UPAS users,

This quick start guide can help you understand the basic functions of the UPAS V2+ and how to start collecting samples. Visit our website for more information and/or to contact our team for help. Our team is here to make your air sampling experience easy and productive.

www.accsensors.com/airsampling

Please read all instructions before starting a UPAS sample.

The UPAS is available in two main configurations, the V2.0 and the V2+. This guide refers to the **UPAS V2+**

Feature	UPAS V2.0	UPAS V2+
Filter Sampler	X	X
PM-Inlet Generation Compatibility	Generation-1 (G1) and Generation-2 (G2)	Generation-1 (G1) and Generation-2 (G2)
Filter media size	37 mm	37 mm
GPS	X	X
PM sensor		X
CO² sensor		X
NOX and VOC sensor		X
Light sensor		X
Motion sensor		X
Image (no *Filter Cartridge* or *PM-Inlet* installed)		

The UPAS System consists of two components:

- ❑ A hardware component: can be worn in the subject's breathing zone or mounted on a tripod (not included) for general environmental testing
- ❑ A software component: The UPAS Bluetooth® interface allows programming via a mobile device and UPAS application (free to download)

Document Compatibility:

This guide is compatible with the following items specific to the UPAS V2+

- ❑ PM-Inlet Generation(s): *G1 and G2*
- ❑ UPAS V2+ Firmware: *Rev127 (UPAS_v2_x.NUCLEO_L476RG_RELEASE_20220603_rev127)*
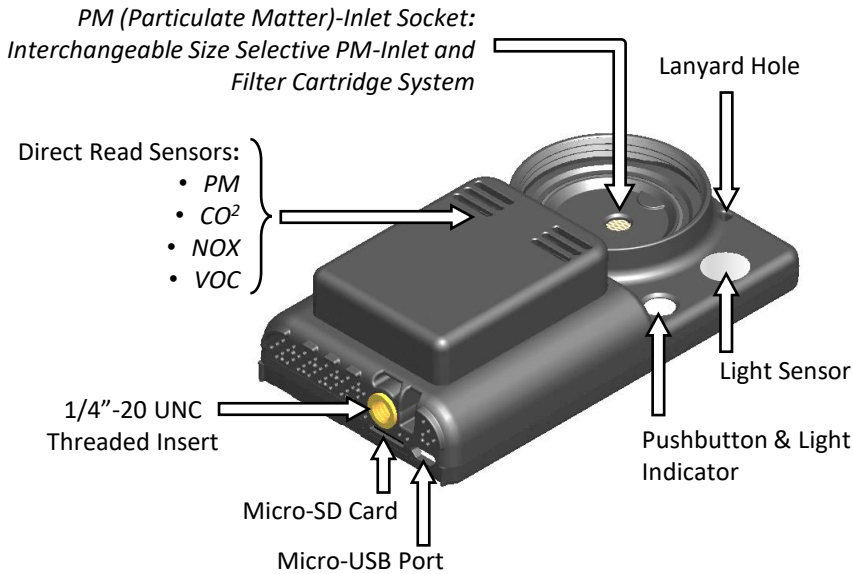- ❑ "AST UPAS" Mobile Device App: *Version 1.0.1, Build 1.0.3*

TABLE OF CONTENTS

I. UPAS V2+ INTRODUCTION

1. **UPAS V2+ Hardware Overview:** The sampler monitors air pollution by passing ambient air at a regulated flow rate through a size-selective inlet and a 37 mm filter inside of a cartridge. Additionally, the sampler has integrated **time-resolved PM, CO2, light, and motion (acceleration) sensing.**

PM (Particulate Matter)-Inlet Socket:
Interchangeable Size Selective PM-Inlet and Filter Cartridge System

Lanyard Hole

Direct Read Sensors:
- *PM*
- *CO²*
- *NOX*
- *VOC*

Light Sensor

1/4"-20 UNC Threaded Insert

Pushbutton & Light Indicator

Micro-SD Card

Micro-USB Port

> **IMPORTANT NOTES:**
> - ❑ **THE UPAS IS NOT WATERPROOF AND IS ONLY INTENDED FOR INDOOR USE.** Shield the UPAS from water, water spray, precipitation, etc.
> - ❑ **THERE ARE NO USER SERVICABLE PARTS INSIDE THE UPAS.** *Refer to Access Sensor Technologies for help*

2. What is included with my UPAS?
   a. Items included with each UPAS V2+
      i. *Micro-SD card*
      ii. *Micro-SD to SD card adapter*
      iii. *O-ring replacement for the PM-Inlet Socket (1x35mm Black)*
   b. Items included with each UPAS Filter Cartridge
      i. *O-ring replacement for the Upper Cartridge (1x35mm Black)*
   c. Items included with each PM-Inlet
      i. *O-ring replacement kit respective to the PM-Inlet type*
      ii. *Foam tipped cyclone cleaning swab*

TOP view of UPAS

BOTTOM view of UPAS

PM2.5-1LPM Inlet Filter & Filter Cartridge installed

Unique Serial ID Label

PSP00001

3. Optional UPAS Accessories Available
   a. Items available for the UPAS
      i. USB-A to micro-USB Cord
      ii. Wall Adapter (Type-B or Type-F) to USB-A
   b. Items available for PM-Inlets
      i. Flow Check (FC) Adapter - G1 or G2 specific
      ii. Inlet Installation Tool - G2 Only
      iii. Filter Cartridge Opening Tool - G2 Only

