

microAeth® AE51

Operating Manual



TABLE OF CONTENTS

| | | | |
|---|----|---|----|
| 1. Introduction | 4 | 2.6.7 Status Indications..... | 23 |
| 1.1 Serial Number..... | 4 | 2.6.7.1 LED Status Indications..... | 23 |
| 1.2 Overview..... | 4 | 2.6.7.2 Data File Status Codes | 23 |
| 1.3 Instrument Diagram..... | 5 | 2.7 Upgrading microAeth AE51 Operating System Firmware..... | 24 |
| 1.4 Technical Specifications..... | 6 | 2.8 Manual Flow Calibration Procedure | 27 |
| 1.5 Symbols and Cautions | 7 | | |
| 1.5.1 Explanation of Operation Symbols..... | 7 | | |
| 1.5.2 Important Safeguards..... | 7 | | |
| 1.5.2.1 Power Source..... | 7 | | |
| 1.5.2.2 Object and Liquid Entry | 7 | | |
| 1.5.2.3 Accessories..... | 7 | | |
| 1.5.2.4 Servicing | 8 | | |
| 1.5.2.5 Replacement Parts..... | 8 | | |
| 1.5.2.6 Other Warnings | 8 | | |
| 2. Configuration and Operation..... | 9 | | |
| 2.1 Overview..... | 9 | | |
| 2.2 Recommendations for Best Use Practices | 10 | | |
| 2.2.1 Instrument Settings: Measurement TimeBase and Flow Rate..... | 10 | | |
| 2.2.2 Recommended Settings of microAeth AE51 for Different Scenarios..... | 11 | | |
| 2.2.3 Contamination, Maintenance, and Cleaning of Sample Chamber..... | 12 | | |
| 2.3 Filter Media..... | 13 | | |
| 2.3.1 General | 13 | | |
| 2.3.2 Filter Strip Installation and Removal | 13 | | |
| 2.4 Power | 14 | | |
| 2.5 microAethCOM PC Software Installation | 14 | | |
| 2.6 Operation and Communication | 16 | | |
| 2.6.1 microAeth AE51 Operation..... | 16 | | |
| 2.6.2 Configuration of Instrument Operating Parameters | 17 | | |
| 2.6.2.1 Time & Time Sync | 18 | | |
| 2.6.2.2 Flow Set Point | 18 | | |
| 2.6.2.3 Timebase..... | 18 | | |
| 2.6.2.4 Operating Mode | 19 | | |
| 2.6.2.5 Shutdown Mode..... | 19 | | |
| 2.6.2.6 Sound Notifications..... | 19 | | |
| 2.6.3 Downloading Data..... | 19 | | |
| 2.6.4 Erasing Data..... | 20 | | |
| 2.6.5 Viewing and/or Analyzing Measurement Data | 21 | | |
| 2.6.6 Data File Structure..... | 22 | | |

1. INTRODUCTION

1.1 Serial Number

The model and serial number are located on the back panel. Record the serial number in the space provided below. Refer to these numbers whenever you contact AethLabs for service.

Model No.: microAeth® AE51

Serial number: AE51-S__-____-____

1.2 Overview

Real-time Aerosol Black Carbon Personal Exposure Measurement Device

- Pocket-size, lightweight Aethalometer (250 g)
- Fast response: 1 second measurement timebase
- Low power consumption: 24 hour run time on one charge
- Onboard data processing, logging and diagnostics
- Flexible sampling options and wide dynamic range
- Filter strips for accurate sample tracking

The microAeth AE51 is designed specifically for investigation of personal exposure to carbonaceous particles found in ambient air. The instrument is based on Aethalometer technology that is widely used for studying indoor or outdoor air quality, and for the mobile mapping of the air quality impacts of localized sources. The instrument provides high quality, short time resolved data essential for assessing the real-time concentration of Black Carbon aerosols in a micro-environment.

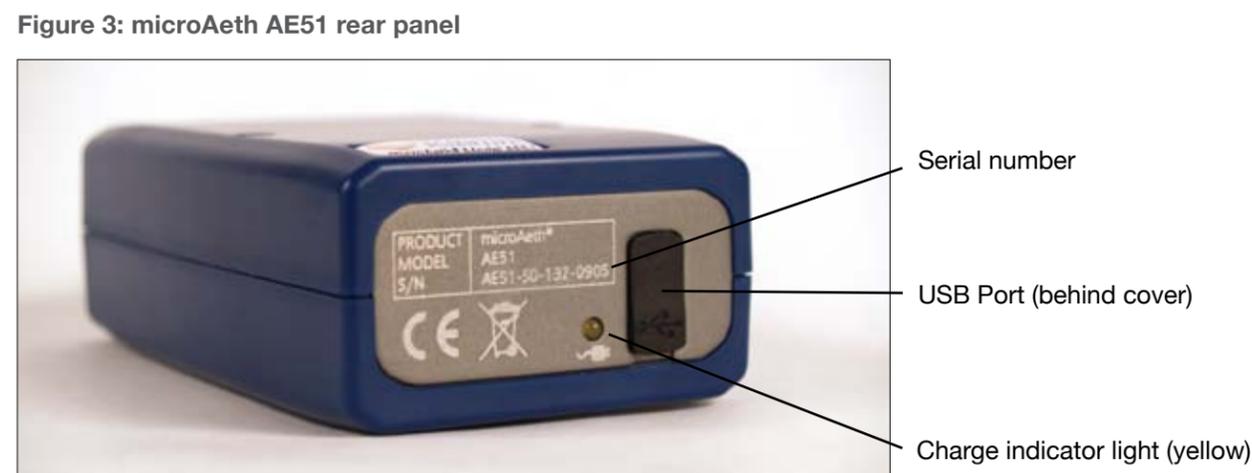
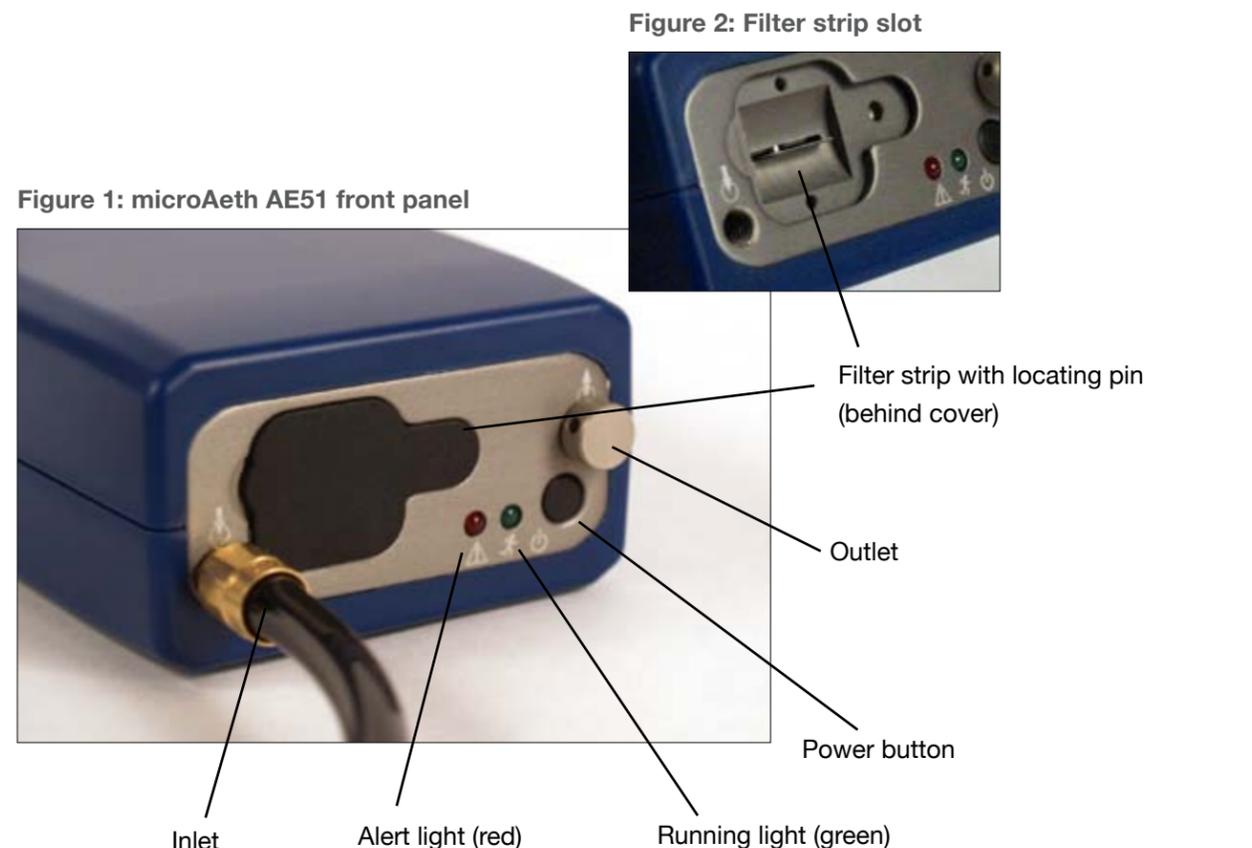
The package includes:

- microAeth AE51 Personal Exposure Monitor
- Self-powered, LED source (880nm-IR), user-selectable measurement timebase settings of 1, 10, 30, 60, 300 seconds, flow rate settings of 50, 100, 150, 200 ml/min with internal active mass flow measurement and control
- Sample collected and analyzed on a filter strip consisting of a T60 Teflon coated borosilicate glass fiber media housed in a protective casing
- USB-based power charger with AC adapter (100-500mA) for internal 5VDC lithium ion battery.
- USB charging / interconnect cable
- Flexible conductive sample tubing (40 inches) with swivel tube connector
- Pack of 5 sample filter strips
- CD containing
 - microAethCOM communications software and USB driver
 - Operating Manual
- Quick Start Guide (hard copy)

For further information on this instrument or Black Carbon measurement, please contact:

AethLabs
San Francisco, California
<https://aethlabs.com>

1.3 Instrument Diagram



1.4 Technical Specifications

Measurement Principle

Real-time analysis by measuring the rate of change in absorption of transmitted light due to continuous collection of aerosol deposit on filter. Measurement at 880 nm interpreted as concentration of Black Carbon ('BC').

Measurement Range

0-1 mg BC/m³, filter life time dependent on concentration and flow rate setting:
 avg. 5 µg BC/m³ for 24 hours @ 100 ml/min
 avg. 100 µg BC/m³ for 3 hours @ 50 ml/min
 avg. 1 mg BC/m³ for 15 minutes @ 50 ml/min

Measurement Resolution

0.001 µg BC/m³

Measurement Precision

±0.1 µg BC/m³, 1 min avg., 150 ml/min flow rate

Measurement Timebase (User setting)

1, 10, 30, 60, or 300 seconds

Flow Rate (User setting)

Internal pump provides 50, 100, 150, or 200 ml/min, monitored by mass flow meter and stabilized by closed-loop control.

Sampling

3 mm spot created on filter strip containing insert of T60 Teflon-coated borosilicate glass fiber filter material. PM2.5 size selective inlet available.

Consumables

Filter strip: 1 filter strip per sampling campaign, typically one per day. High concentration sampling may require more than one filter per day.

Data Storage

4 MB internal flash memory, providing up to 1 month data storage when operating on a 300 second timebase, and 1 week when operating on a 60 second timebase.

Communications

USB connectivity to Windows®-based PC with microAethCOM.

Data Output

Internal data files are uploaded to microAethCOM PC software and stored on local disk.

PC Software

microAethCOM software is included. Provides visual interface including real-time BC mass concentration values. Facilitates settings configuration, calibration routines, downloading data, and uploading new instrument firmware.

Dimensions

4.6 in (117 mm) L x 2.6 in (66 mm) W x 1.5 in (38 mm) D

Weight

Approximately 9.88 ounces (280 g).

Power

Internal rechargeable lithium-ion battery.

Power Supply Adapter

Input: 100~240 VAC 50/60 Hz 0.2 A
 Output: 5VDC / 0.5A

Charging Time

4 hours to full charge (using AC adapter, instrument turned off).

Total Run Time (Single battery charge)

Minimum 24 hours @ 300 second timebase at 100 ml/min flow rate. Run time may vary due to PM concentrations.

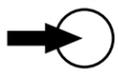
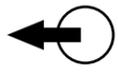
Operation Environment

0 ~ 40 °C operating, non-condensing.

Specifications are subject to change without notice.

1.5 Symbols and Cautions

1.5.1 Explanation Operation Symbols

| | |
|---|---|
|  | Operation indicator |
|  | Charging indicator |
|  | Aerosol inlet |
|  | Aerosol outlet |
|  | System alert indicator |
|  | Filter strip orientation arrow (point indicates orientation of upstream face of filter strip) |
|  | On/Off |
|  | USB port |

1.5.2 Important Safeguards

Please read these safety instructions completely before operating the instrument, and keep this manual for future reference. Carefully observe all warnings, precautions and instructions on the instrument, or as described in the operating manual and product literature.

Do not expose the microAeth AE51 or its batteries to sources of excessive heat such as sunshine or fire.

1.5.2.1 Power Source

The microAeth AE51 should be operated only from the type of power source indicated in the instrument specifications. If you are not sure of the type of electrical power supplied to your home, consult your dealer or local power company. For those devices

designed to operate from battery power, or other sources, refer to the operating instructions. Also, the connections on both ends of the USB interface cable are designed to be inserted into the AC power/charger adapter or the AE51 only one way. These are safety features. If you are unable to insert the AC plug fully into the outlet, try reversing the plug. If the plug should still fail to fit, contact AethLabs.

1.5.2.2 Object and Liquid Entry

Never push objects of any kind into the AC power/charger adapter or into the microAeth AE51 (except for the filter ticket) through openings as they may touch dangerous voltage points or short out parts that could result in a fire or electric shock. Never spill liquid of any kind on the AE51 or its electrical accessories. This instrument should not be exposed to rain or moisture, and objects filled with liquids, such as vases, should not be placed on this instrument.

1.5.2.3 Accessories

Do not use accessories not recommended by the manufacturer, as they may cause hazards.

1.5.2.4 Servicing

Use extra care when servicing the instrument yourself as opening or removing covers exposes sensitive internal hardware to potential damage. Refer to all service documentation and trained, authorized service personnel for assistance.

1.5.2.5 Replacement Parts

Only genuine AethLabs parts should be used in the microAeth AE51. Only trained, authorized service personnel should make repairs or install replacement parts.

Lithium-Ion batteries are recyclable and should be disposed of properly. **Caution:** Do not handle damaged or leaking Lithium-Ion batteries.

2. CONFIGURATION AND OPERATION

2.1 Overview

The AethLabs microAeth® AE51 is a high sensitivity, miniature, portable instrument designed for measuring the optically-absorbing Black Carbon ('BC') component of aerosol particles. The instrument is based on the well-established Aethalometer principle used for over 30 years in laboratory-sized analyzers.

The microAeth AE51 draws an air sample at a flow rate of 50, 100, 150 or 200 ml/min through a 3 mm diameter portion of filter media. Optical transmission through the 'Sensing' spot is measured by a stabilized 880 nm LED light source and photo diode detector. The absorbance ('Attenuation, ATN') of the spot is measured relative to an adjacent 'Reference' portion of the filter once per timebase period. The gradual accumulation of optically-absorbing particles leads to a gradual increase in ATN from one period to the next. The air flow rate through the spot is measured by a mass flow sensor which is also used to stabilize the pump. The electronics and microprocessor measure and store the data each period to determine the increment during each timebase. This is then converted to a mass concentration of BC expressed in nanograms per cubic meter (ng/m³) using the known optical absorbance per unit mass of Black Carbon material.

The instrument's operating parameters are set up by an external software application (microAethCOM) and uploaded to the microAeth AE51 by a USB interface cable. Operation is completely automatic after the instrument is switched on. During operation, the microprocessor performs the optical measurements, measures and stabilizes the air flow, calculates the BC mass concentration and records data to internal non-volatile memory. The data may be downloaded at a later time by the same external software package.

The microAeth AE51 derives its power from an internal rechargeable battery. The same USB interface cable serves to recharge the battery from either the USB port of a connected external computer, or an AC power supply. The instrument will operate for 6 to 24 hours on a single charge, depending on operational settings.

2.2 Recommendations for Best Use Practices

The small size and light weight of the microAeth® AE51 allow it to be used to gather data in a wide range of operational scenarios, not always possible using larger instruments. Optimization of performance across this breadth of applications requires an understanding of operational settings, precautions, and maintenance procedures. The following recommendations provide general guidelines.

