>

Where <XX> equals DS when sampling in DualSpot mode
OR
Where <XX> equals SS when sampling in SingleSpot mode
AND
<FFF.FF> equals the current user selected target flow rate

On line 4: SAMPLING

5.9. Command Line Interface (CLI) for Polled Serial Data Mode

The command line interface (CLI) can be used to control and request status information and data from the microAeth when the instrument serial data mode is set to polled.

The following default settings (as described in section 5.5.3. 3.3V TTL Serial) or the serial baud rate setting as has been changed by the user are used to communicate with the microAeth through the serial port.

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

The microAeth has a 4-pin serial port for communication through 3.3V TTL serial with external data acquisition systems or for direct integration into another system. Communication though the 3.3V TTL serial port can be established to a computer through a terminal emulator using the custom AethLabs 4-pin Serial to USB converter cable.

NOTE: The serial baud rate can be changed using the on-board LCD interface and the Change Serial Baud menu or using the microAeth Manager and the Baud rate setting under Serial and Communications.

5.9.1. AethLabs Serial Protocol

The following AethLabs Serial Protocol commands can be used in polled serial data mode:

AethLabs Serial Protocol		
To issue a command, send command + carriage return (<CR>, ASCII code 0x0D)		
Name	**Command**	**Description / Response**
Data request	dr	Requests most recent recorded data line. Most recent data line is returned in either Verbose or Minimal serial data format depending on instrument setting. See section 6.2. Serial Data Format Structures.
Measurement start / stop	ms	Instrument starts or stops sampling and measurements depending on current state of the instrument.
Check status	cs	Requests current status of instrument. The following is returned: 'firstId = <aaaaa>, nextId = <bbbbb>, currentId = <ccccc>, sampling = <0=false or 1=true>' where aaaaa, bbbbb, ccccc = Whole numbers.
Check battery	cb	Requests current remaining battery. The following is returned: 'Battery Perc : <xxx>' where xxx = Whole number (0-100).
Activate left button	ul	Simulates a physical push of the left button of the on-board user interface.
Activate center button	uc	Simulates a physical push of the center button of the on-board user interface.
Activate right button	ur	Simulates a physical push of the right button of the on-board user interface.

5.9.2. Bayern-Hessen Protocol

This section describes Hessen network protocol as implemented in AethLabs' MA Series instruments. The MA Series instruments act as a slave to a remote host communicating over the MA Series instrument serial port. The following AethLabs Bayern-Hessen Protocol implementation can be used in polled serial data mode:

Requirements:

- Physical connection from host device to MA Series instrument serial port.
- Serial Baud configuration matching on both the Host and MA Series instrument devices
- Serial Data setting must be set to 'Polled'

Bayern-Hessen Protocol Abbreviations Used		
Message Field	**Length (bytes)**	**Description**
<CR>	1	Carriage return (ASCII code 0x0D)
<STX>	1	Start of text character (ASCII code 0x02)
<ETX>	1	End of text character (ASCII code 0x03)
<BCC>	2	Block checksum characters
<SP>	1	Space character (ASCII code 0x20)

Bayern-Hessen Protocol Basic Command Structure
<STX>Command message<ETX><BCC>
OR
Command message<CR>

Each command is framed by either <STX> at the start and terminated with <ETX> or without a start and terminated only with <CR>. If a command is terminated with <ETX> then additional two characters <BCC> block checksum is attached after <ETX>.

AethLabs' implementation of the Hessen protocol does not itself support multi-drop installations, the instrument instead responds to broadcast command messages that do not specify an instrument ID. As the MA Series instruments do not have a traditional zero or span mode, normally associated with gas monitors, this functionality is not supported. MA Series instrument serial ports are 3.3v TTL logic level serial. Care must be taken when interfacing to this hardware as it is not isolated. Minimum serial baud rate communication speed for the MA Series instruments is 57600 baud.

Command for AethLabs Implementation of Bayern-Hessen Protocol		
Command Message	**Description**	**Examples**
DA	Data Query Command	<STX>DA<ETX><BCC> (<STX>DA<ETX>04)
		OR
		DA<CR>

NOTE: It is possible to make the same request simply by sending 'DA <CR>' not using <STX>, <ETX>, and <BCC>.

Bayern-Hessen Protocol Response Message Fields		
Message Field	**Length (bytes)**	**Description**
<STX>	1	Start of text character (ASCII code 0x02)
MD	2	'MD' is the message header.
<aa>	2	This is the number of gases (AethLabs measurements) being reported in the message
<SP>	1	Space character (ASCII code 0x20)
<nnn>	3	Three-digit gas (AethLabs measurement) ID number.
<SP>	1	Space character (ASCII code 0x20)
<smmmmsee>	8	Gas (AethLabs measurement) concentration.
<SP>	1	Space character (ASCII code 0x20)
<oo>	2	8 operational status bits, formatted as a two digit hexadecimal number.
<SP>	1	Space character (ASCII code 0x20)
<ff>	2	8 failure status bits, formatted as a two digit hexadecimal number.
<SP>	1	Space character (ASCII code 0x20)
<iii>	3	Three-digit instrument ID number.
<SP>	1	Space character (ASCII code 0x20)
000000	6	Spare field. Set to all zeros.
<SP>	1	Space character (ASCII code 0x20)
<ETX>	1	End of text character (ASCII code 0x03)
<BCC>	2	Block checksum
TOTAL	9 + 30 x A	'A" is the number of gases (AethLabs measurements) being reported in the message.

Response Message for AethLabs Implementation of Bayern-Hessen Protocol
Complete Response for Data Query Command (DA):
<STX>MD<aa><nnn><SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP><SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP><SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP><SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP><SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP><SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP><ETX><BCC>
Preamble of Response:
<STX>MD<aa><nnn>

Response Message for AethLabs Implementation of Bayern-Hessen Protocol
For each data line measurement returned: (e.g. UV BC1, Blue BC1, Green BC1, Red BC1, IR BC1, FlowTotal, Tape Postion):
<SP><smmmmsee><SP><oo><SP><ff><SP><iii><SP>000000<SP>
End of Response:
<ETX><BCC>

If the instrument is in SingleSpot mode, BC1 value for each optical wavelength will be returned. If the instrument is in DualSpot mode, the BCc (compensated) value for each optical wavelength will be returned. The instrument will provide the following channel values in response to a 'DA' command message:

Response Message for AethLabs Implementation of Bayern-Hessen Protocol	
Measurement / Status Data	**Units / Format**
SingleSpot mode:	
UV BC1	Nanograms per cubic meter (ng/m^3) (Integer)
Blue BC1	Nanograms per cubic meter (ng/m^3) (Integer)
Green BC1	Nanograms per cubic meter (ng/m^3) (Integer)
Red BC1	Nanograms per cubic meter (ng/m^3) (Integer)
IR BC1	Nanograms per cubic meter (ng/m^3) (Integer)
FlowTotal	Milliliters per minute (ml/min) (Decimal number)
Tape Position	Whole number
DualSpot mode:	
UV BCc	Nanograms per cubic meter (ng/m^3) (Integer)
Blue BCc	Nanograms per cubic meter (ng/m^3) (Integer)
Green BCc	Nanograms per cubic meter (ng/m^3) (Integer)
Red BCc	Nanograms per cubic meter (ng/m^3) (Integer)
IR BCc	Nanograms per cubic meter (ng/m^3) (Integer)
FlowTotal	Milliliters per minute (ml/min) (Decimal number)
Tape Position	Whole number

Example Response Message for AethLabs Implementation of Bayern-Hessen Protocol
The following hypothetical dataline (DualSpot) that might be available on the instrument at the time the 'DA' command message is issued:

Example Response Message for AethLabs Implementation of Bayern-Hessen Protocol
MA200-0011,25157,18,1,1.08,2018-12-06T20:29:01.00,-480,37.746172547,-122.420371919,0.146,60,64,100,342,-611,-24357,1,100.00,99.99,58.56,41.43,32.95,23.97,9.69,100596.00,33.62,DS-UV-B-G-R-IR,681907,622183,917573,25.9730,18.4158,-0.0198,780829,620878,736176,19.5300,13.7320,-0.0103,781964,625168,706936,16.6708,11.6571,0.0168,806763,690497,782392,13.4350,9.3264,-0.0353,675814,773992,951767,9.4010,6.3921,-0.1671,415,374,274,396,376,330,427,478,594,377,340,255,510,410,198,5D91

Expected response message:
MD07 001 +2740+02 00 00 011 000000 002 +3300+02 00 00 011 000000 003 +5940+02 00 00 011 000000 004 +2550+02 00 00 011 000000 005 +1980+02 00 00 011 000000 006 +1000+02 00 00 011 000000 007 +1000+00 00 00 011 000000

Expected response message values:	
UV BCc	274
Blue BCc	330
Green BCc	594
Red BCc	255
IR BCc	198
FlowTotal	100
Tape Position	1

5.10. 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.**

The tape position counter counts each time the filter tape cartridge advances. This counter is reset every time the tape clamp mechanism is released and then reclamped. The instrument does not specifically know the position of the filter tape in the filter tape cartridge in relation to the beginning or end of a filter tape cartridge. The user is responsible for keeping track of this process using the counter as a guide. The instrument is able to know and notify the user when a filter tape cartridge has reached the end of the tape.

5.11. Data Safety

AethLabs highly recommends keeping a prestine 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, App version, Date / time local, Timezone offset (mins), Date local (yyyy/MM/dd), Time local (hh:mm:ss), GPS lat (ddmm.mmmmm), GPS long (dddmm.mmmmm), GPS speed (km/h), GPS sat count, Timebase (s), 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, Readable status, UV BC1 smoothed (ng/m^3), UV BCc smoothed (ng/m^3), Blue BC1 smoothed (ng/m^3), Blue BCc smoothed (ng/m^3), IR BC1 smoothed (ng/m^3). IR BCc smoothed (ng/m^3), Cref, AAE biomass, AAE fossil fuel, Biomass BCc (ng/m^3). Fossil fuel BCc (ng/m^3), AAE, BB (%), Delta-C (ng/m^3), Pump drive, Reporting Temp (C), Reporting Pressure (Pa), WiFi RSSI

Exported Data File Structure Details

Header	Units / Format	Example Data	Description
Serial number	Model and number (MAxxx-xxxx)	MA200-0001	Unique identification number for the Instrument.
Datum ID	Whole number	1	Identification number assigned to each line of recorded data.
Session ID	Whole number	1	Identification number assigned to each sampling and measurement session. This value is incremented each time a new sampling and measurement session is started (changes from STOPPED to SAMPLING mode).
Data format version	Natural number	1	Unique identification number for exported data file structure used when exporting data from microAeth Manager software.
Firmware version	Decimal number	1.08	Unique identification number for firmware running on instrument when measurement was recorded.
App version	Decimal number	1.03	Unique identification number for microAeth Manager software that was used to export data file.
Date / time local	Year, month, day, hours, minutes, seconds (yyyy-MM-ddTxx:xx:xx)	2018-03-21T14:17:00	Local date and time calculated from instrument's internal clock using Coordinated Universal Time (UTC) and Timezone offset.
Timezone offset (mins)	Minutes (Integer)	-420	Timezone offset from Coordinated Universal Time (UTC) in minutes.
Date local (yyyy/MM/dd)	Year, month, day (yyyy/MM/dd)	2018/03/21	Local date calculated from instrument's internal clock using Coordinated Universal Time (UTC) and Timezone offset.
Time local (hh:mm:ss)	Hours, minutes, seconds (hh:mm:ss)	14:17:00	Local time calculated from instrument's internal clock using Coordinated Universal Time (UTC) and Timezone offset.