> **IMPORTANT NOTES:**
> ❑ **FULLY CHARGE THE UPAS BEFORE FIRST TIME USE**
> - *Charging hardware is not included with the UPAS (available for purchase)*
> - *Verify the charging hardware, including the cable and wall adapter, are rated to output at least **2 Amps***
> - *Connect the UPAS to power with a micro-USB to USB-A cord for approximately 4 hours*
> - *Failure to initially fully charge could lead to inaccurate battery percent state of charge (%SOC) readings*

4. Size Selective PM-Inlet System:

    a.   Each PM-Inlet System requires four main parts for filter sampling:
        i.   UPAS Pump
        ii.   Filter Cartridge
        iii.   Filter Media-37 mm
        iv.   PM-Inlet

    b.   There are two generations, Generation 1 (G1) and Generation 2 (G2), of PM-Inlet Systems

        i.   G1 and G2 Inlet Systems are compatible with the UPAS V2.0 and UPAS V2+.

        ii.   G1 and G2 parts are NOT cross compatible. Only use parts of like generation together.

PM-Inlet System Generations (DO NOT MIX)
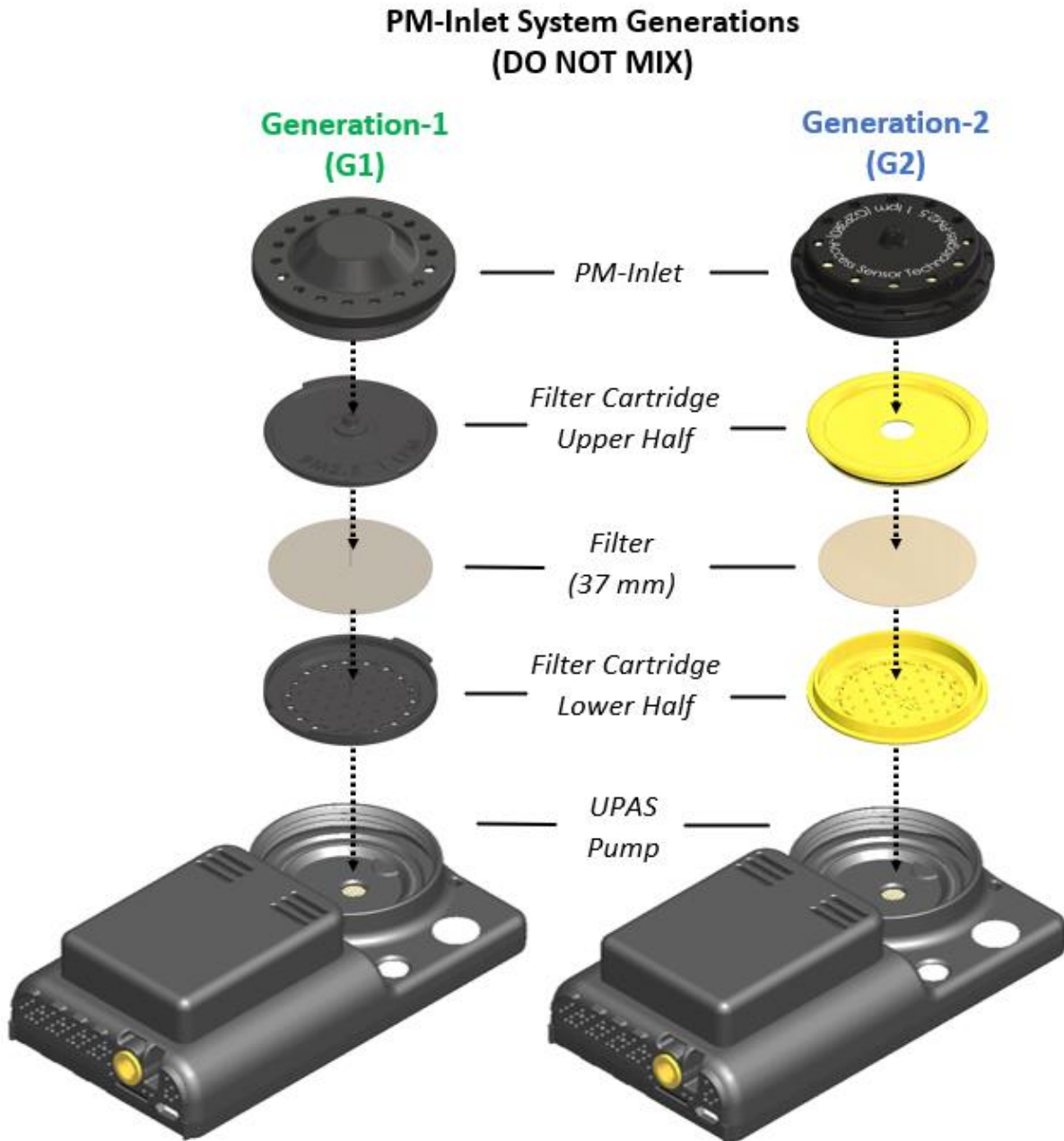
5. Filter Cartridge:

   a. The Filter Cartridge has two main parts: the Upper and Lower half.

   b. There are two generations of UPAS Filter Cartridge: Generation 1 (G1) and Generation 2 (G2).

      i. *G1 and G2 Filter Cartridges are compatible with 37-mm diameter filter media.*

      ii. *G1 and G2 Filter Cartridges are NOT cross compatible.*

Filter Cartridge- G1 (Generation 1)   **Filter Cartridge- G2** (Generation 2)

Filter Cartridge-Upper (1x35mm Black O-ring Installed)

Filter Media-37mm diameter

Filter Cartridge-Lower

   c. Each Lower Cartridge has a unique three-digit alphanumeric and corresponding QR code that can be entered in the App, and then automatically stored in the log file (see later sections).