2.2.1 Instrument Settings: Measurement Timebase and Flow Rate

In order to get the best data from the microAeth AE51 for the sampling campaign, we highly recommend that the **instrument warm up for approximately 10-15 minutes** so that it can equilibrate to its environment. The microAeth AE51 can acquire data on five timebase settings: 1, 10, 30, 60, and 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 AE51 pump can operate at four sampling flow rate settings: 50, 100, 150, and 200 ml/min. The choice of these parameters affects the operation and data as follows.

Battery Run Time on Single Charge: Affected by flow rate and timebase.

NOTE: Battery life will gradually diminish after many cycles (~ 1 year of use). The following are approximate runtimes which can vary based on individual microAeth AE51 instruments and specific environments.

| | 50 ml/min | 100 ml/min | 150 ml/min | 200 ml/min |
|--------------------|------------|------------|------------|------------|
| 1 second | > 21 hours | > 18 hours | > 14 hours | > 12 hours |
| 10 seconds | > 21 hours | > 19 hours | > 15 hours | > 12 hours |
| 30 seconds | > 23 hours | > 19 hours | > 15 hours | > 13 hours |
| 60 seconds | > 28 hours | > 24 hours | > 20 hours | > 15 hours |
| 300 seconds | > 30 hours | > 24 hours | > 21 hours | > 15 hours |

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

| 1 second | 60 seconds | 300 seconds |
|-----------------------|-------------------------|--------------------------|
| < 5 ug/m ³ | < 0.1 ug/m ³ | < 0.05 ug/m ³ |

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

| 1 second | 10 seconds | 30 seconds | 60 seconds | 300 seconds |
|------------|------------|------------|------------|--------------|
| very large | large | moderate | moderate | least effect |

2.2.2 Recommended Settings of microAeth® AE51 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. 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.

| | ← Filter Life → | | | |
|--------------|---|--|--|---|
| | 50 ml/min | 100 ml/min | 150 ml/min | 200 ml/min |
| 1 s | ‘Data Acquisition Mode’ for immediate emissions and impacts at high concentrations. | ‘Data Acquisition Mode’ for emissions and impacts in typical urban and traffic environments. | ‘Data Acquisition Mode’ for higher time resolution at lower BC concentrations. | ‘Data Acquisition Mode’ for higher time resolution at lower BC concentrations or shorter sampling durations. |
| 10 s | Traffic and transportation impacts in high BC concentrations. | Traffic and transportation impacts. | Traffic and transportation impacts at lower BC concentrations. | Traffic and transportation impacts at lower BC concentrations. |
| 30 s | Personal Exposure Monitoring in high BC concentrations. Occupational Exposure. | Recommended Setting for General Applications. Personal Exposure Monitoring. Traffic impact. High time resolution ambient monitoring. | Personal Exposure Monitoring. Traffic impact. High time resolution ambient monitoring. | Personal Exposure Monitoring. Traffic impact. Ambient monitoring. Higher sensitivity for low BC concentrations. |
| 60 s | Personal Exposure Monitoring. Occupational Exposure. High BC concentrations. | Personal Exposure Monitoring. Indoor Air Quality. | Personal Exposure Monitoring. Indoor Air Quality. Low BC concentration. | Personal Exposure Monitoring. Higher sensitivity for low BC concentrations. |
| 300 s | Epidemiology. Area monitoring. Indoor air quality. High BC concentration. | Epidemiology. Area monitoring. Indoor air quality. | Epidemiology. Area monitoring. Indoor air quality. Low BC concentration. | Epidemiology. Area monitoring. Indoor air quality. Lowest BC concentration. Lowest data noise. |

2.2.3 Contamination, Maintenance & Cleaning of Sample Chamber

If a loose particle of contamination enters the sample chamber of the microAeth AE51 or the instrument experiences vibration or impact, the data will be degraded. Shaking or tapping a “dirty” instrument will 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.

Contamination Probability for Various Use Scenarios

| Sampling Scenario | 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 | Medium |
| Outdoor urban environments | Medium |
| Outdoor rural environments (without dust, fluff, pollen) | Low |
| Residential indoor environments | Low |

Recommended Hours of Operation Between Cleaning & Maintenance

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

NOTE: If a microCyclone™ is being used with your microAeth AE51, please clean it on a frequent basis, depending on sampling environment and concentrations.

2.3 Filter Media

IMPORTANT NOTE:

- Always make sure that a filter strip is installed in the microAeth AE51 when it is operating.
- Whenever the filter strip is exchanged, the microAeth AE51 should be turned off to prevent dust or debris from being drawn into the inlet and analysis chamber.

2.3.1 General

The sample collection and analysis is performed on a filter strip, consisting of a small section of filter material held between and supported by a specially designed filter holder to create the filter strip assembly. 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 3 mm in diameter. The microAeth AE51 determines the attenuation of the source light as the accumulated black carbon increases the optical density of the filter spot. After the optical density reaches a certain level, the filter strip must be replaced to maintain measurement integrity.

To maintain a leak-free sample path, the filter strip is clamped between two halves of the spring-loaded sampling head. A release button opens the clamp to allow the filter strip to be inserted and removed. A locating pin in the head engages in a matching hole in the filter strip holder to ensure correct placement.

2.3.2 Filter Strip Installation and Removal

1. The sample deposit side of the filter strip is the white side. When the filter strip is installed in the sample chamber, the white side of the filter strip should be facing the same direction as indicated by the white arrow on the faceplate of the microAeth AE51.



Figure 5: Top of microAeth AE51



Figure 6: Bottom of AE51 with filter strip release button.



Figure 7: White sample deposit side of filter strip faces the top.



Figure 8: Metal side of filter strip faces the bottom.

2. Hold the AE51 in one hand so that the filter chamber release button is on the bottom of the enclosure (Figure 9) (all of the icons will be right side up).
3. Loosen the rubber cover on the front of the AE51 by pulling the tab away from the instrument. This will expose the filter strip slot.



Figure 9: Inserting and removing filter strip while depressing filter release button on bottom of microAeth AE51.

4. If there is a filter strip already installed, depress the release button with your thumb and pull the filter strip out of the sampling head.
5. Install a new filter strip by pressing and holding the release button and then inserting the new filter strip into the sample chamber opening with the white plastic side facing up (Figure 9).
6. Make sure to push the new filter strip all the way into the slot and that the locating pinhole on the filter strip is not visible.
7. Release the release button and verify the locating pin has registered properly in the filter strip locating hole.
8. Replace the rubber cover. A tight fit is essential to prevent the entry of contamination and stray light into the sample chamber.

2.4 Power

The power switch is located on the front panel of the instrument. There are two options for recharging:

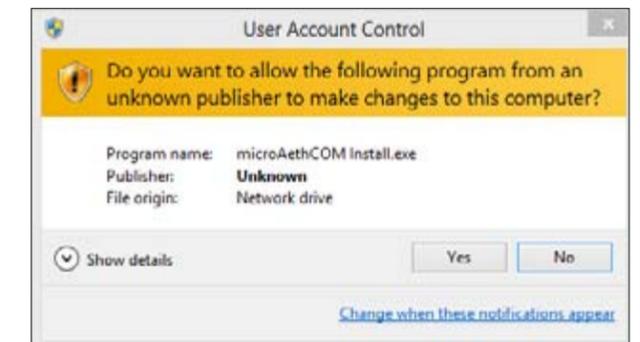
- USB to PC-USB port (500mA): 4 hours to full charge
- USB to AC-USB wall adapter (500mA): 4 hours to full charge.

The instrument uses a USB-based power charger (100-500mA) for internal 5VDC lithium ion battery. The yellow charging light illuminates when the microAeth AE51 is connected to an external power source and is recharging the battery. When the battery is fully charged, the yellow light turns off.

2.5 microAethCOM PC Software Installation

The microAethCOM software application is designed to install and operate on a PC using Windows® XP with Service Pack 3, Windows® 7, and Windows® 8. All software components are included in the installer named microAethCOM Install.exe which is located on the CD included with the microAeth AE51 or can be downloaded from the AethLabs website. This installer will install the microAethCOM, manual flow calibration software and the firmware file.