Exported Data File Structure Details

Header	Units / Format	Example Data	Description
GPS lat (ddmm.mmmmm)	Degrees (ddmm.mmmmm)	37.7461101412773	Measured latitude or relative angular distance north or south on Earth's surface in degrees from the equator.
GPS long (dddmm.mmmmm)	Degrees (dddmm.mmmmm)	-122.420443087816	Measured longitude or relative angular distance east or west on Earth's surface in degrees from the prime meridian.
GPS speed (km/h)	Kilometers per hour (Decimal number)	0.144168466329574	Measured speed using GPS in kilometers per hour. GPS is based on GPS lat and long, which are required for GPS speed calculation.
GPS sat count	Whole number	3	Number of satellites that are visible to the instrument's internal GPS receiver.
Timebase (s)	Seconds (Natural number)	60	Value in seconds of the measurement interval between measurements.
Status	Whole number	1	See section 6.3. Status Codes for detailed information.
Battery remaining (%)	Percent (Whole number)	88	Percent of instrument internal battery remaining.
Accel X	Integer	-5	Measured instantaneous acceleration in the x-axis.
Accel Y	Integer	-8	Measured instantaneous acceleration in the y-axis.
Accel Z	Integer	-255	Measured instantaneous acceleration in the z-axis.
Tape position	Whole number	1	Value of tape position counter. Increments by 1 after each tape advance. Counter is reset when 'Release Tape' is used to release the tape cartridge no matter the position of the newly inserted tape cartridge.
Flow setpoint (mL/min)	Milliliters per minute (Whole number)	100	Target value of the instrument total flow rate in milliliters per minute. Used in SingleSpot™ and DualSpot® sampling modes.
Flow total (mL/min)	Milliliters per minute (Decimal number)	100.10	Measured total flow through the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow1 (mL/min)	Milliliters per minute (Decimal number)	60.23	Measured flow through sample spot sense1 of the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow2 (mL/min)	Milliliters per minute (Decimal number)	39.87	Calculated flow through sample spot sense2 of the instrument in milliliters per minute. Calculated in DualSpot® sampling mode. No flow in SingleSpot™ sampling mode.
Sample temp (C)	Degrees celsius (Decimal number)	26.6705474853515	Measured temperature of instrument sampling stream in degrees celsius.
Sample RH (%)	Percent (Decimal number)	22.6140441894531	Measured relative humidity of instrument sampling stream in percent.
Sample dewpoint (C)	Degrees celsius (Decimal number)	10.3270139694213	Calculated temperature of dewpoint of instrument sampling stream in degrees celsius.
Internal pressure (Pa)	Pascal (Natural number)	100692	Measured pressure inside instrument case in pascals.
Internal temp (C)	Degrees celsius (Decimal number)	35.375	Measured temperature inside instrument case in Celsius.
Optical config	<DUAL or SINGLE>SPOT-XX-XXXX-XXXXX-XXX-XX	DUALSPOT-UV-BLUE-GREEN-RED-IR	Identification of sampling mode (SingleSpot™ or DualSpot®) and only the optical wavelengths used for each measurement are displayed.

Exported Data File Structure Details

Header	Units / Format	Example Data	Description
UV Sen1	Counts (Whole number)	710434	Measured optical intensity of ultraviolet (UV) wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
UV Sen2	Counts (Whole number)	724526	Measured optical intensity of ultraviolet (UV) wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
UV Ref	Counts (Whole number)	907699	Measured optical intensity of ultraviolet (UV) wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
UV ATN1	Attenuation units (Decimal number)	20.031862	Calculated attenuation of ultraviolet (UV) wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV ATN2	Attenuation units (Decimal number)	12.559727	Calculated attenuation of ultraviolet (UV) wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
UV K	Unitless (Decimal number)	0.0046992627903819	Calculated loading compensation factor for ultraviolet (UV) wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Blue Sen1	Counts (Whole number)	751124	Measured optical intensity of blue wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Blue Sen2	Counts (Whole number)	759335	Measured optical intensity of blue wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Blue Ref	Counts (Whole number)	843783	Measured optical intensity of blue wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Blue ATN1	Attenuation units (Decimal number)	15.778888	Calculated attenuation of blue wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Blue ATN2	Attenuation units (Decimal number)	9.550997	Calculated attenuation of blue wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Blue K	Unitless (Decimal number)	0.00198470731265842	Calculated loading compensation factor for blue wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Green Sen1	Counts (Whole number)	810122	Measured optical intensity of green wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Green Sen2	Counts (Whole number)	829080	Measured optical intensity of green wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Green Ref	Counts (Whole number)	902411	Measured optical intensity of green wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Green ATN1	Attenuation units (Decimal number)	13.872042	Calculated attenuation of green wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.

Exported Data File Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
Green ATN2	Attenuation units (Decimal number)	8.236315	Calculated attenuation of green wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Green K	Unitless (Decimal number)	0.00123747368343174	Calculated loading compensation factor for green wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Red Sen1	Counts (Whole number)	794974	Measured optical intensity of red wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Red Sen2	Counts (Whole number)	759396	Measured optical intensity of red wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Red Ref	Counts (Whole number)	888090	Measured optical intensity of red wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Red ATN1	Attenuation units (Decimal number)	11.366656	Calculated attenuation of red wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Red ATN2	Attenuation units (Decimal number)	6.714724	Calculated attenuation of red wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Red K	Unitless (Decimal number)	-0.00194589456077665	Calculated loading compensation factor for red wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
IR Sen1	Counts (Whole number)	657342	Measured optical intensity of infrared (IR) wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
IR Sen2	Counts (Whole number)	792594	Measured optical intensity of infrared (IR) wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
IR Ref	Counts (Whole number)	976403	Measured optical intensity of infrared (IR) wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
IR ATN1	Attenuation units (Decimal number)	8.610901	Calculated attenuation of infrared (IR) wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
IR ATN2	Attenuation units (Decimal number)	5.190925	Calculated attenuation of infrared (IR) wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
IR K	Unitless (Decimal number)	-0.00266132899560034	Calculated loading compensation factor for infrared (IR) wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
UV BC1	Nanograms per cubic meter (ng/m^3) (Integer)	23201	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV BC2	Nanograms per cubic meter (ng/m^3) (Integer)	24101	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.

Exported Data File Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
UV BCc	Nanograms per cubic meter (ng/m^3) (Integer)	25613	Calculated mass concentration with DualSpot® loading compensation for ultraviolet (UV) wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Blue BC1	Nanograms per cubic meter (ng/m^3) (Integer)	24325	Calculated mass concentration for blue wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Blue BC2	Nanograms per cubic meter (ng/m^3) (Integer)	24635	Calculated mass concentration for blue wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Blue BCc	Nanograms per cubic meter (ng/m^3) (Integer)	25111	Calculated mass concentration with DualSpot® loading compensation for blue wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Green BC1	Nanograms per cubic meter (ng/m^3) (Integer)	24088	Calculated mass concentration for green wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Green BC2	Nanograms per cubic meter (ng/m^3) (Integer)	24259	Calculated mass concentration for green wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Green BCc	Nanograms per cubic meter (ng/m^3) (Integer)	24509	Calculated mass concentration with DualSpot® loading compensation for green wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Red BC1	Nanograms per cubic meter (ng/m^3) (Integer)	24137	Calculated mass concentration for red wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Red BC2	Nanograms per cubic meter (ng/m^3) (Integer)	23923	Calculated mass concentration for red wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Red BCc	Nanograms per cubic meter (ng/m^3) (Integer)	23615	Calculated mass concentration with DualSpot® loading compensation for red wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
IR BC1	Nanograms per cubic meter (ng/m^3) (Integer)	23958	Calculated mass concentration for infrared (IR) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
IR BC2	Nanograms per cubic meter (ng/m^3) (Integer)	23745	Calculated mass concentration for infrared (IR) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
IR BCc	Nanograms per cubic meter (ng/m^3) (Integer)	23422	Calculated mass concentration with DualSpot® loading compensation for infrared (IR) wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Readable status	Text	Start up	Human readable description of status codes. See section 6.3. Status Codes for detailed information.

Exported Data File Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
UV BC1 smoothed (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	23422	Ultraviolet BC1 data with 15 minute double exponential moving average smoothing applied
UV BCc smoothed (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	23422	Ultraviolet BCc (loading compensated) data with 15 minute double exponential moving average smoothing applied
Blue BC1 smoothed (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	23422	Blue BC1 data with 15 minute double exponential moving average smoothing applied
Blue BCc smoothed (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	23422	Blue BCc (loading compensated) data with 15 minute double exponential moving average smoothing applied
IR BC1 smoothed (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	23422	IR BC1 data with 15 minute double exponential moving average smoothing applied
IR BCc smoothed (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	23422	IR BCc data with 15 minute double exponential moving average smoothing applied
Cref	(Decimal number)	1.30	Aethalometer multple scattering coefficient used for source apportionment calculations. An empirical constant used to compensate for filter specific measurement errors
AAE biomass	(Decimal number)	2	Absorption Ångström absorption for woodburning or biomass sources. Default value 2.
AAE fossil fuel	(Decimal number)	1	Absorption Ångström absorption for traffic of fossil fuel sources. Default value 1.
Biomass BCc (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	233	BCc (loading compensated) data representing the contribution from biomass (wood burning)
Fossil fuel BCc (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	11211	BCc (loading compensated) data representing the contribution from traffic (fossil fuel)
AAE	(Decimal number)	1.03	Absorption Ångström exponent, an aerosol optical parameter relevant for source apportionment and aerosol characterization
BB (%)	Percent (Whole number)	2	Calculated percentage of biomass burning
Delta-C (ng/m^3)	Nanograms per cubic meter (ng/m^3) (Integer)	738	"Delta-C" woodsmoke indicator[1]
Pump drive	(Whole number)	135	Pump power level. Maximum is 1024
Reporting Temp (C)	Degrees celsius (Decimal number	35.375	Temperature acquired during flow calibration from the external Alicat flowmeter
Reporting Pressure (Pa)	Pascal (Natural number)	100692	Pressure acquired during flow calibration from the external Alicat flowmeter

Exported Data File Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
WiFi RSSI	(Integer)	-52	Received Signal Strength Indicator (RSSI), provides a measurement of router or access point WiFi signal strength. Range is -120dbm (minimum) to 0 (maximum). -127 indicates that WiFi is disabled. This is a relative measurement and does not represent absolute signal strength or transmit power of the access point or router. This is helpful for determining if signal strength is sufficient for WiFi communications. AethLabs recommends values of -65 to 0 for proper WiFi operation.

[1] Allen, GA, Babich, P, Poirot, RL. Evaluation of a New Approach for Real Time Assessment of Wood Smoke PM, Air & Waste Management Association Visibility Specialty Conference on Regional and Global Perspectives on Haze: Causes, Consequences and Controversies, Asheville, NC, October 2004

6.2. Serial Data Output Format Structures

The output format structures of the measurement serial data in streaming and polled data transmission modes that are output through the 4-pin serial port of the microAeth are as follows.

6.2.1. Version 3 Structure

Version 3: Highly recommended. Compatible with WiFi steaming. New data format supported with Firmware version 1.12 and newer. Includes version 2 data format but has additional data for source apportionment and

Serial number,Datum ID,Session ID,Data format version,Firmware version,Date / time UTC,Timezone offset,GPS lat,GPS long,GPS speed,Timebase,Status,Battery remaining,Accel X,Accel Y,Accel Z,Tape position,Flow setpoint,Flow total,Flow1,Flow2,Sample temp,Sample RH,Sample dewpoint,Internal pressure,Internal temp,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,UV BC1 Smooth,UV BCc Smooth,Blue BC1 Smooth,Blue BCc Smooth,IR BC1 Smooth,IR BCc Smooth,Cref,AAE WB,AAE FF,BCc WB,BCc FF,AAE,BB,Delta-C,Pump Drive,Reporting Temp,Reporting Pressure,WiFi RSSI,CKSUM

Version 3 Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
Serial number	Model and number (MAxxx-xxxx)	MA200-0011	Unique identification number for the Instrument.
Datum ID	Whole number	1	Identification number assigned to each line of recorded data.
Session ID	Whole number	1	Identification number assigned to each sampling and measurement session. This value is incremented each time a new sampling and measurement session is started (changes from STOPPED to SAMPLING mode).