Filter Cartridge-Lower

Unique 3-digit Alphanumeric
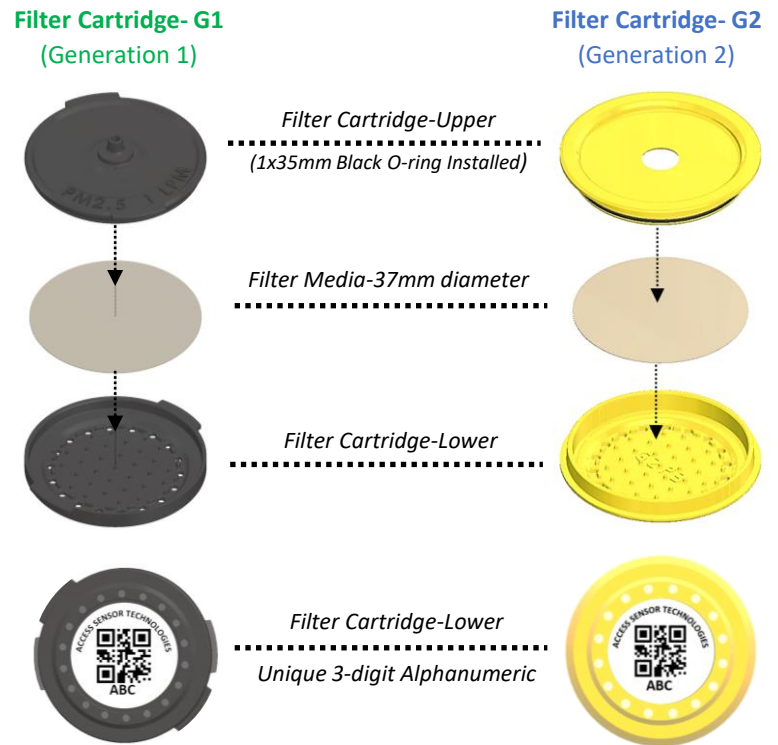
   d. Opening the Filter Cartridge

      i. G1: use the offset tabs to gently separate the Upper and Lower with your fingers

      ii. G2: Use the Filter Cartridge Opening Tool to separate the Upper and Lower. Alternatively, use the flanges on the Upper and Lower Cartridge to separate the halves with your fingers

Filter Cartridge- G1 (Generation 1)   **Filter Cartridge- G2** (Generation 2)

Offset Tabs

Insert

Twist

Filter Cartridge Opening Tool (G2 Only)
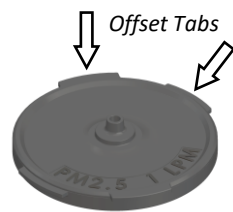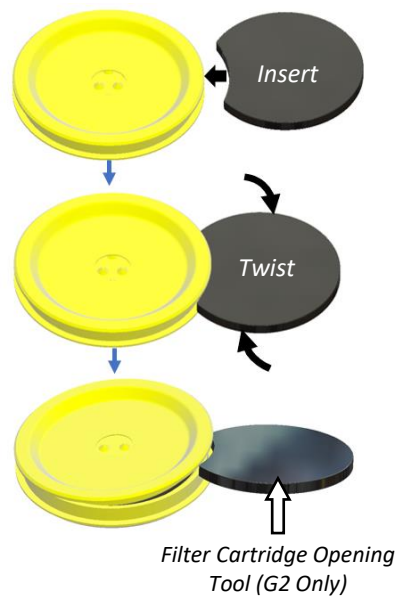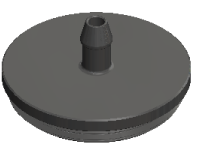
I. UPAS V2+ INTRODUCTION (continued)

6. Available Size-Selective PM-Inlet Systems:

    a. Each *PM-Inlet* is assembled with two main parts: the *Cap* (aluminum) and the *Insert* (plastic).

    b. The table below shows the compatibility of parts, separated by PM-Inlet generation (G1 or G2).

    c. Each G2 PM-Inlet is engraved with the PM Size Cut and Flow Rate specific to the inlet .

IMPORTANT NOTE:
G1 and G2 PM-Inlet and Filter Cartridge pieces are NOT cross compatible

	Filter Cartridge (37 mm filter)	PM-Inlet Size Cut (Flow Rate)				Flow Check (FC) Adapter
		PM2.5 (1LPM)	PM2.5 (2LPM)	Respirable (2LPM)	Thoracic & PM10 (2LPM)	
G2 PM-Inlet System	+					+
G1 PM-Inlet System	+		Not available for G1			or

7. Flow Check (FC) Adapter:

    a. The Flow Check (FC) Adapter is not included with the PM-Inlets. However, it is recommended for all users that need to perform flow rate calibration with a primary flow rate meter.