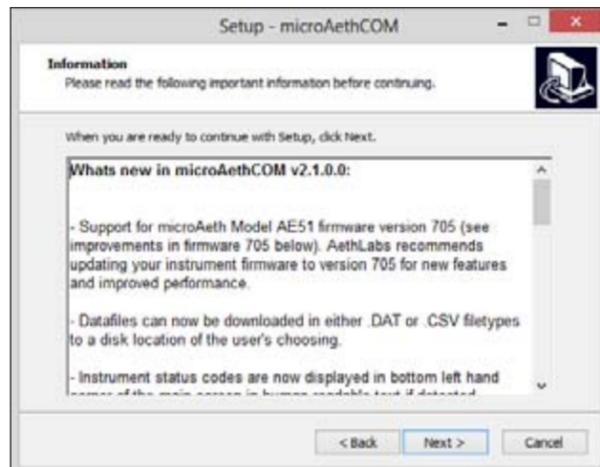
1. Do not connect the microAeth AE51 to the USB port on the computer until the software installation is complete.
2. Make sure that you have the necessary user privileges on your computer to install software.
3. Locate and double click microAethCOM Install.exe to start the install. The installer will prompt you through the setup.



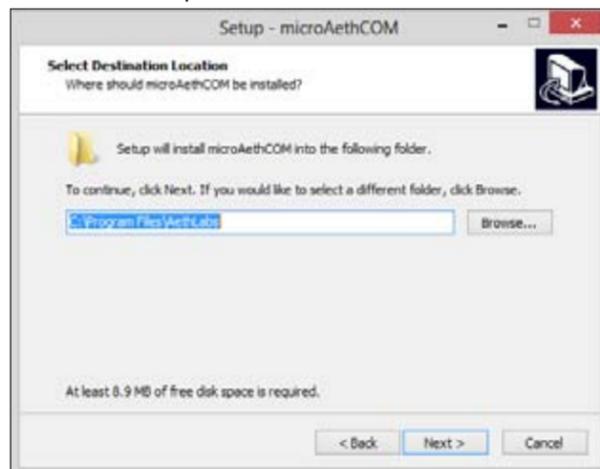
- In order to install the microAethCOM software, please read and accept the license agreement.



- Please review changes to microAethCOM and firmware.



- Select the directory location where microAethCOM, manual flow calibration software and the firmware file should be installed on the computer.



- The communication drivers will need to be installed next. The installer will prompt you through this section of the setup.



- Once all the correct drivers are installed, the setup will be complete.



2.6 Operation and Communication

Before starting a sampling run, it is recommended that the user verify all parameter settings. A description of each operating parameter and its configuration is described in section 2.6.2 Configuration of Instrument Operating Parameters.

The microAeth AE51 startup sequence automatically begins when the power is turned on. Sampling and data collection begin starting the next minute after the startup process is complete. A new measurement data file is created for the new sampling session. The microAeth AE51 will continue sampling and storing data until the instrument is shutdown. At shutdown, the data file is closed. Any active sampling session and data file will also be closed if data is downloaded or erased or if settings are saved to the AE51. In order to start a new sampling session, the AE51 must be restarted.

Status indicator lights located on each end panel of the AE51 provide information regarding the instrument operating status. Please read section 2.6.8.1 LED Status Indications for more information.

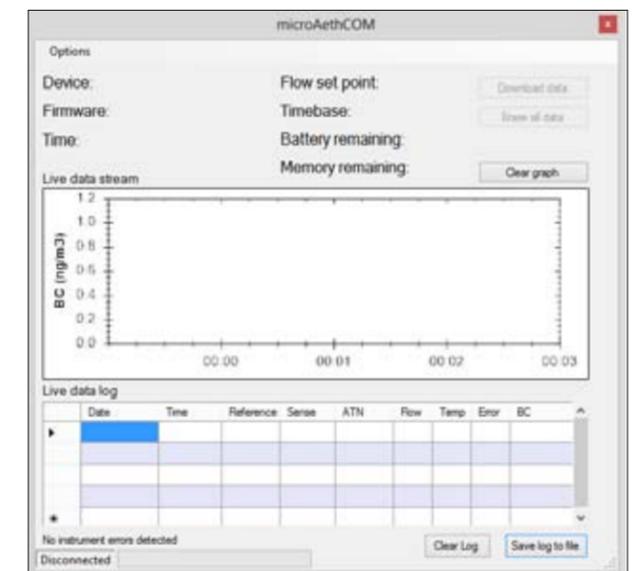
2.6.1 microAeth AE51 Operation

IMPORTANT NOTE:

- Always make sure that a filter strip is installed in the microAeth AE51 when it is operating.
- Whenever the filter strip is exchanged, the microAeth AE51 should be turned off to prevent dust or debris from being drawn into the inlet and analysis chamber.
- A new sampling session and data file is created each time the microAeth AE51 is turned on and completes the automatic startup sequence.
- Any active sampling session and data file will be closed if the microAeth AE51 is shutdown, data is downloaded or erased, or if settings are saved to the AE51. In order to start a

new sampling session, the AE51 must be restarted.

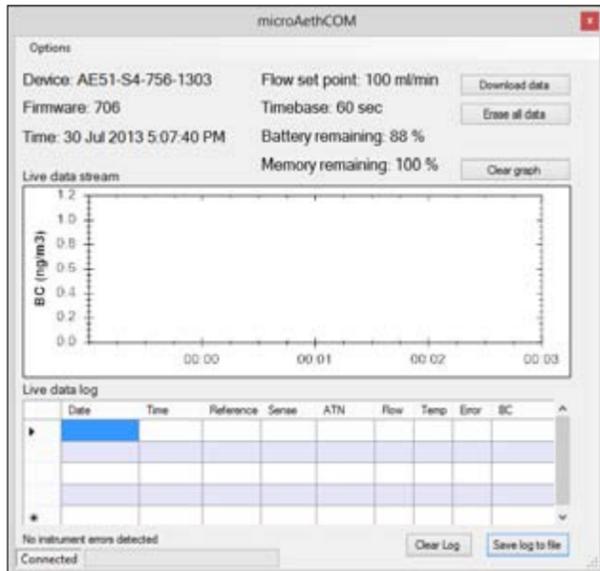
- Make sure that a filter strip is installed in the microAethAE51. Turn on the microAeth AE51 by depressing the power button for 4 seconds until the AE51 beeps for the second time and the red and green LEDs illuminate together.
- Release the power button and wait for a few seconds. The pump will turn on and the LEDs will then begin to blink on and off in unison about every second until the beginning of the next minute. When the LEDs stop blinking, the instrument will chirp indicating the start of data collection.
- While the unit is operating, the green LED will blink periodically. If the unit is set to store data to its internal memory, the green LED will emit single blinks every few seconds. If it has been set to store data internally and stream data, the green LED will blink twice every few seconds.
- Start the microAethCOM software.



- Connect the USB cable to the AE51 and your computer.



- After the AE51 establishes communication with the microAethCOM software, the connection status in the bottom left corner of the main screen will change to Connected and the microAeth AE51 serial number, status, and settings will be displayed.



- If the serial number, status, and settings are not displayed, disconnect the USB cable and reinsert it.

- To shut down the microAeth AE51 through the microAethCOM software, click Options then Shut down microAeth AE51. Depending on the current settings of the AE51, the power button on the front of the instrument can be used to shut down the instrument.



2.6.2 Configuration of Instrument Operating Parameters

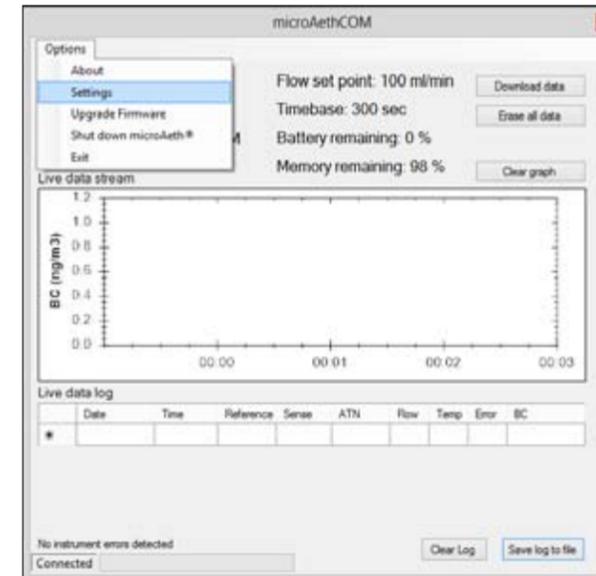
IMPORTANT NOTE:

- The AE51 will not collect data with new saved settings until it has been restarted.