Version 3 Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
Data format version	Natural number	1	Unique identification number for exported data file structure used when exporting data from microAeth Manager software.
Firmware version	Decimal number	1.08	Unique identification number for firmware running on instrument when measurement was recorded.
Date / Time UTC	Year, month, day, hours, minutes, seconds (yyyy-MM-ddTxx:xx:xx.xx)	2018-03-21T14:17:00.00	Coordinated Universal Time (UTC) produced from instrument's internal clock
Timezone offset	Minutes (Integer)	-420	Timezone offset from Coordinated Universal Time (UTC) in minutes.
GPS lat	Degrees (ddmm.mmmmm)	37.7461101412773	Measured latitude or relative angular distance north or south on Earth's surface in degrees from the equator.
GPS long	Degrees (dddmm.mmmmm)	-122.420443087816	Measured longitude or relative angular distance east or west on Earth's surface in degrees from the prime meridian.
GPS speed	Kilometers per hour (Decimal number)	0.144168466329574	Measured speed using GPS in kilometers per hour. GPS is based on GPS lat and long, which are required for GPS speed calculation.
Timebase	Seconds (Natural number)	60	Value in seconds of the measurement interval between measurements.
Status	Whole number	1	See section 6.3. Status Codes for detailed information.
Battery	Percent (Whole number)	88	Percent of instrument internal battery remaining.
Accel X	Integer	-5	Measured instantaneous acceleration in the x-axis.
Accel Y	Integer	-8	Measured instantaneous acceleration in the y-axis.
Accel Z	Integer	-255	Measured instantaneous acceleration in the z-axis.
Tape position	Whole number	1	Value of tape position counter. Increments by 1 after each tape advance. Counter is reset when 'Release Tape' is used to release the tape cartridge no matter the position of the newly inserted tape cartridge.
Flow setpoint	Milliliters per minute (Whole number)	100	Target value of the instrument total flow rate in milliliters per minute. Used in SingleSpot™ and DualSpot® sampling modes.
Flow total	Milliliters per minute (Decimal number)	100.10	Measured total flow through the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow1	Milliliters per minute (Decimal number)	60.23	Measured flow through sample spot sense1 of the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow2	Milliliters per minute (Decimal number)	39.87	Calculated flow through sample spot sense2 of the instrument in milliliters per minute. Calculated in DualSpot® sampling mode. No flow in SingleSpot™ sampling mode.
Sample temp	Degrees celsius (Decimal number)	26.6705474853515	Measured temperature of instrument sampling stream in degrees celsius.
Sample RH	Percent (Decimal number)	22.6140441894531	Measured relative humidity of instrument sampling stream in percent.

Version 3 Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
Sample dewpoint	Degrees celsius (Decimal number)	10.3270139694213	Calculated temperature of dewpoint of instrument sampling stream in degrees celsius.
Int pressure	Pascal (Natural number)	100692	Measured pressure inside instrument case in pascals.
Int temp	Degrees celsius (Decimal number)	35.375	Measured temperature inside instrument case in Celsius.
Optical config	<SS or DS>-XX-X-X-X-XX	DS-UV-B-G-R-IR	Identification of sampling mode (SingleSpot™ (SS) or DualSpot® (DS)) and only the optical wavelengths used for each measurement are displayed.
UV Sen1	Counts (Whole number)	710434	Measured optical intensity of ultraviolet (UV) wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
UV Sen2	Counts (Whole number)	724526	Measured optical intensity of ultraviolet (UV) wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
UV Ref	Counts (Whole number)	907699	Measured optical intensity of ultraviolet (UV) wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
UV ATN1	Attenuation units (Decimal number)	20.031862	Calculated attenuation of ultraviolet (UV) wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV ATN2	Attenuation units (Decimal number)	12.559727	Calculated attenuation of ultraviolet (UV) wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
UV K	Unitless (Decimal number)	0.0046992627903819	Calculated loading compensation factor for ultraviolet (UV) wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Blue Sen1	Counts (Whole number)	751124	Measured optical intensity of blue wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Blue Sen2	Counts (Whole number)	759335	Measured optical intensity for blue wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Blue Ref	Counts (Whole number)	843783	Measured optical intensity of blue wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Blue ATN1	Attenuation units (Decimal number)	15.778888	Calculated attenuation of blue wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Blue ATN2	Attenuation units (Decimal number)	9.550997	Calculated attenuation of blue wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Blue K	Unitless (Decimal number)	0.00198470731265842	Calculated loading compensation factor for blue wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Green Sen1	Counts (Whole number)	810122	Measured optical intensity of green wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.

Version 3 Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
Green Sen2	Counts (Whole number)	829080	Measured optical intensity of green wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Green Ref	Counts (Whole number)	902411	Measured optical intensity of green wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Green ATN1	Attenuation units (Decimal number)	13.872042	Calculated attenuation of green wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Green ATN2	Attenuation units (Decimal number)	8.236315	Calculated attenuation of green wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Green K	Unitless (Decimal number)	0.00123747368343174	Calculated loading compensation factor for green wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Red Sen1	Counts (Whole number)	794974	Measured optical intensity of red wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Red Sen2	Counts (Whole number)	759396	Measured optical intensity of red wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Red Ref	Counts (Whole number)	888090	Measured optical intensity of red wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Red ATN1	Attenuation units (Decimal number)	11.366656	Calculated attenuation of red wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Red ATN2	Attenuation units (Decimal number)	6.714724	Calculated attenuation of red wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Red K	Unitless (Decimal number)	-0.00194589456077665	Calculated loading compensation factor for red wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
IR Sen1	Counts (Whole number)	657342	Measured optical intensity of infrared (IR) wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
IR Sen2	Counts (Whole number)	792594	Measured optical intensity of infrared (IR) wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
IR Ref	Counts (Whole number)	976403	Measured optical intensity of infrared (IR) wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
IR ATN1	Attenuation units (Decimal number)	8.610901	Calculated attenuation of infrared (IR) wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
IR ATN2	Attenuation units (Decimal number)	5.190925	Calculated attenuation of infrared (IR) wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.

Version 3 Structure Details			
Header	**Units / Format**	**Example Data**	**Description**
IR K	Unitless (Decimal number)	-0.00266132899560034	Calculated loading compensation factor for infrared (IR) wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
UV BC1	Nanograms per cubic meter (ng/m³) (Integer)	23201	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV BC2	Nanograms per cubic meter (ng/m³) (Integer)	24101	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
UV BCc	Nanograms per cubic meter (ng/m³) (Integer)	25613	Calculated mass concentration with DualSpot® loading compensation for ultraviolet (UV) wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Blue BC1	Nanograms per cubic meter (ng/m³) (Integer)	24325	Calculated mass concentration for blue wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Blue BC2	Nanograms per cubic meter (ng/m³) (Integer)	24635	Calculated mass concentration for blue wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Blue BCc	Nanograms per cubic meter (ng/m³) (Integer)	25111	Calculated mass concentration with DualSpot® loading compensation for blue wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Green BC1	Nanograms per cubic meter (ng/m³) (Integer)	24088	Calculated mass concentration for green wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Green BC2	Nanograms per cubic meter (ng/m³) (Integer)	24259	Calculated mass concentration for green wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Green BCc	Nanograms per cubic meter (ng/m³) (Integer)	24509	Calculated mass concentration with DualSpot® loading compensation for green wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Red BC1	Nanograms per cubic meter (ng/m³) (Integer)	24137	Calculated mass concentration for red wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Red BC2	Nanograms per cubic meter (ng/m³) (Integer)	23923	Calculated mass concentration for red wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Red BCc	Nanograms per cubic meter (ng/m³) (Integer)	23615	Calculated mass concentration with DualSpot® loading compensation for red wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.

Version 3 Structure Details			
Header	Units / Format	Example Data	Description
IR BC1	Nanograms per cubic meter (ng/m³) (Integer)	23958	Calculated mass concentration for infrared (IR) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
IR BC2	Nanograms per cubic meter (ng/m³) (Integer)	23745	Calculated mass concentration for infrared (IR) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
IR BCc	Nanograms per cubic meter (ng/m³) (Integer)	23422	Calculated mass concentration with DualSpot® loading compensation for infrared (IR) wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
UV BC1 Smooth	Nanograms per cubic meter (ng/m³) (Integer)	23422	Ultraviolet BC1 data with 15 minute double exponential moving average smoothing applied
UV BCc Smooth	Nanograms per cubic meter (ng/m³) (Integer)	23422	Ultraviolet BCc (loading compensated) data with 15 minute double exponential moving average smoothing applied
Blue BC1 Smooth	Nanograms per cubic meter (ng/m³) (Integer)	23422	Blue BC1 data with 15 minute double exponential moving average smoothing applied
Blue BCc Smooth	Nanograms per cubic meter (ng/m³) (Integer)	23422	Blue BCc (loading compensated) data with 15 minute double exponential moving average smoothing applied
IR BC1 Smooth	Nanograms per cubic meter (ng/m³) (Integer)	23422	IR BC1 data with 15 minute double exponential moving average smoothing applied
IR BCc Smooth	Nanograms per cubic meter (ng/m³) (Integer)	23422	IR BCc data with 15 minute double exponential moving average smoothing applied
Cref	(Decimal number)	1.30	Aethalometer multple scattering coefficient used for source apportionment calculations. An empirical constant used to compensate for filter specific measurement errors
AAE WB	(Decimal number)	2	Absorption Ångström absorption for woodburning or biomass sources. Default value 2.
AAE FF	(Decimal number)	1	Absorption Ångström absorption for traffic of fossil fuel sources. Default value 1.
BCc WB	Nanograms per cubic meter (ng/m³) (Integer)	233	BCc (loading compensated) data representing the contribution from biomass (wood burning)
BCc FF	Nanograms per cubic meter (ng/m³) (Integer)	11211	BCc (loading compensated) data representing the contribution from traffic (fossil fuel)
AAE	(Decimal number)	1.03	Absorption Ångström exponent, an aerosol optical parameter relevant for source apportionment and aerosol characterization
BB	Percent (Whole number)	2	Calculated percentage of biomass burning
Delta-C	Nanograms per cubic meter (ng/m³) (Integer)	738	"Delta-C" woodsmoke indicator[1]

Version 3 Structure Details			
Header	Units / Format	Example Data	Description
Pump Drive	{Whole number)	135	Pump power level. Maximum is 1024
Reporting Temp	Degrees celsius (Decimal number)	35.375	Temperature acquired during flow calibration from the external Alicat flowmeter
Reporting Pressure	Pascal (Natural number)	100692	Pressure acquired during flow calibration from the external Alicat flowmeter
WiFi RSSI	(Integer)	-52	Received Signal Strength Indicator (RSSI), provides a measurement of router or access point WiFi signal strength. Range is -120dbm (minimum) to 0 (maximum). -127 indicates that WiFi is disabled. This is a relative measurement and does not represent absolute signal strength or transmit power of the access point or router. This is helpful for determining if signal strength is sufficient for WiFi communications. AethLabs recommends values of -65 to 0 for proper WiFi operation.
CKSUM	Alphanumeric (XXXX)	434B	

[1]Allen, GA, Babich, P, Poirot, RL. Evaluation of a New Approach for Real Time Assessment of Wood Smoke PM, Air & Waste Management Association Visibility Specialty Conference on Regional and Global Perspectives on Haze: Causes, Consequences and Controversies, Asheville, NC, October 2004

6.2.2. Version 2 Structure (previously 'Verbose')

Version 2 (previously "Verbose"): Compatible with WiFi steaming. Data format supported with Firmware v1.08 and newer.

Serial number,Datum ID,Session ID,Data format version,Firmware version,Date / time UTC,Timezone offset,GPS lat,GPS long,GPS speed,Timebase,Status,Battery remaining,Accel X,Accel Y,Accel Z,Tape position,Flow setpoint,Flow total,Flow1,Flow2,Sample temp,Sample RH,Sample dewpoint,Internal pressure,Internal temp,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,CKSUM

Version 2 Structure Details (previously 'Verbose')			
Header	Units / Format	Example Data	Description
Serial number	Model and number (MAxxx-xxxx)	MA200-0011	Unique identification number for the Instrument.
Datum ID	Whole number	1	Identification number assigned to each line of recorded data.
Session ID	Whole number	1	Identification number assigned to each sampling and measurement session. This value is incremented each time a new sampling and measurement session is started (changes from STOPPED to SAMPLING mode).
Data format version	Natural number	1	Unique identification number for exported data file structure used when exporting data from microAeth Manager software.