    b. There are two generations of FC-Adapters: Generation-1 (G1) and Generation-2 (G2)

        i. *G1 and G2 FC Adapters are NOT cross compatible*

        ii. *G1 and G2 FC Adapters are only compatible with parts of like Generation.*
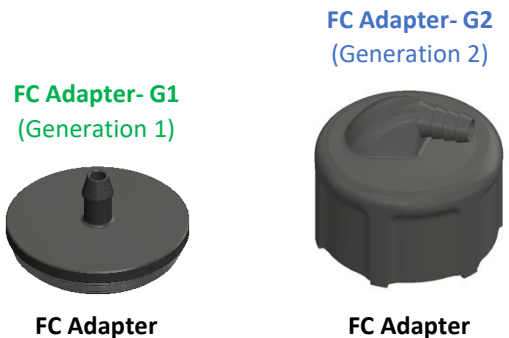
    c. FC Adapter O-ring Inspection

        i. *G1: On the bottom of the FC-Adapter, make sure the O-ring (Brown, 1x20mm) is pressed evenly in the O-ring groove and in good condition.*

        ii. *G2: On the inside of the FC-Adapter, near the alignment feet, make sure the O-ring (Black, 1.5x43 mm) is pressed evenly in the O-ring groove and in good condition.*
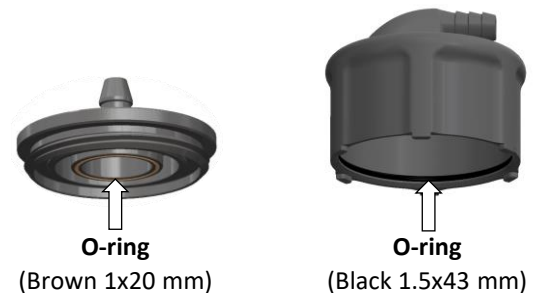
    d. Tubing compatible with the FC Adapter

        i. Material: Flexible Tubing (Tygon, Viton, Silicone, etc.)

        ii. G1: Tube ID = 1/4", Wall thickness = 1/16" or larger

        iii. G2: Tube ID = 1/4", Wall thickness = 1/16" to 3/32"

FC Adapter- G1
(Generation 1)

FC Adapter

FC Adapter- G2
(Generation 2)

FC Adapter

O-ring
(Brown 1x20 mm)

O-ring
(Black 1.5x43 mm)

I. UPAS V2+ INTRODUCTION (continued)

8. Filter Media and the UPAS:
   a. The UPAS Filter Cartridge is only intended for use with 37mm diameter filter media.
   b. The filter media, pre-sample, and post-sample analysis are not provided by AST.
   c. Information specific to the types of filter media tested with the UPAS can be found in the table below.

General Gravimetric analysis	Dissolvable (for chemical Analysis)	Scannable via XREF EDS, etc.	Microscopy Analysis	Biological Sampling	Relative Flow Resistance (lower means longer UPAS battery life)	Manufacturer	Product Family	Product ID	Filter Media Material Type	Filter Media Pore Size (μm)	Support Ring Material
+	–	+	+	+	1.0	Tisch Scientific	PTFE	SF17382	PTFE (Teflon) membrane	5.0	none
+	–	+	+	+	1.2	GE Lifesciences Whatman	TE 38	10411108	PTFE (Teflon) membrane	5.0	none
+	–	+	+	+	1.3	Pall Laboratory	Teflo	R2PJ037	PTFE (Teflon) membrane	2.0	PMP Ring
+	–	+	+	+	1.7	Measurement Technology Laboratories (MTL)	PTFE	PT37P-PF03	PTFE (Teflon) membrane	2.0	FEP Ring
+	±	+	+	+	4.2	SKC	PVC	225-5-37	PVC membrane	5.0	none
+	–	+	–	–	5.0	Pall Laboratory	Tissuquartz	2500QAT-UP	Quartz fiber (unbonded)	-	none
+	–	+	–	–	5.1	Pall Laboratory	EMFAB	TX40HI20WW-37 mm	Borosilicate microfiber w/ woven glass, PTFE bonded	-	none
+	–	+	+	+	6.6	Pall Laboratory	Zefluor	P5PJ037	PTFE (Teflon) membrane	2.0	PTFE Ring
±	+	+	+	+	10.0	SKC	MCE	225-1938	Mixed cellulose ester (MCE) membrane	5.0	none
±	+	+	+	+	16.2	SKC	MCE	225-1939	Mixed cellulose ester (MCE) membrane	0.8	none
±	+	+	+	+	16.2	SKC	MCE	225-334	Mixed cellulose ester (MCE) membrane	0.8	none
±	+	+	+	+	17.7	EMD Millipore	MF	AAWP03700	Mixed cellulose ester (MCE) membrane	0.8	none
±	+	+	+	+	19.0	GE Lifesciences Whatman	ME27	10400909	Mixed cellulose ester (MCE) membrane	0.8	none

+ means typical use, ± means optional use, – means not typically used.

APPLICATION NOTE:
The achievable sample duration of the UPAS, determined by the capacity of the internal battery, is related to the relative resistance of the filter media being used. A lower relative filter resistance is correlated to a longer achievable sampled duration. Other factors in the sampling environment can also influence the achievable sample duration (e.g., PM concentration in the sampling environment)

II.   PART INSPECTION AND CLEANING

1. Recommendations before every UPAS sample:

    a. Clean and inspect all parts intended for use in the sample. This includes the UPAS pump, the PM-Inlet System, and Filter Cartridge.

    b. Make sure the following are clean, in place, and in good condition. If you are missing or need to replace any parts, check the spare part kit included with the UPAS, or contact AST to receive a replacement.