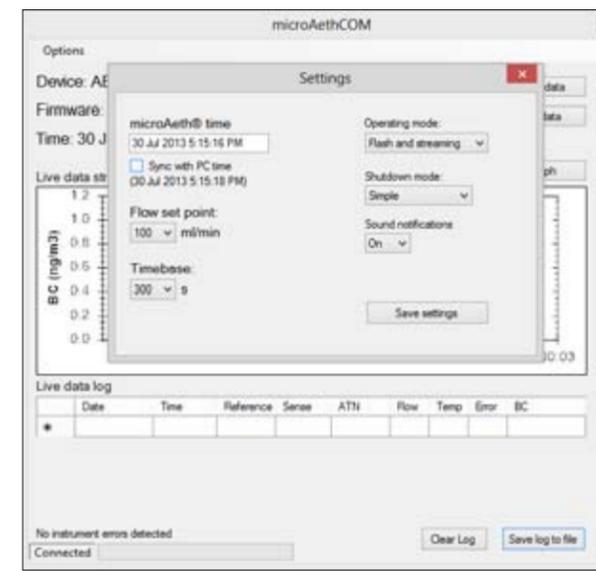
All instrument parameters are configured through the microAethCOM user interface. The various parameters are accessed through Settings in the Options menu on the tool bar.

- Turn on the microAeth AE51.
- Start the microAethCOM software.
- Connect the USB cable to the microAeth AE51 and the computer. Wait until the AE51 establishes communication with microAethCOM.

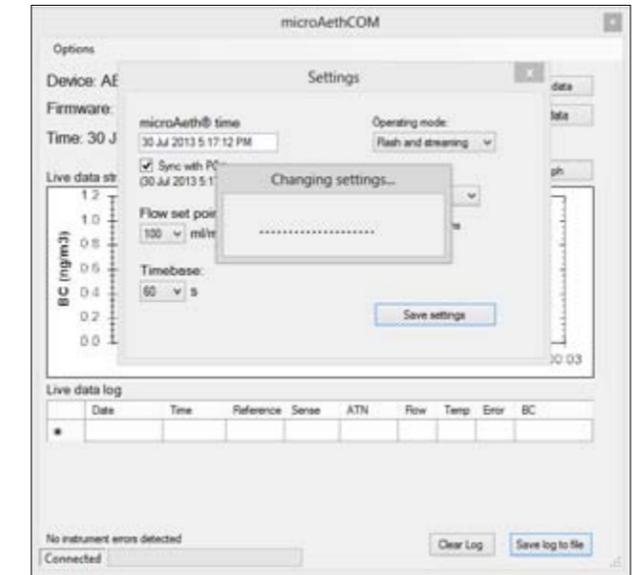
- Click Options then Settings



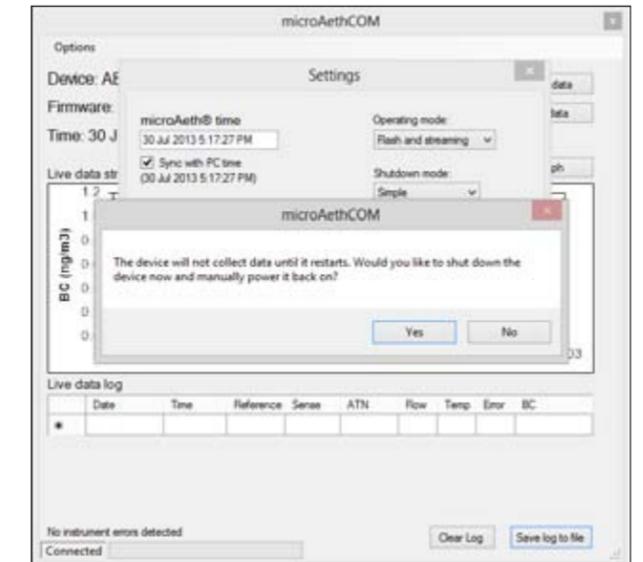
- On the Settings screen, the microAeth AE51 can be configured.



- When all settings are selected as desired, click the Save settings button.



- Once the settings have been saved, you will be prompted to shut down the microAeth AE51. **The AE51 will not collect data with the new saved settings until it has been restarted.**



2.6.2.1 Time & Time Sync

The time on the microAeth AE51 is displayed. In order to sync the time on the AE51 with the PC time, click the Sync with PC time check box.

It is very important to confirm the date and time of the PC prior to synchronizing to the AE51. Once confirmed, it is good operating practice to always synchronize the date and time when configuring the microAeth AE51 before starting a new sample session.

2.6.2.2 Flow Set Point

The flow set point permits the user to select a flow rate set point of 50, 100, 150, or 200 ml/min.

We recommend using lower flows in areas with high BC concentrations, and higher flow rates when maximum sensitivity is required in areas of low BC concentration. A lower flow rate should also be selected for longer run times and extended battery life. Please read section 2.2 Best Use Practices Recommendations for more information.

2.6.2.3 Timebase

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

We recommend 30 or 60 seconds for most 'human exposure' or 'ambient monitoring' use. Faster timebases will result in higher noise on each measurement point, 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 used to extend battery life and run time. Please read section 2.2 Best Use Practices Recommendations for more information.

2.6.2.4 Operating Mode

The operating mode permits the user to configure data storage and streaming options.

- **Store to flash** saves data to the internal memory only.
- **Flash and streaming** saves data to the internal memory and outputs a continuous data stream through the USB port.

2.6.2.5 Shutdown Mode

The shutdown mode permits the user to configure how the instrument is shutdown.

- **Simple** mode will allow the microAeth AE51 to be shut down by depressing the power button for 3 seconds.
- **USB only** mode will only allow the microAeth AE51 to be shut down using the microAethCOM software.
- **Secure** mode will allow the microAeth AE51 to be shut down by pressing and releasing the power button three times in succession. The smoothly-timed sequence is coordinated by a simultaneous beep and blink of the red and green LED indicator lights.

Each cycle of the Secure mode takes about 1 second as follows:

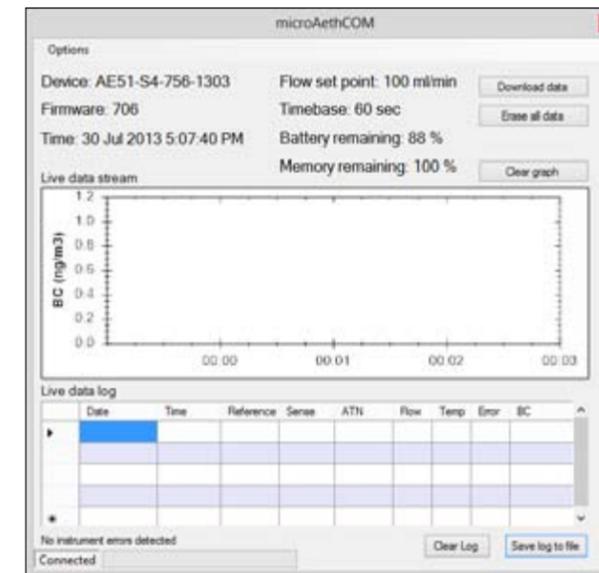
1. Press and hold the power button.
2. When you hear/see the first 'beep/blink' release the button quickly.
3. When you hear/see the next 'beep/blink' quickly press and hold the power button.
4. When you hear/see the next 'beep/blink' release the button quickly.
5. When you hear/see the next 'beep/blink' quickly press and hold the power button.
6. When you hear/see the next 'beep/blink' release the button quickly.
7. The microAeth AE51 will then shut down.