Version 2 Structure Details (previously 'Verbose')			
Header	**Units / Format**	**Example Data**	**Description**
Firmware version	Decimal number	1.08	Unique identification number for firmware running on instrument when measurement was recorded.
Date / Time UTC	Year, month, day, hours, minutes, seconds (yyyy-MM-ddTxx:xx:xx.xx)	2018-03-21T14:17:00.00	Coordinated Universal Time (UTC) produced from instrument's internal clock
Timezone offset	Minutes (Integer)	-420	Timezone offset from Coordinated Universal Time (UTC) in minutes.
GPS lat	Degrees (ddmm.mmmmm)	37.7461101412773	Measured latitude or relative angular distance north or south on Earth's surface in degrees from the equator.
GPS long	Degrees (dddmm.mmmmm)	-122.420443087816	Measured longitude or relative angular distance east or west on Earth's surface in degrees from the prime meridian.
GPS speed	Kilometers per hour (Decimal number)	0.144168466329574	Measured speed using GPS in kilometers per hour. GPS is based on GPS lat and long, which are required for GPS speed calculation.
Timebase	Seconds (Natural number)	60	Value in seconds of the measurement interval between measurements.
Status	Whole number	1	See section 6.3. Status Codes for detailed information.
Battery	Percent (Whole number)	88	Percent of instrument internal battery remaining.
Accel X	Integer	-5	Measured instantaneous acceleration in the x-axis.
Accel Y	Integer	-8	Measured instantaneous acceleration in the y-axis.
Accel Z	Integer	-255	Measured instantaneous acceleration in the z-axis.
Tape position	Whole number	1	Value of tape position counter. Increments by 1 after each tape advance. Counter is reset when 'Release Tape' is used to release the tape cartridge no matter the position of the newly inserted tape cartridge.
Flow setpoint	Milliliters per minute (Whole number)	100	Target value of the instrument total flow rate in milliliters per minute. Used in SingleSpot™ and DualSpot® sampling modes.
Flow total	Milliliters per minute (Decimal number)	100.10	Measured total flow through the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow1	Milliliters per minute (Decimal number)	60.23	Measured flow through sample spot sense1 of the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow2	Milliliters per minute (Decimal number)	39.87	Calculated flow through sample spot sense2 of the instrument in milliliters per minute. Calculated in DualSpot® sampling mode. No flow in SingleSpot™ sampling mode.
Sample temp	Degrees celsius (Decimal number)	26.6705474853515	Measured temperature of instrument sampling stream in degrees celsius.
Sample RH	Percent (Decimal number)	22.6140441894531	Measured relative humidity of instrument sampling stream in percent.
Sample dewpoint	Degrees celsius (Decimal number)	10.3270139694213	Calculated temperature of dewpoint of instrument sampling stream in degrees celsius.
Int pressure	Pascal (Natural number)	100692	Measured pressure inside instrument case in pascals.

Version 2 Structure Details (previously 'Verbose')			
Header	**Units / Format**	**Example Data**	**Description**
Int temp	Degrees celsius (Decimal number)	35.375	Measured temperature inside instrument case in Celsius.
Optical config	<SS or DS>-XX-X-X-X-XX	DS-UV-B-G-R-IR	Identification of sampling mode (SingleSpot™ (SS) or DualSpot® (DS)) and only the optical wavelengths used for each measurement are displayed.
UV Sen1	Counts (Whole number)	710434	Measured optical intensity of ultraviolet (UV) wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
UV Sen2	Counts (Whole number)	724526	Measured optical intensity of ultraviolet (UV) wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
UV Ref	Counts (Whole number)	907699	Measured optical intensity of ultraviolet (UV) wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
UV ATN1	Attenuation units (Decimal number)	20.031862	Calculated attenuation of ultraviolet (UV) wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV ATN2	Attenuation units (Decimal number)	12.559727	Calculated attenuation of ultraviolet (UV) wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
UV K	Unitless (Decimal number)	0.0046992627903819	Calculated loading compensation factor for ultraviolet (UV) wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Blue Sen1	Counts (Whole number)	751124	Measured optical intensity of blue wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Blue Sen2	Counts (Whole number)	759335	Measured optical intensity for blue wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Blue Ref	Counts (Whole number)	843783	Measured optical intensity of blue wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Blue ATN1	Attenuation units (Decimal number)	15.778888	Calculated attenuation of blue wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Blue ATN2	Attenuation units (Decimal number)	9.550997	Calculated attenuation of blue wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Blue K	Unitless (Decimal number)	0.00198470731265842	Calculated loading compensation factor for blue wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Green Sen1	Counts (Whole number)	810122	Measured optical intensity of green wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Green Sen2	Counts (Whole number)	829080	Measured optical intensity of green wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.

Version 2 Structure Details (previously 'Verbose')			
Header	**Units / Format**	**Example Data**	**Description**
Green Ref	Counts (Whole number)	902411	Measured optical intensity of green wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Green ATN1	Attenuation units (Decimal number)	13.872042	Calculated attenuation of green wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Green ATN2	Attenuation units (Decimal number)	8.236315	Calculated attenuation of green wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Green K	Unitless (Decimal number)	0.00123747368343174	Calculated loading compensation factor for green wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
Red Sen1	Counts (Whole number)	794974	Measured optical intensity of red wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Red Sen2	Counts (Whole number)	759396	Measured optical intensity of red wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
Red Ref	Counts (Whole number)	888090	Measured optical intensity of red wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
Red ATN1	Attenuation units (Decimal number)	11.366656	Calculated attenuation of red wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
Red ATN2	Attenuation units (Decimal number)	6.714724	Calculated attenuation of red wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
Red K	Unitless (Decimal number)	-0.00194589456077665	Calculated loading compensation factor for red wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.
IR Sen1	Counts (Whole number)	657342	Measured optical intensity of infrared (IR) wavelength for sample spot sense1 in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
IR Sen2	Counts (Whole number)	792594	Measured optical intensity of infrared (IR) wavelength for sample spot sense2 in counts. Measured in DualSpot® sampling mode.
IR Ref	Counts (Whole number)	976403	Measured optical intensity of infrared (IR) wavelength for reference spot in counts. Measured in SingleSpot™ and DualSpot® sampling modes.
IR ATN1	Attenuation units (Decimal number)	8.610901	Calculated attenuation of infrared (IR) wavelength for sample spot sense1 in attenuation units. Calculated in SingleSpot™ and DualSpot® sampling modes.
IR ATN2	Attenuation units (Decimal number)	5.190925	Calculated attenuation of infrared (IR) wavelength for sample spot sense2 in attenuation units. Calculated in DualSpot® sampling mode.
IR K	Unitless (Decimal number)	-0.00266132899560034	Calculated loading compensation factor for infrared (IR) wavelength using sample spots sense1 and sense2, used to compensate BC1 value resulting in BCc. Calculated in DualSpot® sampling mode.

Version 2 Structure Details (previously 'Verbose')			
Header	**Units / Format**	**Example Data**	**Description**
UV BC1	Nanograms per cubic meter (ng/m^3) (Integer)	23201	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV BC2	Nanograms per cubic meter (ng/m^3) (Integer)	24101	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
UV BCc	Nanograms per cubic meter (ng/m^3) (Integer)	25613	Calculated mass concentration with DualSpot® loading compensation for ultraviolet (UV) wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Blue BC1	Nanograms per cubic meter (ng/m^3) (Integer)	24325	Calculated mass concentration for blue wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Blue BC2	Nanograms per cubic meter (ng/m^3) (Integer)	24635	Calculated mass concentration for blue wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Blue BCc	Nanograms per cubic meter (ng/m^3) (Integer)	25111	Calculated mass concentration with DualSpot® loading compensation for blue wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Green BC1	Nanograms per cubic meter (ng/m^3) (Integer)	24088	Calculated mass concentration for green wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Green BC2	Nanograms per cubic meter (ng/m^3) (Integer)	24259	Calculated mass concentration for green wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Green BCc	Nanograms per cubic meter (ng/m^3) (Integer)	24509	Calculated mass concentration with DualSpot® loading compensation for green wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Red BC1	Nanograms per cubic meter (ng/m^3) (Integer)	24137	Calculated mass concentration for red wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
Red BC2	Nanograms per cubic meter (ng/m^3) (Integer)	23923	Calculated mass concentration for red wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
Red BCc	Nanograms per cubic meter (ng/m^3) (Integer)	23615	Calculated mass concentration with DualSpot® loading compensation for red wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
IR BC1	Nanograms per cubic meter (ng/m^3) (Integer)	23958	Calculated mass concentration for infrared (IR) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.

Version 2 Structure Details (previously 'Verbose')			
Header	**Units / Format**	**Example Data**	**Description**
IR BC2	Nanograms per cubic meter (ng/m³) (Integer)	23745	Calculated mass concentration for infrared (IR) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
IR BCc	Nanograms per cubic meter (ng/m³) (Integer)	23422	Calculated mass concentration with DualSpot® loading compensation for infrared (IR) wavelength using sample spots sense1 and sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
CKSUM	Alphanumeric (XXXX)	434B	

6.2.3. Version 1 Structure (previously 'Minimal')

Version 1 (previously "Minimal"): Not compatible with WiFi streaming.

When in SingleSpot™ sampling mode:
Preamble, Date / Time UTC, Timezone offset, Status, Battery, Tape position, Flow total, UV BC, IR BC, CKSUM

When in DualSpot® sampling mode:
Preamble, Date / Time UTC, Timezone offset, Status, Battery, Tape position, Flow total, Flow1, Flow2, UV BC1, UV BC2, IR BC1, IR BC2, CKSUM

Version 1 Structure Details (previously 'Minimal')			
Header	**Units / Format**	**Example Data**	**Description**
Preamble	Alphanumeric (XXXXXX)	55AAFF	Identification for serial data stream format.
Date / Time UTC	Year, month, day, hours, minutes, seconds (yyyy-MM-ddTxx:xx:xx.xx)	2018-03-21T14:17:00.00	Coordinated Universal Time (UTC) produced from instrument's internal clock
Timezone offset	Minutes (Integer)	-420	Timezone offset from Coordinated Universal Time (UTC) in minutes.
Status	Whole number	1	See section 6.3. Status Codes for detailed information.
Battery	Percent (Whole number)	88	Percent of instrument internal battery remaining.
Tape position	Whole number	1	Value of tape position counter. Increments by 1 after each tape advance. Counter is reset when 'Release Tape' is used to release the tape cartridge no matter the position of the newly inserted tape cartridge.
Flow total	Milliliters per minute (Decimal number)	100.10	Measured total flow through the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.
Flow1	Milliliters per minute (Decimal number)	60.23	Measured flow through sample spot sense1 of the instrument in milliliters per minute. Measured in SingleSpot™ and DualSpot® sampling modes.

Version 1 Structure Details (previously 'Minimal')			
Header	**Units / Format**	**Example Data**	**Description**
Flow2	Milliliters per minute (Decimal number)	39.87	Calculated flow through sample spot sense2 of the instrument in milliliters per minute. Calculated in DualSpot® sampling mode. No flow in SingleSpot™ sampling mode.
UV BC1	Nanograms per cubic meter (ng/m³) (Integer)	23201	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
UV BC2	Nanograms per cubic meter (ng/m³) (Integer)	24101	Calculated mass concentration for ultraviolet (UV) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
IR BC1	Nanograms per cubic meter (ng/m³) (Integer)	23958	Calculated mass concentration for infrared (IR) wavelength for sample spot sense1 in nanograms per cubic meter. Calculated in SingleSpot™ and DualSpot® sampling modes.
IR BC2	Nanograms per cubic meter (ng/m³) (Integer)	23745	Calculated mass concentration for infrared (IR) wavelength for sample spot sense2 in nanograms per cubic meter. Calculated in DualSpot® sampling mode.
CKSUM	Alphanumeric (XXX)	D39	

6.3. Status Codes

Code Value	Readable status	Status Description
1		No status notifications
2	Start up	Instrument in sampling and measurement startup
4	Tape advance	Tape advance occurring during sampling and measurement period
8		N/A
16	Optical saturation	Optical saturation
32	Sample timing error	Sample timing error
64		Sampling spot 2 of DualSpot® loading compensation is active
128	Flow unstable	Flow unstable during sampling and measurement period. Flow deviates from target flow setpoint by more than ±5%.
256	Pump drive limit	Flow out of range during sampling and measurement period
512	Time source manual	Time synchronization source is manual (synchronized to application/ computer time or no GPS time is available)
1024	User skipped tape advance	User skipped tape advance. No tape advance occurred at start of sampling and measurements. **NOT RECOMMENDED!** **SKIPPING THE AUTOMATIC TAPE ADVANCE AT THE BEGINNING OF SAMPLING AND MEASUREMENTS SHOULD ONLY BE USED WHEN GOOD DATA QUALITY IS NOT NEEDED.**
2048	System busy	Device stops sampling after receiving a command via USB or serial that requires the device stop operation.
4096	S.A. disabled	Source apportionment disabled due to measurement configuration. Check Settings to re-enable source apportionment calculations
8192	Tape jam	Tape is jammed. Inspect tape. Release and clamp tape to attempt to clear the jam error.
16384	Tape at end	Tape is at end. Replace tape.
32768	Tape not ready	Tape is not ready. Check that the tape is installed and clamped.
65536	Tape transport not ready	Tape transport is not ready. Check that tape is installed and clamped and there are no other errors.
131072	Ext. power	Device is powered through the barrel jack input or circular connector (MA350) by external 5v source.
262144	Invalid date/time	Date and time are not set or are invalid. Set the clock with proper date/time.
524288	Tape error	Tape Error. A generic error for the tape. Possible reasons are tape is not detected in the instrument.
16777216	WiFi Forced Timebase to 60s	When WiFi is enabled and timebaseis set to less than 60 seconds, the timebase will be forced to 60 seconds as this is the minimum timebase for WiFi functionality.
4294967296	WiFi Line Full	WiFi data buffer is full.