2. UPAS V2+ Pump Inspection and Cleaning:

    a. Locate the O-ring, 1x35mm black, on the inside of the UPAS PM-Inlet Socket. To clean the O-ring and PM-Inlet Socket, leave the O-ring installed and use a wipe wetted with water, or isopropyl alcohol (IPA), to clean the surface and threads. Do not expose the center of the Inlet socket to moisture of any kind.

O-ring 1x35mm Black

    b. Inspect the Inlet and Outlet of the PM, CO2, Light and Motion sensor to make sure it is free of debris. You can use a swab wetted with water to clean the Inlet and Outlet slots. Do not press the swab into the slots all the way. Only clean the openings.

Only clean the openings, do not insert the swab further into the cavity of the Inlet or Outlet

INLET

OUTLET
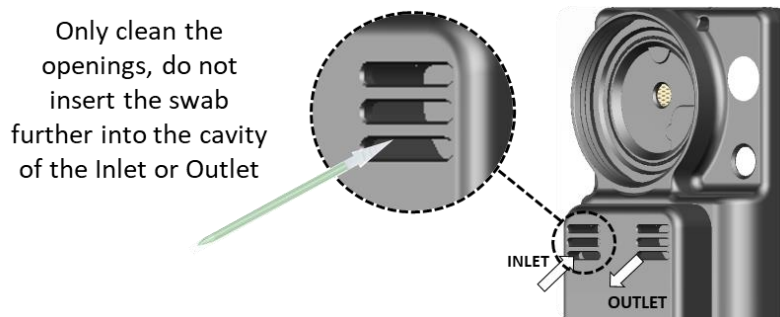
3. Filter Cartridge Inspection and Cleaning:

    a. Locate the O-ring, 1x35mm black, installed in the *Filter Cartridge Upper. T*o clean the *Filter Cartridge Upper* and *Lower*, use a mild detergent and water, these parts can be fully submerged. Alternatively, wipe the parts with isopropyl alcohol, or ethanol

G1-Filter Cartridge Upper   **G2-Filter Cartridge Upper**

O-Ring: 1x35mm Black
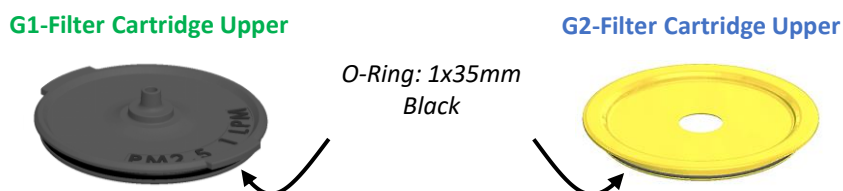
4.   PM-Inlet Inspection and Cleaning:

   a.   Removing the Insert from the Cap

   i.   *G1 PM-Inlets: To remove the plastic Insert from the aluminum Cap use a small flathead-screwdriver or tweezers. Insert the screwdriver or tweezers between the Cap and the Insert from the bottom side of the PM-Inlet, and gently pry the Insert out.*

   ii.   *G2 PM-Inlets: To remove the plastic Insert from the aluminum Cap, firmly tap the assembled PM-Inlet on a flat surface until the Insert releases from the Cap. The Respirable Insert has an Upper and Lower piece. Pull them apart with the outermost flanges. Alternatively, insert and embossing stylus (narrow neck with a 2mm ball tip) into the PM-Inlet Cap holes from the top, and evenly press out the Insert from the Cap. Press through multiple holes from the top of the Cap to ease removal.*

   b.   Locate the O-ring(s) in the PM-Inlet Insert. See the O-ring(s) specific to each PM-Inlet part in the figure below. To clean the PM-Inlet Cap and Insert parts, use mild detergent and water. These parts can be fully submerged. Alternatively, wipe the parts with IPA, or ethanol.
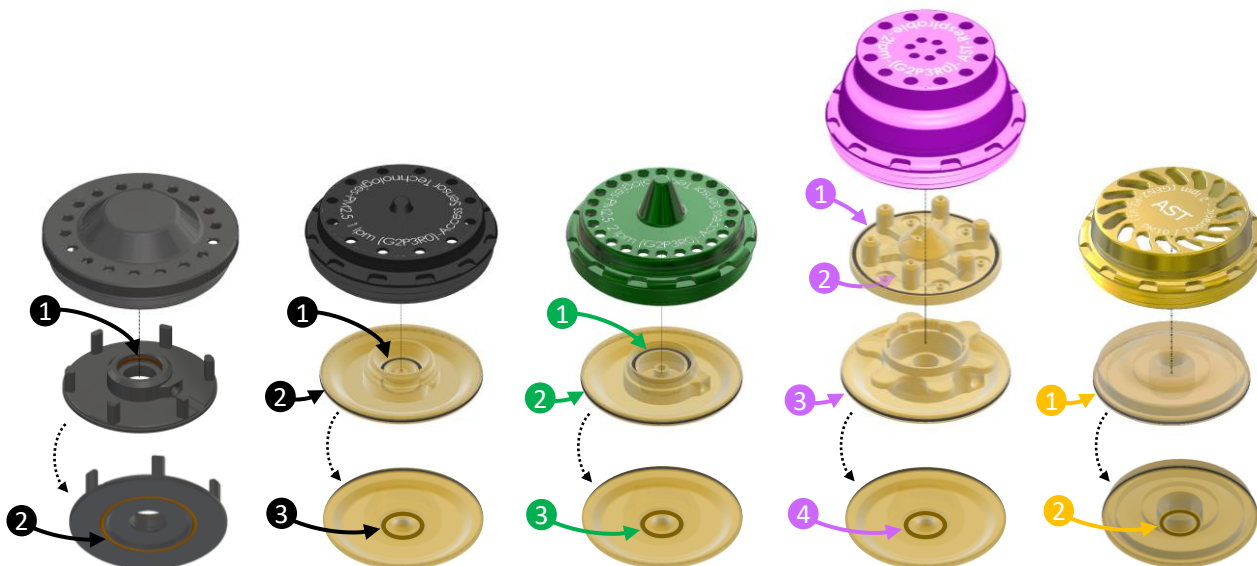
Generation	G1	G2	G2	G2	G2
PM-Inlet	2.5-1LPM	2.5-1LPM	2.5-2LPM	Respirable-2LPM	PM10/Thoracic-2LPM
O-RING 1	1x10mm Brown	1x9mm Black	1x14mm Black	1x35mm Black	1x39mm Black
2	1x20mm Brown	1x39mm Black	1x39mm Black	1x20mm Black	1x9mm Brown
3	-	1x9mm Brown	1x9mm Brown	1x39mm Black	-
4	-	-	-	1x9mm Brown	-