2.6.2.6 Sound Notifications

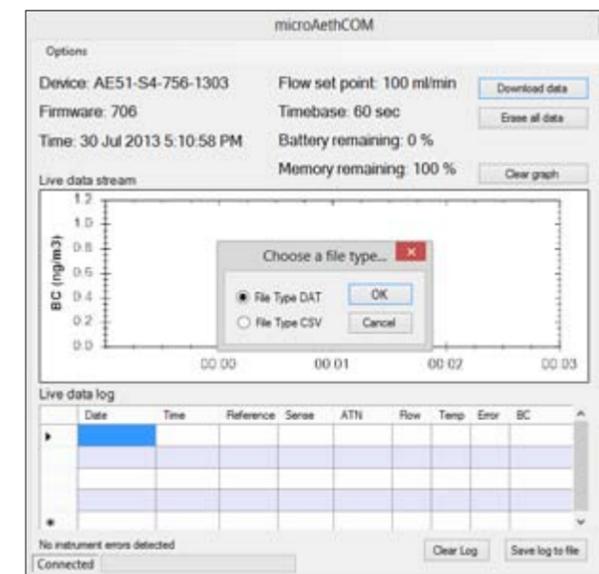
The sound notifications setting permits the user to select if the audible notifications issued by the microAeth AE51 are turned On or Off.

2.6.3 Downloading Data

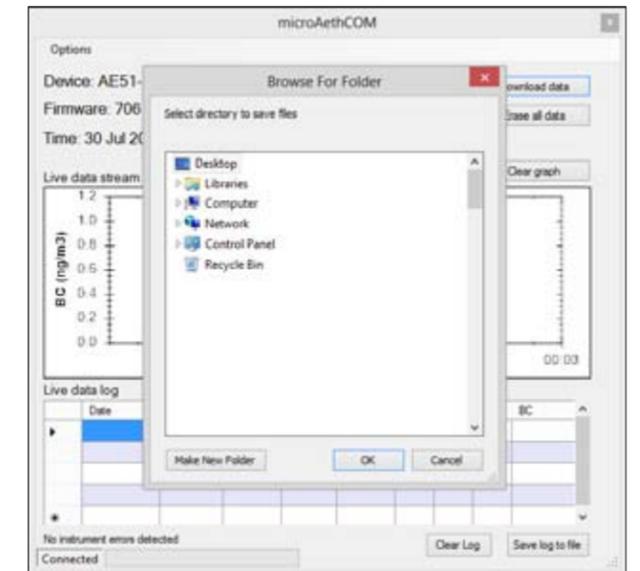
1. Turn on the microAeth AE51.
2. Start the microAethCOM software.
3. Connect the USB cable to the microAeth AE51 and the computer. Wait until the AE51 establishes communication with microAethCOM.



4. Click the Download data button to download the data stored on the internal memory of the AE51.
5. Select .DAT or .CSV data file type to download.



will be saved in a folder named **AE51-SX-XXX-YYMM** in this directory.

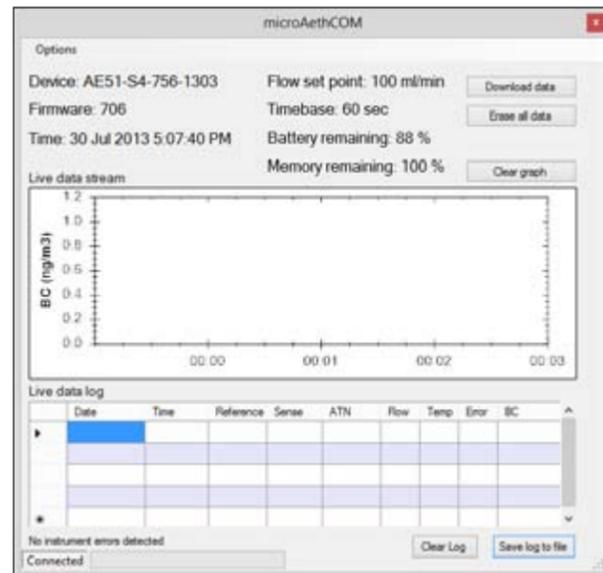


7. Wait until the download has completed. The progress bar in the bottom left corner of the main screen will show you the progress of the download. The status window will also inform you when the download is complete.

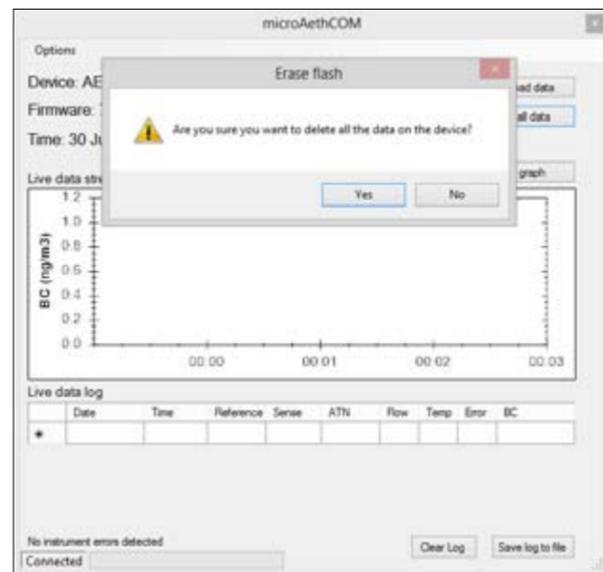


2.6.4 Erasing Data

1. Turn on the microAeth AE51.
2. Start the microAethCOM software.
3. Connect the USB cable to the microAeth AE51 and the computer. Wait until the AE51 establishes communication with microAethCOM.



4. Click the Erase all data button to erase all the data stored on the internal memory of the AE51.
5. You will be prompted to confirm to erase all the data stored on the AE51.



status window will show that the memory is being erased.



7. The status window will disappear when the memory has been erased.

2.6.5 Viewing and/or Analyzing Measurement Data

Data files are named using the following naming convention: AE51-SX-XXX-YYYYMMDD, where XXX is the instrument unique identifier number. Data files are formatted such that they can be imported directly into Microsoft Excel® or can be uploaded to the AethLabs website. Please note that when opening data files in Microsoft Excel®, formatting may automatically be changed, making it difficult to upload to the website.

2.6.6 Data File Structure

The data files are plain text with the extension .dat or .csv. The file consists of a header containing descriptive information; a line identifying the columns; and then a number of data lines with each item separated by a semicolon or comma depending on the file format chosen at the time of download.

An example of the header is:

“Delimiter = ;”
AethLabs
Device ID = AE51-S4-558-1204
Application version = 2.2.4.0
Flow = 100 ml/min
Timebase = 60 s
Start date = 2015/05/07
Start time = 18:10:00
Original date format = yyyy/MM/dd
Original time format = hh:mm:ss
Flow units = ml/min
PCB temp units = deg C
Battery units = %
BC units = ng/m³

Date;Time;Ref;Sen;ATN;Flow;PCB temp;Status;Battery;BC

The first line of data does not contain the final BC calculation; all subsequent lines show this expressed in units of ng/m³ of BC. A typical excerpt of data lines is shown below:

```
2015/05/07;18:10:00;922087;869206;5.906;100;30;0;74;
2015/05/07;18:11:00;922264;869322;5.912;100;30;0;74;332
2015/05/07;18:12:00;922279;869287;5.917;100;29;0;74;321
2015/05/07;18:13:00;922294;869215;5.927;100;29;0;74;563
2015/05/07;18:14:00;922301;869151;5.935;100;29;0;73;461
2015/05/07;18:15:00;922399;869175;5.943;100;29;0;73;447
2015/05/07;18:16:00;922409;869110;5.952;100;29;0;73;486
2015/05/07;18:17:00;922388;869037;5.958;100;28;0;73;348
2015/05/07;18:18:00;922336;868932;5.964;100;28;0;73;366
2015/05/07;18:19:00;922458;868999;5.970;100;28;0;73;313
2015/05/07;18:20:00;922424;868920;5.975;100;28;0;73;307
```

2.6.7 Status Indications

2.6.7.1 LED Status Indications

The microAeth AE51 has one yellow LED located on the rear panel that turns on when the instrument is charging. The microAeth AE51 has two LED indicators, one green and one red, located on the front panel immediately to the right of the filter chamber. These lights indicate the instrument's current operating status. The green LED generally indicates that the instrument is functioning properly and is or is not collecting data. The red LED indicator generally indicates that the unit is not operating in a normal sampling state. The status indications signaled by the LEDs are given in the following table.