Code Value	Readable status	Status Description
274877906944	Remote power down	Power down command received remotely via serial connection.

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. Display and Check All Settings

The Display All Settings menu outputs all the current settings and status information of the microAeth via the 4-pin serial port to a terminal emulator (AethLabs only supports Tera Term for Windows) on a computer using the AethLabs 4-pin Serial to USB converter cable.

To view all settings, the on-board user interface on the front of the microAeth is used to send all settings information of the instrument which includes the flow calibration table (See section 5.8.3.12. Display All Settings).

Below are descriptions of all the settings and is an example of a settings table that will be displayed using the Display All Settings menu item. The values in the settings table can be analyzed and verified in order to determine the current state of the instrument.

7.2.1. Display All Settings Descriptions

The display all settings menu transmits via the serial port a complete summary of all settings and status of the microAeth.

Setting / Status	Format	Example	Description
Manufacturer	Alphanumeric	AethLabs	
Serial Number	Model and number (MAxxx-xxxx)	MA200-0011	Unique identification number for the Instrument.
Firmware Version	Alphanumeric	1.12.05	Unique identification number for firmware running on instrument when measurement was recorded.
Bootloader Version	Alphanumeric	0.18L	Unique identification number for bootloader running on instrument when measurement was recorded.
Name	Alphanumeric	MA Device	User editable device name through microAeth Manager.
Timezone Offset	Minutes (Integer)	-480	Timezone offset from Coordinated Universal Time (UTC) in minutes.
WiFi Enabled	Whole number	1	WfiFi on or off.
WiFi SSID	Alphanumeric	myNetwork	Network name.
WiFi PWD	Alphanumeric password	*******	Hidden password
WiFi Dev Cert	Alphanumeric	N/A	WiFi Certificate value
WiFi Dev Key	Alphanumeric	N/A	WiFi Key value
WiFi CA Cert	Alphanumeric	N/A	WiFi Certificate authority value
Flow	Milliliters per minute (Whole number)	100	Target setpoint value of the instrument total flow rate in milliliters per minute. Used in SingleSpot™ and DualSpot® sampling modes.
Timebase	Seconds (Natural number)	60	Value in seconds of the measurement interval between measurements.
Tape Advance ATN	Attenuation units (Natural number, 1-100)	50	Tape advance ATN threshold value 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.
Tape Advance Time		0 00:00:00.000Z	Not available in current firmware.
Tape Advance Intv	Two (2) Whole numbers	0 1	Not available in current firmware.
AutoSample	Whole number	0	Value of setting to automatically start sampling and measurements.
DualSpot	Whole number	1	DualSpot mode on or off.
GPS	Two (2) Whole numbers	1 1	Value of GPS setting.
GPS Time Sync	Whole number	1	GPS time sync on or off.
Bluetooth Enabled	Whole number	0	Not available in current firmware.
Serial Mode	Whole number	1	Value of serial mode.
Serial Format	Whole number	0	Value of serial format.

Setting / Status	Format	Example	Description
Serial Baud	Whole number with corresponding baud rate value	5 (1000000)	Value of serial baud rate.
Wavelengths	XX X X X XX	IR R G B UV	Identification of the optical wavelengths used for each measurement are displayed.
Spot2 Active		False	Current state of sample spot sense2.
Session Id	Whole number	54	Identification number assigned to each sampling and measurement session. This value is incremented each time a new sampling and measurement session is started (changes from STOPPED to SAMPLING mode).
(Next) Datum Id	Whole number	351055	ID of the next data line.
Datum Offset	Whole number	351055	ID of the first data line stored on the instrument.
Datum Size	Whole number	372	Length of each data line.
SD Sector Count	Whole number	31116288	Value of secure digital card sector.
SD Sector Size	Whole number	512	Value of size of secure digital card.
Tape At End	Whole number	0	Tape is a end.
Tape Error	Whole number	0	Tape error.
Tape Position	Whole number	1	Value of tape position counter. Increments by 1 after each tape advance. Counter is reset when 'Release Tape' is used to release the tape cartridge no matter the position of the newly inserted tape cartridge.
Tape Sample Time	Milliseconds (Whole number)	0	Length of time of sampling at current filter tape spot location.
Door State	Whole number	1	Not available in current firmware.
Battery Perc	Whole number	100	Percent of instrument internal battery remaining.
Battery Mean	Voltage (Whole number with 'V')	4.20V	Value of current voltage of battery.
Current	Current (Whole number with 'mA')	0mA	Not available in current firmware.
Baro Temperature	Degrees celsius (Decimal number)	19.37	Measured temperature inside instrument case in Celsius.
Baro Pressure	Pascals (Decimal number)	101512.00	Measured pressure inside instrument case in pascals.
Alt Resets	Whole number	1	Not available in current firmware
Humidity	Percent (Decimal number)	0.00	Measured relative humidity of instrument sampling stream in percent.
Temperature	Degrees celsius (Decimal number)	0.00	Measured temperature of instrument sampling stream in degrees celsius.
Acceleration	X <x.xxx> Y <y.yyy> Z <z.zzz)	X 5.466 Y -18.466 Z -277.333	Measured instantaneous acceleration in the x-axis, y-axis, and z-axis.
Satellites	Whole number	0	Number of satellites that are visible to the instrument's internal GPS receiver.
Latitude	Degrees (ddmm.mmmmm)	37.74619191	Measured latitude or relative angular distance north or south on Earth's surface in degrees from the equator.

Setting / Status	Format	Example	Description
Longitude	Degrees (dddmm.mmmmm)	-122.42032557	Measured longitude or relative angular distance east or west on Earth's surface in degrees from the prime meridian.
Speed	Kilometers per hour (Decimal number)	0.0000	Measured speed using GPS in kilometers per hour. GPS is based on GPS lat and long, which are required for GPS speed calculation.
RTC Time	Year, month, day, hours, minutes, seconds (yyyy/MM/dd hh:mm:ss)	18/11/21 01:17:29	Date and time of instrument's internal clock in Coordinated Universal Time (UTC).
Time Source	<GPS or Manual>	GPS	Time source is GPS or manual.
GPS Time	Year, month, day, hours, minutes, seconds (yyyy/MM/dd hh:mm:ss)	18/11/21 01:17:29	Date and time provided by GPS in Coordinated Universal Time (UTC).
WiFi	<OK or Not OK or Sleeping>	OK	Not available in current firmware.
Bluetooth	<OFF>	OFF	Not available in current firmware.
Angstrom WB	Decimal number	2.000000	Value used for calculation of source apportionment Biomass
Angstrom FF	Decimal number	1.000000	Value used for calculation of source apportionment Fossil Fuel
Cref	Decimal number	1.299999	Value used for calculation of source apportionment Cref

7.2.2. Display All Settings Example

Settings	
Manufacturer :	AethLabs
Serial Number :	MA200-0011
Firmware Versionn :	1.12.05
Bootloader Version :	0.18L
Name :	MA Device
Timezone Offset :	-480
WiFi Enabled :	1
WiFi SSID :	myNetwork
WiFi PWD :	********
WiFi Dev Cert : : : : :	(805) 30 82 03 21 30 82 02 8a a0 03 02 01 02 02 02 10 2c 30 0d 06 09 2a 86 48 86 f7 0d 01 01 0b 05 00
WiFi Dev Key : : : : :	(607) 30 82 02 5b 02 01 00 02 81 81 00 a1 27 24 7d 81 3f fb 78 6c a0 d8 97 ac ab 1d fe fd 9e 2e dc e9
WiFi CA Cert : : : : :	(696) 30 82 02 b4 30 82 02 1d a0 03 02 01 02 02 09 00 a7 b1 82 c5 99 06 36 79 30 0d 06 09 2a 86 48 86
Flow :	100
Timebase :	60
Tape Advance ATN :	50
Tape Advance Time :	0 00:00:00.000Z
Tape Advance Intv :	0 1
AutoSample :	0
DualSpot :	1
GPS :	1 1
GPS Time Sync :	1
Bluetooth Enabled :	0
Serial Mode :	1
Serial Format :	0
Serial Baud :	5 (1000000)
Wavelengths :	IR R G B UV
Spot2 Active:	False
Session Id :	54
(Next) Datum Id :	351055
Datum Offset :	351055
Datum Size :	372
SD Sector Count :	31116288
SD Sector Size :	512
Tape At End :	0
Tape Error :	0
Tape Position :	1
Tape Sample Time :	0
Door State :	1
Battery Perc :	100
Battery Mean :	4.20V
Current :	0mA

Baro Temperature :	19.37
Baro Pressure :	101512.00
Alt Resets :	1
Humidity :	0.00
Temperature :	0.00
Acceleration :	X 5.466 Y -18.466 Z -277.333
Satellites :	0
Latitude :	37.74619191
Longitude :	-122.42032557
Speed :	0.0000
RTC Time :	18/11/21 01:17:29
Time Source :	GPS
GPS Time :	18/11/21 01:17:29
WiFi :	OK
Bluetooth :	OFF
Angstrom WB :	2.000000
Angstrom FF :	1.000000
Cref :	1.299999

FlowCal Table
Device ID: MA200-0011
Flow Meter Serial #: 146654
Timestamp: 2018-11-20T17:17:20.00
Battery (V): 4.245
Sample temp (C): 22.51
Sample RH (%): 37.63
Internal pressure (Pa): 102392.0
Standard temp (C): 25.9
Standard pressure (Pa): 101146.125
SingleSpot Pump Start: 100
SingleSpot Pump Stop: 12
SingleSpot Flow Min: 19
SingleSpot Flow Max: 281
DualSpot Pump Start: 5
DualSpot Pump Stop: 1
DualSpot Flow Min: 21
DualSpot Flow Max: 299

-----------SingleSpot Mode-----------						-----------DualSpot Mode------------					
#	**TargetS**	**SFlowT**	**SFlow1**	**PumpS**	**SSD**	**TargetD**	**DFlowT**	**DFlow1**	**PumpD**	**DSD**	**S1/S2**
0	0.00	124.99	124.03	0	0.00	0.00	124.90	123.90	0	0.01	0.00
1	43.93	180.30	179.20	69	2.04	45.75	181.79	164.51	49	2.46	1.41
2	58.82	197.69	197.76	88	1.65	58.74	197.48	175.92	65	1.82	1.42
3	74.38	215.58	216.97	112	1.21	74.90	215.49	190.49	87	1.48	1.41
4	89.79	231.66	235.80	140	0.94	90.07	231.28	203.94	111	1.21	1.41
5	104.83	245.98	253.85	170	0.78	105.09	245.39	217.09	139	0.99	1.41
6	120.17	259.53	271.43	203	0.60	120.35	258.28	229.99	169	0.86	1.41
7	135.40	272.50	288.69	238	0.53	135.78	271.66	243.48	201	0.68	1.41
8	149.71	283.43	304.11	273	0.45	150.28	282.74	255.69	233	0.60	1.41