5. PM-Inlet Inspection and Cleaning (continued):

    c. PM-Inlet Cap: with the PM-Inlet Cap and Insert separated, make sure the holes in the Cap, the underside of the Cap, and the cyclone cone (for applicable Inlets) are all free of debris. To clean the PM-Inlet Cap(s), use a mild detergent and water, these parts can be fully submerged. Alternatively, wipe the parts with IPA, or ethanol

|	
PM2.5-1LPM (G1) Cap	
PM2.5-1LPM (G2) Cap	
PM2.5-2LPM (G2) Cap	
Respirable-2LPM (G2) Cap	
PM10/Thoracic-2LPM (G2) Cap	
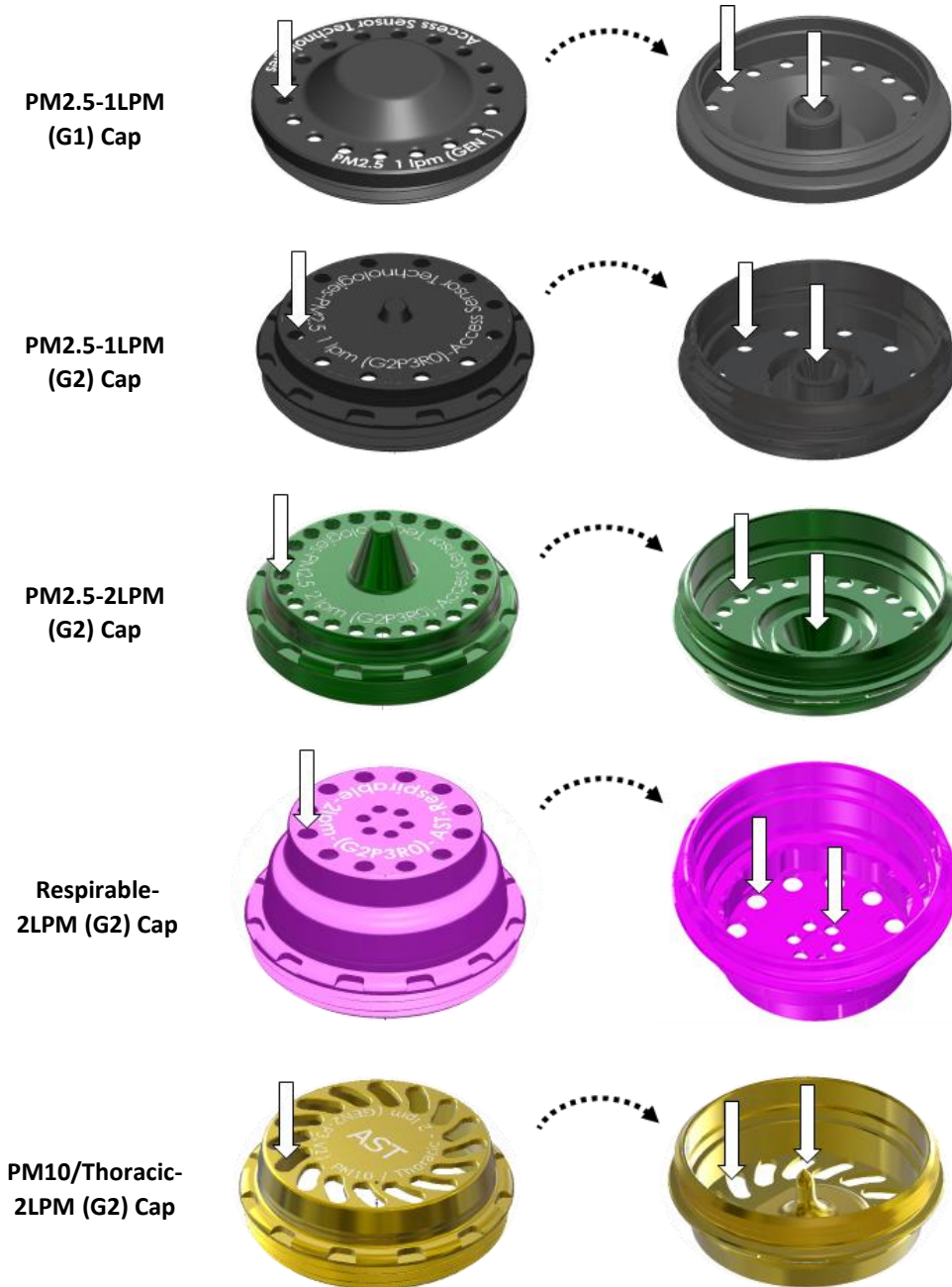
5. PM-Inlet Inspection and Cleaning (continued):

    d. PM-Inlet Insert: use a conical swab wetted with water, isopropyl alcohol, or ethanol, to clean out the features of the PM-Inlet Insert(s).