| Run Modes | | |
|---|--|---|
| Green | 1 long blink & beep sound | Start of data storing to internal memory. |
| Green | 1 blink every 3 sec | Acquiring data to internal memory. |
| Green | 2 blinks every 3 sec | Acquiring data to internal memory and streaming. |
| Green | 1 long blink every 1 or 5 min | Data write to internal memory (1, 5 min timebase). |
| Status Warnings during Run Modes (see above) | | |
| Green indicates Run Mode (see above), Red indicates Warning (see below) | | |
| Red | 1 blinks every 1 sec | Warning - Change filter strip |
| Red | 2 blinks every 1 sec | Warning - Battery low |
| Red | 3 blinks every 1 sec | Warning - Flow error |
| Stop Modes | | |
| Red & Green | synchronous 1 blink every 1 sec | Startup - Beeping, Not collecting data until ready. Idle - No Beeping, Not collecting data, Restart Req'd |
| Red Only | Repeat blink on/off sequence; on time is same as off time. Emits one series of 3 triple beeps. | Critical hardware error: <ul style="list-style-type: none"> Main supply voltage too high or too low Light source current too high or too low Light source feedback circuit error. |

2.6.7.2 Data File Status Codes

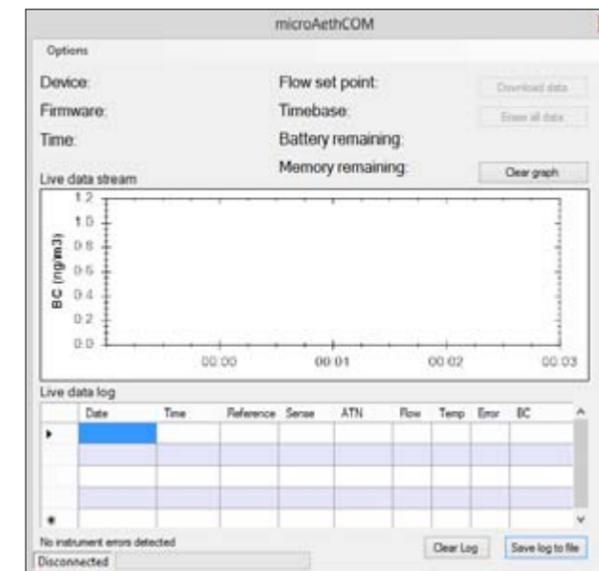
| Reported Status Code in Data File | Reason / Indication |
|-----------------------------------|--|
| 1 | Battery Low |
| 2 | Flow out of range |
| 4 | Change filter ticket / Sense signal out of range |
| 8 | Optical signal feedback out of range |
| 16 | Power supply 5V out of range |
| 32 | LED current out of range |
| 64 | Flash memory full |
| 128 | Automatic shutdown occurred on configured schedule |
| 0 | OK - Instrument operating within specifications |

NOTE: If more than one status error 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 battery is low (status code = 1) and the flow is out of range (status code = 2), the status code shown in the data file will be 3.

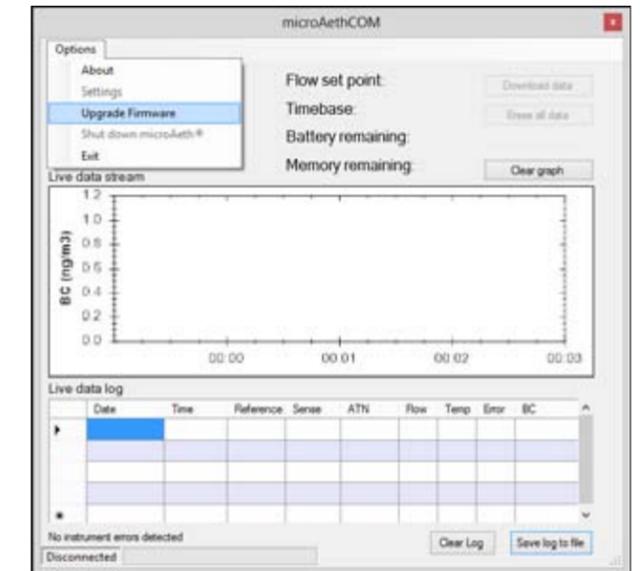
2.7 Upgrading microAeth AE51 Operating System Firmware

Before upgrading the microAeth AE51 operating system firmware, make sure that all data on the instrument has been downloaded. After the new firmware has been installed, the memory of the AE51 will need to be erased.

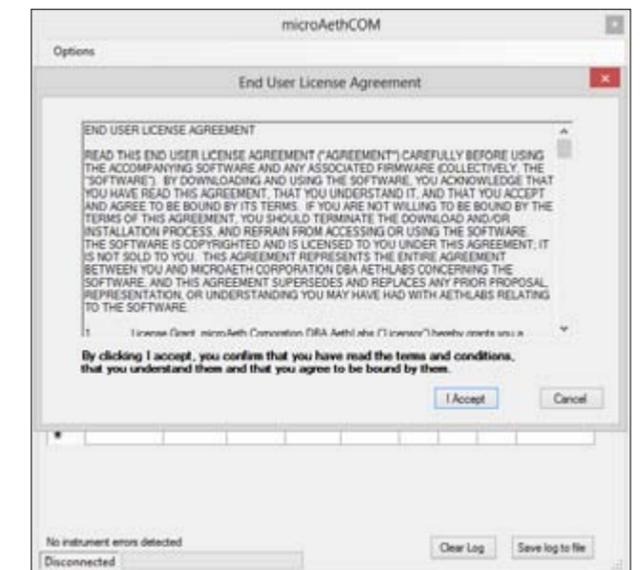
1. Start the microAethCOM software.
2. Connect the USB cable to the microAeth AE51 and the computer. **Do not turn on the microAeth AE51.** The microAethCOM software will show that the AE51 is Disconnected.



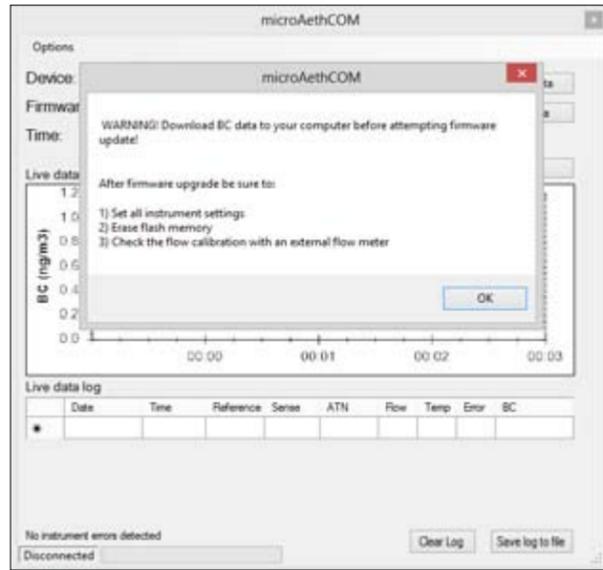
3. Click Options then Upgrade Firmware



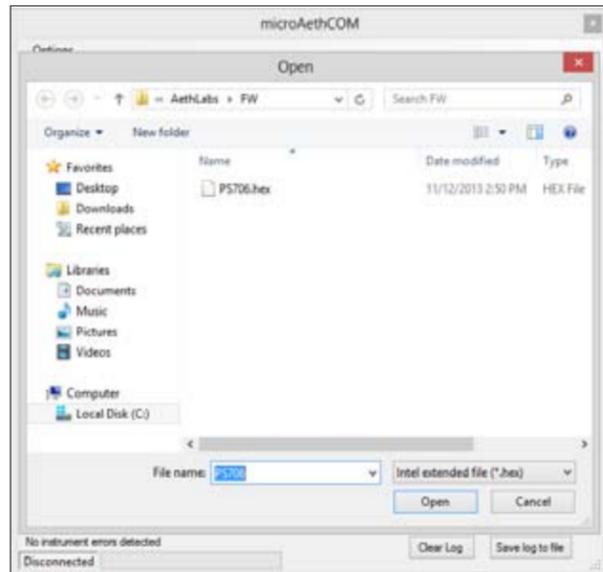
4. In order to install the firmware on the AE51, please read and accept the license agreement.



- A warning window will appear to make sure that all data on the device has been downloaded and to inform the user of what should be completed after the upgrade.



- Select the hex file PSxxx.hex where xxx refers to the version number to install on the AE51.



- When prompted, turn on the AE51 within 5 seconds.



- If the microAeth AE51 is not turned on within 5 seconds, the user will be told that the device did not respond. The user will have to close the window and start the firmware upgrade over again. If this occurs, go back to step 3.