9	164.67	293.83	319.65	315	0.37	164.56	293.13	267.65	267	0.51	1.40
10	179.39	303.29	334.45	360	0.31	179.79	303.28	280.27	306	0.42	1.40
11	194.06	310.21	348.08	409	0.25	194.67	311.80	292.35	348	0.37	1.40
12	209.38	319.61	362.21	469	0.22	209.56	321.00	303.94	396	0.33	1.40
13	223.92	327.67	375.51	535	0.19	224.24	329.85	315.56	450	0.26	1.39
14	238.91	334.19	388.55	617	0.17	239.08	338.19	326.65	512	0.22	1.39
15	253.92	340.43	401.32	728	0.14	253.44	343.88	337.23	584	0.24	1.38
16	269.59	344.87	413.57	843	0.21	268.32	349.48	348.23	680	0.20	1.38
17	0.00	0.00	0.00	0	0.00	283.32	357.21	359.09	789	0.14	1.37
18	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
19	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
20	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
21	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
FlowCal Results: OK 35/35											

<table>
<tr><td>X0 |</td><td>1230 |</td><td>1100 |</td><td>962792 |</td><td>962792 |</td><td>869646 |</td><td>0.00016</td></tr>
<tr><td>X1 |</td><td>1170 |</td><td>3700 |</td><td>914794 |</td><td>858989 |</td><td>786032 |</td><td>0.00016</td></tr>
<tr><td>X2 |</td><td>1220 |</td><td>1800 |</td><td>929682 |</td><td>860234 |</td><td>805442 |</td><td>0.00020</td></tr>
<tr><td>X3 |</td><td>1320 |</td><td>1200 |</td><td>783172 |</td><td>890499 |</td><td>904778 |</td><td>0.00022</td></tr>
<tr><td>X4 |</td><td>1280 |</td><td>2700 |</td><td>910128 |</td><td>776819 |</td><td>916232 |</td><td>0.00019</td></tr>
</table>

7.3. Flow Calibration

7.3.1. 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. Parameters of the environment, microAeth, and external flowmeter from the MA Series Flow Calibration Kit used to calibrate the microAeth are also stored as part of the header of the flow calibration table.

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 external flowmeter in the microAeth MA Series Flow Calibration Kit is a custom unit made for AethLabs specifically for the microAeth MA Series instruments to optimize the measurement flow range for the low flow and low back pressure requirements. The flow calibration process requires multiple calibration passes and the calibration of multiple flowmeters with multiple solenoid switches 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.

Other flowmeters may not be suitable for use with the MA Series instruments for a few reasons. (1) Other flowmeters with wider flow measurement ranges may only have one or two calibration setpoints in the full range of the MA Series instuments. (2) Many ΔP based flowmeters have higher backpressure, and as such, very little flow will be drawn through the instrument. (3) Bubble meters are far too slow to be used

with the MA Series instruments in the required automated flow calibration process. (4) The flow calibration of MA Series instruments must be automated because the process is complicated with multiple solenoid switches and a high possibility for human error, therefore it requires a direct communication interface with the external flowmeter.

7.3.2. Display and Check Flow Calibration Table

The flow calibration table stored in the microAeth can be viewed in order to verify that a good, complete flow calibration table exists. A good, complete flow calibration table is critical in order to obtain the best results from the microAeth.

To view the flow calibration table and the complete results from the previous flow calibration, the on-board user interface on the front of the microAeth is used to send all settings information of the instrument which includes the flow calibration table (See section 5.8.3.12 Display All Settings) via the 4-pin serial port to a terminal emulator (AethLabs only supports CoolTerm for macOS and Tera Term for Windows) on a computer using the AethLabs 4-pin Serial to USB converter cable.

7.3.2.1. Flow Calibration Table Results Descriptions

The flow calibration table shows a summary of the final results of the current flow calibration. Below the flow calibration table itself is the text 'FlowCal Results:' after which the detailed summary results are displayed. At the completion of a flow calibration, the same abbreviated results shown in the 'Result' column of the below table are displayed on the LCD screen. If results other than 'OK <yy/yy>' are displayed then another flow calibration should be run. **It can take multiple flow calibration attempts to achieve the best calibration.**

FlowCal Results	
Result	**Description**
OK <yy/yy>	Flow calibration completed sucessfully. A complete table without warnings or failures occurred. 'yy' equals the amount of flow calibration setpoints that were calibrated. yy/yy = 100% (Example: OK 35/35)
WARNING <xx/yy>	Flow calibration completed sucessfully but with warnings to review. 'Review rows marked with *' will be displayed below 'FlowCal Results: WARNING <xx/yy>' and all flow calibration setpoints that have possible issues are marked with '*'. xx/yy < 100% (Example: WARNING 34/35)
FAIL MIN <xx/yy>	Flow calibration completed but with failure to reach minimum flow rate in SingleSpot™ and or DualSpot®. 'Min Flow of 40 Not Achieved in <SingleSpot or DualSpot> Mode (<actual minimum flow>)' will be displayed below 'FlowCal Results: FAIL MIN <xx/yy>' where xx/yy <= 100%. If xx/yy < 100%, then 'Review rows marked with *' will also be displayed and all flow calibration setpoints that have possible issues are marked with '*'.
FAIL MAX <xx/yy>	Flow calibration completed but with failure to reach maximum flow rate in SingleSpot™ and or DualSpot®. 'Max Flow of 182 Not Achieved in <SingleSpot or DualSpot> Mode (<actual maximum flow>)' will be displayed below 'FlowCal Results: FAIL MAX <xx/yy>' where xx/yy <= 100%. If xx/yy < 100%, then 'Review rows marked with *' will also be displayed and all flow calibration setpoints that have possible issues are marked with '*'.

FlowCal Results	
Result	**Description**
FAIL MIN MAX <xx/yy>	Flow calibration completed but with failure to reach minimum and maximum flow rates in SingleSpot™ and or DualSpot®. Both 'Min Flow of 40 Not Achieved in <SingleSpot or DualSpot> Mode (<actual minimum flow>)' and 'Max Flow of 182 Not Achieved in <SingleSpot or DualSpot> Mode (<actual maximum flow>)' will be displayed below 'FlowCal Results: FAIL MAX <xx/yy>' where xx/yy <= 100%. If xx/yy < 100%, then 'Review rows marked with *' will also be displayed and all flow calibration setpoints that have possible issues are marked with '*'.

7.3.2.2. Flow Calibration Table Example

Below is an example of a flow calibration table that will be displayed using the Display All Settings menu item. The values in the flow calibration table can be analyzed and verified in order to determine if another flow calibration is required. If multiple flow calibrations have been performed and still there are issues, please contact AethLabs.

FlowCal Table
Device ID: MA200-0011
Flow Meter Serial #: 146654
Timestamp: 2018-11-20T17:17:20.00
Battery (V): 4.245
Sample temp (C): 22.51
Sample RH (%): 37.63
Internal pressure (Pa): 102392.0
Standard temp (C): 25.9
Standard pressure (Pa): 101146.125
SingleSpot Pump Start: 100
SingleSpot Pump Stop: 12
SingleSpot Flow Min: 19
SingleSpot Flow Max: 281
DualSpot Pump Start: 5
DualSpot Pump Stop: 1
DualSpot Flow Min: 21
DualSpot Flow Max: 299

	-----------SingleSpot Mode-----------					-----------DualSpot Mode-----------					
#	**TargetS**	**SFlowT**	**SFlow1**	**PumpS**	**SSD**	**TargetD**	**DFlowT**	**DFlow1**	**PumpD**	**DSD**	**S1/S2**
0	0.00	124.99	124.03	0	0.00	0.00	124.90	123.90	0	0.01	0.00
1	43.93	180.30	179.20	69	2.04	45.75	181.79	164.51	49	2.46	1.41
2	58.82	197.69	197.76	88	1.65	58.74	197.48	175.92	65	1.82	1.42
3	74.38	215.58	216.97	112	1.21	74.90	215.49	190.49	87	1.48	1.41
4	89.79	231.66	235.80	140	0.94	90.07	231.28	203.94	111	1.21	1.41
5	104.83	245.98	253.85	170	0.78	105.09	245.39	217.09	139	0.99	1.41
6	120.17	259.53	271.43	203	0.60	120.35	258.28	229.99	169	0.86	1.41
7	135.40	272.50	288.69	238	0.53	135.78	271.66	243.48	201	0.68	1.41
8	149.71	283.43	304.11	273	0.45	150.28	282.74	255.69	233	0.60	1.41
9	164.67	293.83	319.65	315	0.37	164.56	293.13	267.65	267	0.51	1.40
10	179.39	303.29	334.45	360	0.31	179.79	303.28	280.27	306	0.42	1.40
11	194.06	310.21	348.08	409	0.25	194.67	311.80	292.35	348	0.37	1.40
12	209.38	319.61	362.21	469	0.22	209.56	321.00	303.94	396	0.33	1.40
13	223.92	327.67	375.51	535	0.19	224.24	329.85	315.56	450	0.26	1.39
14	238.91	334.19	388.55	617	0.17	239.08	338.19	326.65	512	0.22	1.39
15	253.92	340.43	401.32	728	0.14	253.44	343.88	337.23	584	0.24	1.38
16	269.59	344.87	413.57	843	0.21	268.32	349.48	348.23	680	0.20	1.38
17	0.00	0.00	0.00	0	0.00	283.32	357.21	359.09	789	0.14	1.37
18	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
19	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
20	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
21	0.00	0.00	0.00	0	0.00	0.00	0.00	0.00	0	0.00	0.00
FlowCal Results: OK 35/35											

7.3.3. Test Flow Procedure

The on-board user interface on the front of the microAeth can be used to test flow setpoints and see what the internal flowmeters are reading in DualSpot or SingleSpot mode. Please note that the external flowmeter of the microAeth MA Series Flow Calibration Kit or other low backpressure external flowmeter is not needed to use this feature but is needed to verify the internal measured flow readings against an external standard.

1) If checking the internal measured flow of the microAeth to an external standard, connect the outlet port of the external flowmeter to the inlet port of the microAeth.
2) Make sure that all connections are tight and sealed so that no leaks are present.
3) Use the left and right buttons of the microAeth to scroll through the top level menu options to the 'Test Flow' option.
4) Press the center button of the microAeth to select the ‘Test Flow’ option.
5) Use the left and right buttons of the microAeth to scroll to the desired target flow of 50, 75, 100, 125, or 150 ml/min. The screen will display the following depending if the microAeth is in SingleSpot or DualSpot mode:

SingleSpot Mode Test Flow Display		**DualSpot Mode Test Flow Display**	
SS Target	xxx.xx	DS Target	xxx.xx
SS Measured	xxx.xx	DS Measured	xxx.xx

NOTE: To use the test flow feature in the desired SingleSpot or DualSpot mode, this sampling mode setting must first be changed using the microAeth Manager software connected to the microAeth by USB.

6) Use the left and right buttons to change the target flow at any time. Allow the microAeth a few seconds to adjust pump speed and for the flow to become stable.
7) The measured flow can be viewed over time as there will be fluctuations. The measured flow can also be compared against the external flowmeter of the MA Series Flow calibration Kit that has its outlet port connected to the inlet port of the microAeth. Only compatible low backpressure external flowmeters should be used.
8) Press the center button to exit the test flow feature.

7.3.4. Flow Calibration Kit Setup

The only way to perform a flow calibration of the MA200, MA300, and MA350 is to use a microAeth MA Series Flow Calibration Kit provided by AethLabs.

It is recommended that all microAeth MA Series Flow Calibration Kits use the provided low backpressure inline disc filter on the inlet of the external flowmeter to keep the external flowmeter clean and to keep the microAeth sampling filter clean during flow calibration. An inline filter isn't required but is recommended especially if a flow calibration is being completed outdoors or in a dirty environment.

Flow Connections: **The inlet port of the microAeth MA Series instrument must be connected to the outlet port of the external flowmeter of the microAeth MA Series Flow Calibration Kit.** The arrow on the front of the external flowmeter shows the air flow direction with the point of the arrow being the outlet port and the opposite being the inlet port. The inlet port of the external flowmeter should be connected to the low backpressure inline disc filter.

Communication Connections: The microAeth MA Series Flow Kit communication cable must be connected to the microAeth serial port and the external flowmeter mini-din 8 port.

Power Connections: The microAeth should be connected to an external power source through the barrel jack port labeled 'DC IN (5V)'. The external flowmeter must be connected to an external power source through the barrel jack.
NOTE: The microAeth internal battery should be fully charged (recommended battery remaining of at least 80%).