        i. For all PM-Inlets these features include the cyclone **body**, **inlet**, and **outlet**.

        ii. Additionally, for the Respirable-2LPM Insert Upper and Lower, gently insert and twist a conical swab into the following hole features. Do this from the top and bottom of the piece. Visually inspect the holes to make sure they are clear of debris.

            o Insert Upper: the four holes on top of the raised columns (red arrows)

            o Insert Upper: the six holes on the main flange (black arrows)

            o Insert Upper: the two holes in the cyclone cone (yellow arrows)

            o Insert Lower: wipe off the six impaction platforms (black arrows)
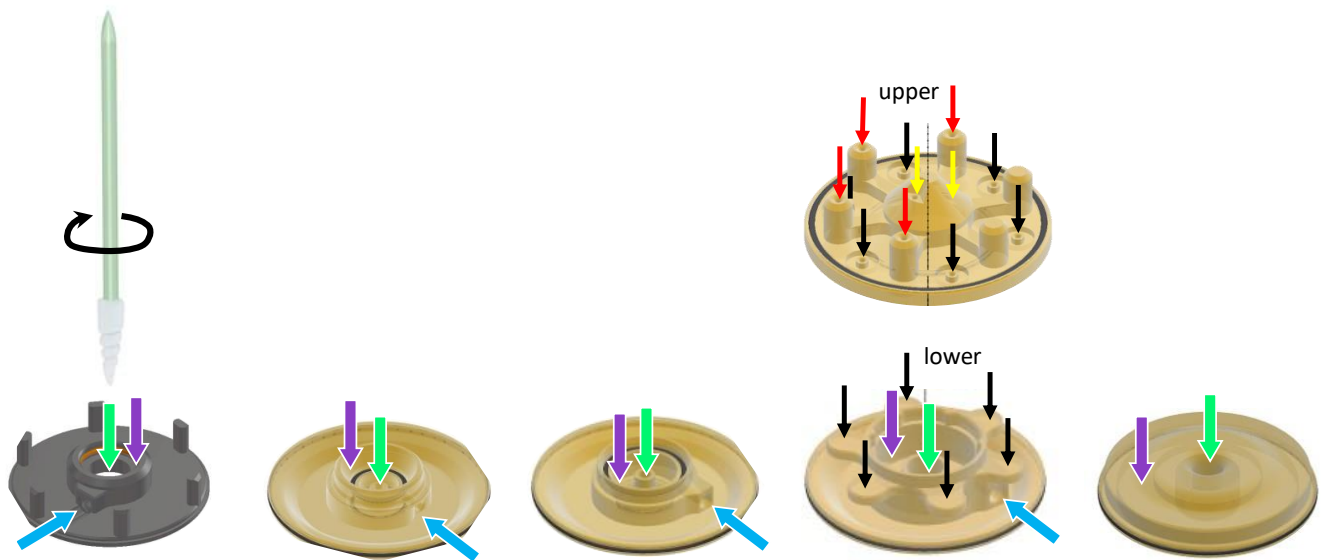
Generation	G1	G2	G2	G2	G2
PM-Inlet Insert	2.5-1LPM	2.5-1LPM	2.5-2LPM	Respirable-2LPM	PM10/Thoracic-2LPM

    e. After detailed cleaning, the user can wash the Cap and Insert with water and a mild detergent. Alternatively, the user can wipe each component down with water, isopropyl alcohol, or ethanol.

    f. Let all parts fully dry before reassembling the PM inlet pieces. Make sure no O-rings were lost during the cleaning process.

6.   Assemble the PM-Inlet Insert into the Cap

    a. G1 PM2.5-1LPM: *with a twist and press motion, install the Insert into the Cap until it snaps into place.*
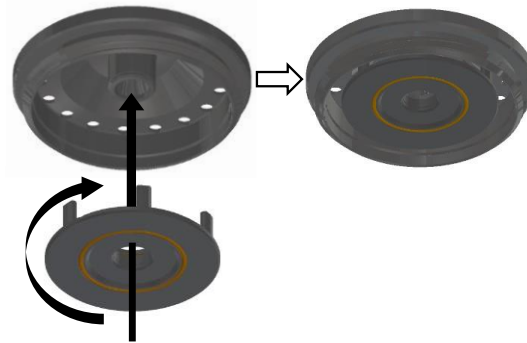
    b. G2 PM2.5-1LPM (black), G2 PM2.5-2LPM (green), G2 PM10/Thoracic-2LPM (gold): *evenly press the Insert into the Cap until it stops and is self retained in the Cap.*

    c. G2 Respirable-2LPM Insert subassembly: *reassemble the Insert Upper and Lower, index the notches and grooves, then press the upper and lower together. Install the Insert assembly into the Cap, align the holes of the Cap with the raised columns of the Insert Upper, and press evenly together.*