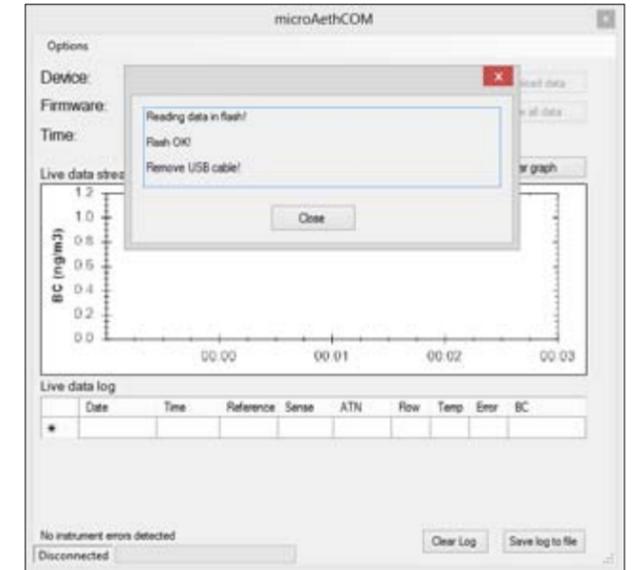
- If the microAeth AE51 is turned on within 5 seconds, the firmware installation will begin. The memory will be erased and the new firmware will be written to memory.



- Once the firmware has been installed, the microAethCOM software will check the memory for errors.



- If no errors are found, the firmware installation will complete and the user will be prompted to unplug the AE51.



- After a successful firmware upgrade, the following should be completed before using the microAeth AE51 for a new sampling session:

- Set all instrument settings.** Please read section 2.6.2 Configuration of Instrument Operating Parameters for more information.
- Erase all data on flash memory.** Please read section 2.6.4 Erasing Data for more information.
- Check the flow calibration with an external flowmeter.** Please read section 2.8 Flow Calibration Procedure for more information.

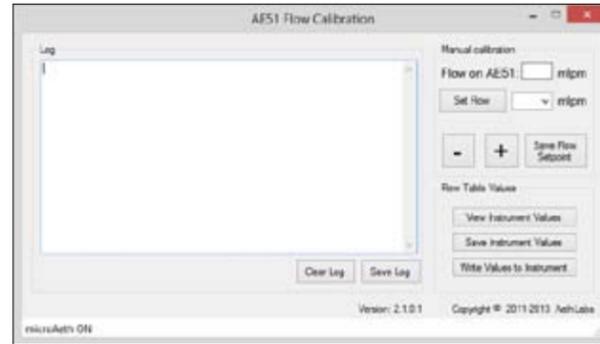
2.8 Manual Flow Calibration Procedure

In order to complete a manual flow calibration of the microAeth AE51, you will need to use the AE51 FlowCal software. The installation of the microAethCOM PC software automatically installs the AE51 FlowCal software into the directory chosen by the user during the installation process. Please read section 2.5 microAethCOM PC Software for more information about the installation process.

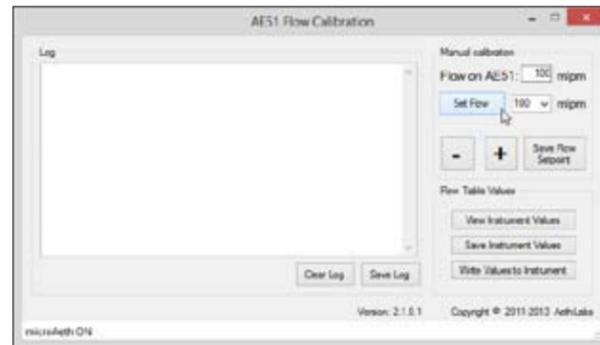
1. Install a clean, unused filter strip into the microAeth AE51. Please read section 2.3.2 Filter Strip Installation and Removal for more information.
NOTE: A pre-used filter strip with heavy loading may create an offset in the flow calibration table of the AE51.

2. Connect the external flowmeter to the inlet of the AE51.
3. Turn on the microAeth AE51 and the external flowmeter. Let the flowmeter stabilize for at least 10 minutes before use.
4. Start the AE51 FlowCal software.

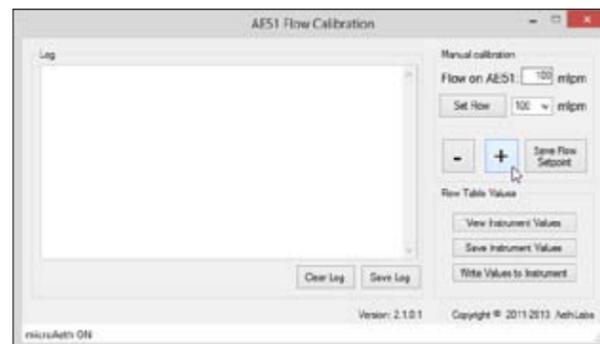
5. Connect the USB cable to the microAeth AE51 and the computer. Wait until the AE51 establishes communication with AE51 FlowCal software. The status bar in the bottom left corner of the software will show the connection status of the microAeth and AE51 FlowCal software. If the status bar does not show microAeth AE51 ON status, check your connections and ensure that communication with the AE51 has been initiated as previously described and disconnect the USB cable from the computer and reinsert it.



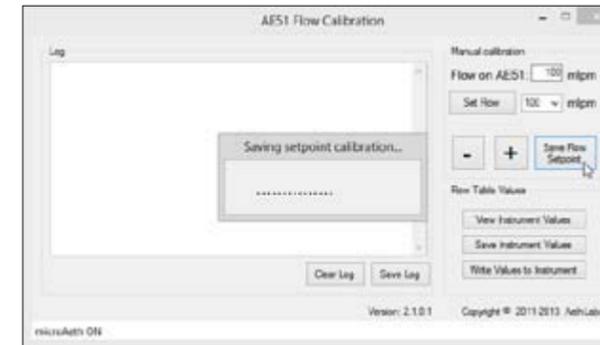
6. Select the flow setpoint to calibrate from the dropdown menu in the Manual calibration section of the software. Then click the Set Flow button.
7. The flow rate of the microAeth AE51 will change and the text box to the right of Flow on AE51: should be populated with the desired flow setpoint.



8. Use the + and - buttons to adjust the pump speed of the microAeth AE51 until the flow rate on the external flowmeter closely matches the selected flow setpoint in the software.



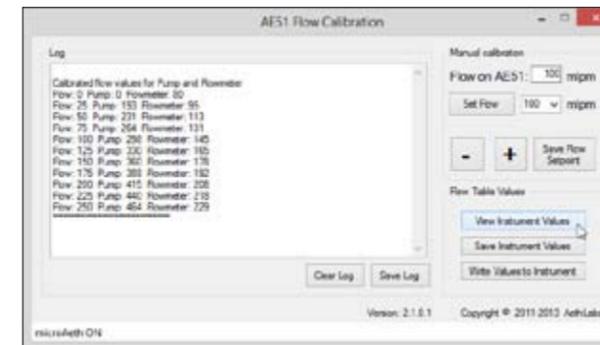
9. Then click the Save Flow Setpoint button to save the setpoint calibration in the microAeth AE51 flow calibration table stored in the instrument.



10. Repeat steps 6-9 for all flow setpoints in the dropdown menu in the Manual calibration section of the software.

NOTE: If the internal pump of the microAeth cannot reach the highest flow rate setpoint, contact AethLabs for further assistance.

11. Click the View Instrument Values button. This will display all the values of the flow calibration table.



12. Please check the values to make sure that as the flow setpoint increases from 0 to 250 ml/min, the pump drive and internal flowmeter values also increase. If this is not the case, please try again to calibrate the AE51. If this issue persists, please contact AethLabs for further assistance.

View Instrument Values

The View Instrument Values button requests the contents of the flow calibration table stored in the AE51.

The flow calibration table shows the pump drive values and internal flowmeter values for the specified flow setpoints.

VERY IMPORTANT: As the flow setpoint increases from 0 to 250 ml/min, the pump drive and internal flowmeter values should increase. If this is not the case, please try again to calibrate the AE51. If this issue persists, please contact AethLabs for further assistance.

Save Instrument Values

The Save Instrument Values button will prompt the user to select a location to save the flow calibration table file.

The flow calibration table values will be read from the AE51 and saved to a selected location where it can be kept for archival purposes and comparison, or can be retrieved and uploaded to the AE51 at a later time.

Write Values to Instrument

The Write Values to Instrument button will prompt the user to select a previously saved flow calibration table file for upload to the AE51.