External Flowmeter Settings: The microAeth MA Series instruments will automatically set all settings on the external flowmeter at the start of the flow calibration process. It is not recommended to change the settings of the external flowmeter. The required settings of the external flowmeter for the flow calibration process are as follows:

microAeth MA Series Flow Calibration Kit External Flowmeter	
Setting	**Value**
Communication Baud Rate:	57600
Unit ID:	A
Gas:	Air
Volumetric Flow Units:	milliliters per minute (ml/m)
Mass Flow Units:	milliliters per minute (Sml/m)
Flow Averaging:	255
Pressure Averaging:	255
Standard Temperature:	25.00 °C
Standard Pressure:	14.70 PSIA
Normal Temperature:	0.00 °C
Normal Pressure:	14.70 PSIA

7.3.5. 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 and its internal battery should be fully charged (recommended battery remaining of at least 80%). 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) The microAeth must be at a new clean filter sampling location for the flow calibration.
2) 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 4.
3) 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.
4) Plug in the microAeth to an external power source through the barrel jack port.
5) Plug in the MA Series Flow Calibration Kit flowmeter to an external power source. Make sure the flowmeter is turned on.
6) Connect the MA Series Flow Calibration Kit communication cable to the microAeth serial port and the flowmeter mini-din 8 port.
7) Connect the outlet port of the MA Series Flow Calibration Kit flowmeter to the inlet port of the microAeth.
8) Make sure that all connections are tight and sealed so that no leaks are present.
9) Use the left and right buttons of the microAeth to scroll through the top level menu options to the ‘Calibrate Flow’ option.
10) Press the center button of the microAeth to select the ‘Calibrate Flow’ option. The screen will display ‘FLOW CALIBRATE Switch to CAL CABLE. Press any button.’
11) Press any button to start the automatic flow calibration of the microAeth.
12) The microAeth will check flow and communications.
13) The screen will display ‘Highest Flow’
14) If there is a communications issue, the screen will display ‘NO COMMS DETECTED'.The screen will then display ‘FLOWCAL - NO COMMS Switch to REG CABLE Press any button’. Press any button to return to the top level menu and return to step 3.
15) If there is a flow issue, the screen will display ‘NO FLOW DETECTED’. The screen will then display ‘FLOWCAL - NO FLOW Switch to REG CABLE Press any button’. Press any button to return to the top level

menu and return to step 3.
16) If there are no issues, the screen will display the max flow that can be reached and will then begin the flow calibration.
17) To cancel the flow calibration at any point, press the center button. The screen will quickly display 'Flow Cal Stopping'. The screen will then display 'FLOWCAL - CANCEL Switch to REG CABLE Press any button'. Press any button to return to the top level menu.
18) When the automatic flow calibration is complete, the screen will display 'FLOWCAL - OK xx/xx Switch to REG CABLE Press any button' Press any button to return to the top level menu.
19) Disconnect the MA Series Flow Calibration Kit communication cable from the microAeth.
20) Disconnect the MA Series Flow Calibration Kit flowmeter from the inlet port of the microAeth.
21) Check the microAeth flow calibration table to verify that a good calibration was completed. Not every flow calibration process will produce the desired flow calibration table. See section 7.3.2. Display and Check Flow Calibration Table.

7.4. Optical Calibration Procedure

The on-board user interface on the front of the microAeth can be used to start the automatic optical calibration process.

IMPORTANT: OPTICAL CALIBRATIONS ARE NOT RECOMMENDED UNLESS INSTRUCTED TO DO SO BY AETHLABS OR AETHLABS AUTHORIZED SERVICE PERSONNEL.

IMPORTANT: Before starting the automatic optical 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 optical calibration should be run only when the filter tape cartridge door is installed and closed. The optical calibration CANNOT be cancelled once it is started.
1) The microAeth must be at a new clean filter sampling location for the optical calibration.
2) 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 4.
3) 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.
4) Plug in the microAeth to an external power source through the barrel jack port.
5) Make sure the filter tape cartridge door is installed and closed.
6) Use the left and right buttons of the microAeth to scroll through the top level menu options to the 'Calibrate Optics' option.
7) Press the center button of the microAeth to select the 'Calibrate Optics' option and to enter the calibrate optics submenu. 'YES OK NO' will be displayed.
8) Press the center button to exit and return to the top level menu.
9) Press the left button 'YES' and the screen will display 'Calibrate? YES'. Press the right button 'NO' and the screen will display 'Calibrate? NO'.
10) Press the center button, 'OK' to select the current yes or no value option. Once selected, the optical calibration will start and 'Starting' will be displayed.
11) As the optical calibration progresses, the screen will display 'Calibrating... xxxx' and the 'xxxx' four digit numbers will be updated.
12) When the optical calibration is complete, 'Calibration Complete' will be displayed and the user interface menu is automatically returned to the top menu level.

7.5. Installing 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 microAeth Manager or 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.

7.5.1. Upgrading firmware using microAeth Manager v1.6.0 or newer

IMPORTANT READ FIRST: DATA ON THE MICROAETH MAY NOT BE ACCESSIBLE AFTER UPGRADING FIRMWARE. Before upgrading the firmware on the microAeth, download and backup all data from the instrument.

BEFORE PROCEEDING: If upgrading the firmware on the microAeth from v1.09 or earlier, please contact AethLabs support.

1) microAeth Manager v1.6.0 or newer is required.
2) Check which version of microAeth Manager is currently being used. Open microAeth Manager and click the 'Manage application' button in the top right corner of the open window, revealing a panel titled 'Application settings'. At the top will be a 'Info' button that will display the application version and allow for more detailed version information to be displayed when clicked.
3) Click the 'Info' button to see detailed microAeth Manager application version, updates available, and other information.
4) If the microAeth Manager application version earlier than v1.6.0, please go to the AethLabs website to download the latest version of the microAeth Manager.
5) If microAeth Manager is verified to be v1.6.0 or newer, please proceed by closing the pop-up window and returning to the main application menu.
6) Click the 'Firmware updates' button in the top right of the main application window will open the 'Update firmware' window. Follow the on screen instructions to update firmware. Complete all steps in order so that a checkmark appears to the right of the instruction.
7) Turn off the microAeth.
8) Plug in the AethLabs Serial to USB converter cable to the microAeth and the computer.
9) Use the 'Select a serial port' dropdown menu to select the serial port connected to the Serual to USB coverter cable and the microAeth. Once selected, the serial port location will appear in this section.
10) If the correct serial port is not available, click the 'Refresh' button.
11) Click the 'Select firmware file' button to open the file select window.
12) Find the firmware '.hex' file and click 'Open'. Once selected, the file location will appear in this section.
13) Power on the microAeth by pressing and holding the left and right buttons on the front panel of the instrument for 3 seconds until the backlight of the LCD of the instrument flashes three times. Release the buttons.
14) When the application interface advances to the next step, press the center button on the microAeth to start the firmware update file transfer to the instrument.
15) The applcation interface will show checkmarks to the left of the steps and advance to the next step

labeled 'Upload firmware to device'. The application will display the updated percent complete and time remaining.
16) If the upgrade fails, the application interface steps will show an 'X' to the left of the remaining steps and under 'Next Steps' will display 'Wait for the unit to power off. To flash a different unit, connect and click "Again".'
17) Click 'Again' to reset the process in the application and start again or click 'Close' to cancel and close the pop-up window.
18) If the process continues successfully, the application will display the updated percent complete and time remaining under the step 'Upload firmware to device'.
19) If the upgrade completes sucessfully, the application interface will show checkmarks to the left of the steps and will display 'Firmware update successful' under the step 'Upload firmware to device'. The application will advance to the final step labeled 'Next step'.
19) Once complete, 'Wait for the unit to power off. To flash a different unit, connect and click "Again".' will be displayed under 'Next Steps'. Click 'Close' to close the pop-up window or click 'Again' to restart the upgrade process with another instrument.

7.5.2. Upgrading firmware using terminal emulator (Tera Term only)

IT IS HIGHLY RECOMMENDED TO USE MICROAETH MANAGER DESKTOP APPLICATION TO UPGRADE FIRMWARE (SEE SECTION 7.5.1)

IMPORTANT READ FIRST: DATA ON THE MICROAETH MAY NOT BE ACCESSIBLE AFTER UPGRADING FIRMWARE. Before upgrading the firmware on the microAeth, download and backup all data from the instrument.

BEFORE PROCEEDING: If upgrading the firmware on the microAeth from v1.09 or earlier, please contact AethLabs support.

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.

AethLabs only supports Tera Term for Windows for firmware upgrades using a terminal emulator,.

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 (AethLabs only supports Tera Term for Windows) 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) When Tera Term opens, a window with the title 'Tera Term: New connection' will appear.
5) Select the 'Serial' radio button.
6) Use the 'Port:' dropdown menu to select the COM port that the microAeth is connected to through the AethLabs 4-pin Serial to USB converter cable.
7) Press 'OK'.
8) The main window will remain and the window title will now be the COM port number.

9) Select the 'Setup' menu and select 'Serial port...'.
10) In the 'Tera Term: Serial port setup' window, change the settings to match the communication settings in Step 3.
11) Press 'OK'.
12) 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.
13) Use the left and right buttons to scroll through the top level menu options to the 'Turn off' option.
14) Press the center button to select the 'Turn off' option.
15) While the microAeth is off, press and hold both the left and right buttons at the same time for about 2 seconds.
16) If successful in entering the bootloader, the screen backlight will flash on three times and stay on.
17) The microAeth will display more information to the terminal emulator.
18) 'Serial Decrypting Bootloader Version x.xxL Serial Number [MAxxx-xxxx] - xxxx' will then be displayed.
19) If unsuccessful in entering the bootloader, the microAeth will turn off and nothing more will be displayed. To try again, make sure the microAeth is off and repeat steps 1-15
20) Follow the instructions displayed in the terminal emulator and bootloader to upgrade the firmware. 'Press CENTER button to start bootlad process, Press LEFT or RIGHT buttons to CANCEL' will be displayed.
21) Once entering the bootloader, you will have 30 seconds to make a selection before the microAeth automatically turns off. If this occurs, 'Timeout. Shutting Down' will be displayed.
22) Press either the left or right buttons to exit the bootloader and cancel the bootload process. 'Cancelled' will be displayed and the microAeth will shut off.
23) Press the center button to start the bootloader firmware upgrade process. 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, display 'LOAD BAD' and shut down. If this occurs, the microAeth will no longer have a valid firmware loaded. Any time the instrument is turned on again, only the bootloader will start.
24) To send a file to the microAeth through Tera Term. Select the 'File' menu and select 'Send file...'
25) The 'Tera Term: Send file' window will open. Select the firmware '.hex' file.
26) Press 'Open'.
27) 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.
28) If the firmware transfer and upgrade fails, 'BAD LOAD' will be displayed. The microAeth will no longer have a valid firmware loaded. Any time the instrument is turned on again, only the bootloader will start.
29) 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. Once the screen backlight turns off, the firmware upgrade is complete.
30) The operating system firmware is upgraded on the microAeth but the flow calibration table should be checked and all settings should be set.
31) Turn on the microAeth. Press and hold only one of the three buttons for 2 seconds. The screen and instrument will turn on and the instrument serial number will be displayed.
32) Use the left and right buttons to scroll through the top level menu options to the 'Display FlowCal Info' option.

33) 'Sent via Serial Port' will display on the screen and the flow calibration table information will be displayed in the terminal emulator. See section 5.8.3.12. Display FlowCal Info for more information.
34) Check the flow calibration table. See section 7.3.2. Display and Check Flow Calibration Table.
35) Set all settings using the microAeth Manager.

7.6 WiFi Setup and Configuration

To use WiFi streaming of data to the AethLabs server, the instrument serial number must be approved by AethLabs. Please contact AethLabs to enable the use of WiFi.

7.6.1. Initial WiFi Setup of Security Certificates

Initial WiFi Setup of Security Certificates ONLY need to be completed if the instrument was not delivered with Firmware v1.12.5 already installed by AethLabs.

The microAeth Manager software must be used to complete the inital setup of WiFi Security Certificates and to update any WiFi network settings. 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 initial setup of the WiFi can be completed.

IMPORTANT: In order to complete initial setup of and enable WiFi, the user must be logged into the AethLabs website through the microAeth Manager Application and the instrument serial number must be approved by AethLabs for WiFi data transmission to the AethLabs server. Please contact AethLabs to enable the use of WiFi.

NOTE: To setup and use WiFi to stream data to the AethLabs server, the instrument must use a timebase of 60 seconds or greater and with Data transmission Mode of 'Streaming' and Data transmission Output format greater than or equal to Version 2.

1) Once the instrument serial number has been approved for WiFi streaming to the AethLabs server, login to the AethLabs server through microAeth Manager.
2) In the AethLabs Server Conectivity Status menu in the top right corner of the main application window, click the dropdown menu green arrow and click 'Log in'.
3) In the 'Log in' pop-up window, enter user credentials from the AethLabs server/dashboard. Click 'Log in'.
4) AethLabs server/dashboard accounts can be created or reset on the AethLabs website by clicking 'Reset Password'.
5) When logged in through microAeth Manager and WiFi data transmission to the AethLabs server has been approved by AethLabs, toggle WiFi to 'ON'.
6) Click the SSID field to input the WiFi network SSID name. Click the checkmark to save and ‘x’ to cancel.
7) Click the Password field to input the WiFi password that correcsponds with the previously entered network SSID name. Click the checkmark to save and ‘x’ to cancel.
8) If WiFi Securiry Certificates are already installed, a checkmark and 'Installed' text will be displayed to the right of 'Certificates' text and to the left of the 'Reinstall' button. Certificates typically do not need to be reinstalled.
9) If WiFi Securiry Certificates are not installed, a 'install' button will be displayed to the right of the 'Certificates' text.
10) To install WiFi Security Certificates, click the 'install' button that is displayed to the right of the 'Certificates' text.
11) In the 'Install Certificates for WiFi Streaming' pop-up window, click the 'Begin' button to start the install process or click 'Cancel' to return to the main application window.
12) Click 'Begin' and the automated install will progress through each step until complete. If the process stalls for more than 30 seconds on any individual step, click the red 'x' in the top right corner of the pop-up window to cancel and exit to the main application window.
13) When complete, click 'Close' to return to the main application window.

7.6.2. Modify WiFi Network SSID and Password Settings

The microAeth Manager software must be used to update any WiFi network settings. 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 WiFi settings can be modified.

NOTE: To use WiFi to stream data to the AethLabs server, the instrument must use a timebase of 60 seconds or greater and with Data transmission Mode of 'Streaming' and Data transmission Output format greater than or equal to Version 2.

1) Toggle WiFi to 'ON'.
2) Click the SSID field to input the WiFi network SSID name. Click the checkmark to save and ‘x’ to cancel.
3) Click the Password field to input the WiFi password that correcsponds with the previously entered network SSID name. Click the checkmark to save and ‘x’ to cancel.

7.6.3. WiFi Connectivity Check

The microAeth Manager software must be used to conduct a WiFi Connectivity Check. 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.

1) In the AethLabs Server Conectivity Status menu in the top right corner of the main application window, click the dropdown menu green arrow and click 'Log in'.
2) In the 'Log in' pop-up window, enter user credentials from the AethLabs server/dashboard. Click 'Log in'.
3) AethLabs server/dashboard accounts can be created or reset on the AethLabs website by clicking 'Reset Password'.
4) When logged in through microAeth Manager, toggle WiFi to 'ON'.
5) The connectivity test history status of the connected instrument will be displayed under 'Connectivity test'. The connectivity test history status will display how long ago a successful test was last completed.
6) Make sure that the WiFi network SSID and Password settings are entered correctly.
7) Click the 'Check WiFi' button to the right of the 'Conectivity test' text.
8) In the 'WiFi connectivity check' pop-up window, the WiFi connectivity check process will automatically start.
9) If the process stalls for more than 30 seconds on any individual step, click the red 'x' in the top right

corner of the pop-up window to cancel and exit to the main application window.
10) When complete, click 'Close' to return to the main application window.
11) The connectivity test history status will update to display how long ago a successful test was last completed.

7.6.4. WiFi Streaming Device Reservation

The microAeth Manager software must be used to Claim device reservation. 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 a WiFi Streaming Device Reservation Claim can be made.

1) In the AethLabs Server Conectivity Status menu in the top right corner of the main application window, click the dropdown menu green arrow and click 'Log in'.
2) In the 'Log in' pop-up window, enter user credentials from the AethLabs server/dashboard. Click 'Log in'.
3) AethLabs server/dashboard accounts can be created or reset on the AethLabs website by clicking 'Reset Password'.
4) When logged in through microAeth Manager, toggle WiFi to 'ON'.
5) The current device reservation status of the connected instrument will be displayed under 'Device reservation'.
6) If the status is 'The device is currently reserved to another user account', the user currently logged in through microAeth Manager can claim the device reservation.
7) Click the 'Claim device reservation' button to the right of the 'Device reservation' text.
8) The current device reservation status will change to 'Claiming device reservation...' and then to 'Loading device reservation status...'.
9) When the device reservation claim successfully completes, the current device reservation status will change to 'The device is reserved to the currently logged in account.'

8. Technical Specifications

8.1. 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, 75, 100, 125,150 or 170 ml/min, DualSpot® compensation not compatible with all settings

Measurement Range
Per sampling location, 0-1 mg BC/m³, filter sampling location lifetime dependent on concentration and flow rate setting, decreasing proportionally with lowest wavelength optical source enabled:
IR only mode, average 5 µg BC/m³ for 24 hours at 100 ml/min
IR only mode, average 100 µg BC/m³ for 3 hours at 50 ml/min
IR only mode, average 1 mg BC/m³ for 15 minutes at 50 ml/min

Measurement Resolution
0.001 µg BC/m³

Limit of Detection
30 ng BC/m³, 5 min timebase., 150 ml/min flow rate, SingleSpot™

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

Flow Control
Internal mass flowmeters with closed-loop control

Filter Material / Capacity
MA200 Filter Tape Cartridge with Polytetrafluoroethylene (PTFE) material (17 sampling locations)

Sampling
3 mm diameter spot(s) created on filter tape. User selectable DualSpot® or SingleSpot™ mode.

Environmental 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
16GB internal flash memory, providing storage for 31,250,000 data lines; 1 second timebase: 361 days of data

On-board Interface
Low Power Screen, 3 Buttons

Location services
GPS with Internal Antenna

Date/Time Format
ISO 8601 with satellite synchronization or manual computer synchronization

Wireless
802.11 b/g/n WiFi with AES hardware encryption, Bluetooth Low Energy. Available in future firmware releases.

Connections
USB 2.0, 3.3V TTL Serial, DC input via barrel jack, Aerosol sample inlet and outlet ports

USB Communication / Client Application
USB connectivity to cross-platform microAeth® Manager software available on macOS® and Windows®. microAeth Manager software is included and facilitates settings configuration and data download. Exported data can be uploaded to AethLabs Dashboard server for processing and visualization.

Serial Communication
3.3V TTL serial connectivity for uploading new instrument firmware, flow calibration, streaming data and polling protocols to request data, modify settings and control. Command line interface (CLI) polling protocols: AethLabs protocol and Bayern-Hessen protocol.

Total Run Time
Up to 14 hours at 60 second timebase, 100 ml/min flow rate on single battery charge. Run time may vary due to PM concentrations and settings.

Battery
Internal 3.6V, 3200 mAh (11.52 Wh), 1 cell rechargeable lithium-ion battery

Charging
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
5 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

8.2. 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, 75, 100, 125, 150 or 170 ml/min, DualSpot® compensation not compatible with all settings

Measurement Range
Per sampling location, 0-1 mg BC/m^3, filter sampling location lifetime dependent on concentration and flow rate setting, decreasing proportionally with lowest wavelength optical source enabled:
IR only mode, average 5 µg BC/m^3 for 24 hours at 100 ml/min
IR only mode, average 100 µg BC/m^3 for 3 hours at 50 ml/min
IR only mode, average 1 mg BC/m^3 for 15 minutes at 50 ml/min

Measurement Resolution
0.001 µg BC/m^3

Limit of Detection
30 ng BC/m^3, 5 min timebase., 150 ml/min flow rate, SingleSpot™

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

Flow Control
Internal mass flowmeters with closed-loop control

Filter Material / Capacity
MA300/MA350 Filter Tape Cartridge with Polytetrafluoroethylene (PTFE) material (85 sampling locations)

Sampling
3 mm diameter spot(s) created on filter tape. User selectable DualSpot® or SingleSpot™ mode.

Environmental 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
16GB internal flash memory, providing storage for 31,250,000 data lines; 1 second timebase: 361 days of data

On-board Interface
Low Power Screen, 3 Buttons

Location Services
GPS with Internal Antenna

Date/Time Format
ISO 8601 with satellite synchronization or manual computer synchronization

Wireless
802.11 b/g/n WiFi with AES hardware encryption, Bluetooth Low Energy. Available in future firmware releases.

Connections
USB 2.0, 3.3V TTL Serial, DC input via barrel jack, Aerosol sample inlet and outlet ports

USB Communication / Client Application
USB connectivity to cross-platform microAeth® Manager software available on macOS® and Windows®. microAeth Manager software is included and facilitates settings configuration and data download. Exported data can be uploaded to AethLabs Dashboard server for processing and visualization.

Serial Communication
3.3V TTL serial connectivity for uploading new instrument firmware, flow calibration, streaming data and polling protocols to request data, modify settings and control. Command line interface (CLI) polling protocols: AethLabs protocol and Bayern-Hessen protocol.

Total Run Time
Up to 56 hours at 60 second timebase, 100 ml/min flow rate on single battery charge. Run time may vary due to PM concentrations and settings.

Battery
Internal 3.6V, 12800 mAh (46.08 Wh), 4 cell rechargeable lithium-ion battery

Charging
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
5 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

8.3. 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, 75, 100, 125, 150 or 170 ml/min, DualSpot® compensation not compatible with all settings

Measurement Range
Per sampling location, 0-1 mg BC/m^3, filter sampling location lifetime dependent on concentration and flow rate setting, decreasing proportionally with lowest wavelength optical source enabled:
IR only mode, average 5 µg BC/m^3 for 24 hours at 100 ml/min
IR only mode, average 100 µg BC/m^3 for 3 hours at 50 ml/min
IR only mode, average 1 mg BC/m^3 for 15 minutes at 50 ml/min

Measurement Resolution
0.001 µg BC/m^3

Limit of Detection
30 ng BC/m^3, 5 min timebase., 150 ml/min flow rate, SingleSpot™

Pump Options
Standard internal diaphragm pump

Flow Control
Internal mass flowmeters with closed-loop control

Filter Material / Capacity
MA300/MA350 Filter Tape Cartridge with Polytetrafluoroethylene (PTFE) material (85 sampling locations)

Sampling
3 mm diameter spot(s) created on filter tape. User selectable DualSpot® or SingleSpot™ mode.

Environmental 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
16GB internal flash memory, providing storage for 31,250,000 data lines; 1 second timebase: 361 days of data

On-board Interface
Low Power Screen, 3 Buttons

Location services
GPS with Internal Antenna

Date/Time Format
ISO 8601 with satellite synchronization or manual computer synchronization

Wireless
802.11 b/g/n WiFi with AES hardware encryption, Bluetooth Low Energy. Available in future firmware releases.

Connections
Via external sealed connector for 3.3V TTL Serial and DC power input via barrel jack, Aerosol sample inlet and outlet ports, USB 2.0 on inside panel

USB Communication / Client Application
USB connectivity to cross-platform microAeth® Manager software available on macOS® and Windows®. microAeth Manager software is included and facilitates settings configuration and data download. Exported data can be uploaded to AethLabs Dashboard server for processing and visualization.

Serial Communication
3.3V TTL serial connectivity for uploading new instrument firmware, flow calibration, streaming data and polling protocols to request data, modify settings and control. Command line interface (CLI) polling protocols: AethLabs protocol and Bayern-Hessen protocol.

Total Run Time
Up to 56 hours at 60 second timebase, 100 ml/min flow rate on single battery charge. Run time may vary due to PM concentrations and settings.

Battery
Internal 3.6V, 12800 mAh (46.08 Wh), 4 cell rechargeable lithium-ion battery

Charging
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
5 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

microAeth® MA Series MA200, MA300, MA350 Operating Manual, May 2023 rev05