Top view of Insert Lower

Side view of Insert Upper and Lower

Bottom view of Insert Upper
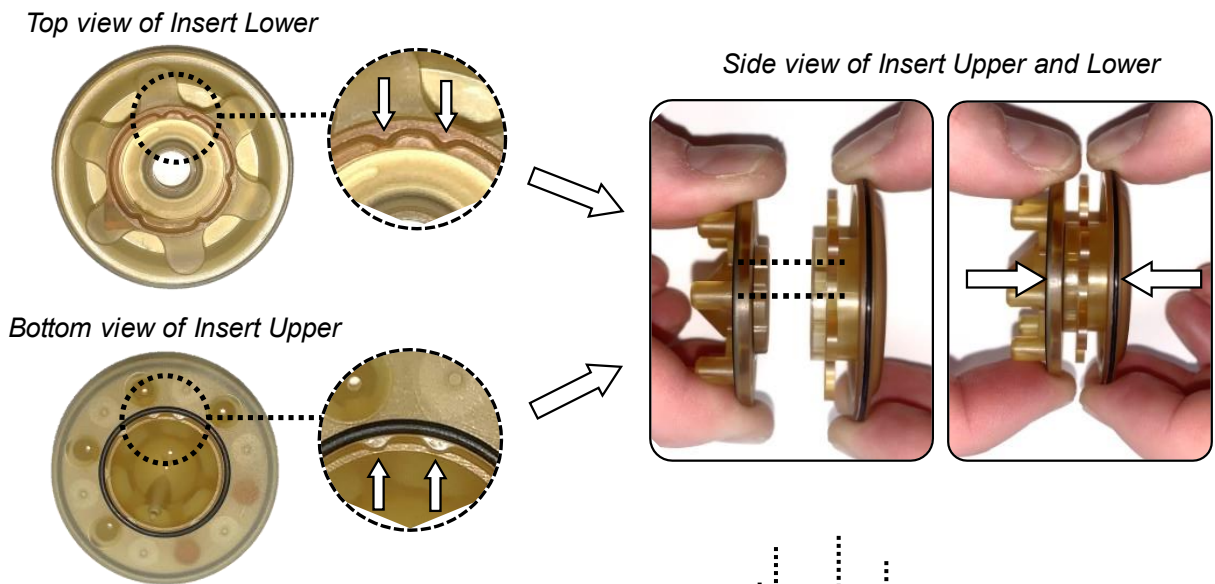
    d. G2 Respirable-2LPM: *Install the Insert subassembly into the Cap. Align the holes of the Cap with the raised columns of the Insert Upper, and press evenly together.*
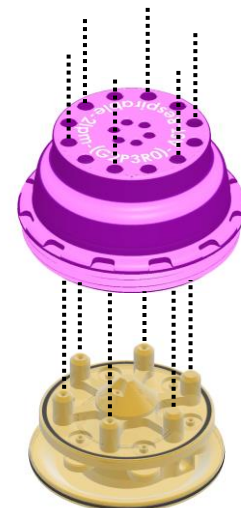
III. PRIMARY FLOW RATE METER AND THE UPAS

1. Flow Rate Meter Compatibility: If you plan to perform flow rate calibration of the UPAS relative to a primary flow rate meter, make sure the model is compatible with the UPAS. If you already have a flow rate meter, the AST team is happy to review the part number and determine compatibility with the UPAS.

2. Flow Rate Meter Requirements: any primary flow rate meter with acceptable accuracy that does not pose significant flow restriction (e.g., low pressure drop models are recommended) and does not use a moving piston in its measurement may be used with the UPAS. Flow meters that work well are listed below.

   a. Recommended Flow Rate Meter

      i. Alicat Scientific MW (line powered) or MWB (battery powered) low-pressure-drop mass flow meter.

      ii. This flow meter is used at AST and is the primary recommendation for use with the UPAS.

MWB Low Pressure Drop Portable Gas Mass Flow Meter
Recommended Model: MWB-5SLPM-D
*This portable (battery powered) model is preferred for use in the field.
https://www.alicat.com/models/mwb-low-pressure-drop-portable-gas-mass-flow-meters/

MW Low-Pressure Drop Gas Mass Flow Meter
Recommended Model: MW-5SLPM-D
https://www.alicat.com/models/mw-low-pressure-drop-gas-mass-flow-meters/

   iii. *AST recommends adding the following components to the Alicat Flow Meter to prevent damage to the meter and the UPAS. Components **A, C, D, E, F** can be found at most general hardware stores or online from vendors such as Amazon. The filter, component **B**, can be ordered at www.etafilters.com. Use Teflon tape on all threads to prevent leaks in the flow path.*

ID	Description
A	Adapter for 3/8" Hose ID, 3/8" NPT Male
B	HC10-4N-PTF - HEPA Capsule Filter, Inline Filter (www.etafilters.com)
C	90 Degree Elbow Adapter, 3/8" NPT Female x Male
D	Bushing Adapter with Hex Body, 3/8 Male x 1/8 Female NPT
E	Straight Connector, 1/8 NPT Male
F	Adapter for 3/8" Hose ID, 1/8 NPT Male

   b. Alternate Primary Flow Rate Meter(s):

BGI tetraCal Air Flow Calibrator
Recommended Model: tetraCal Air Flow Calibrator
https://bgi.mesalabs.com/tetracal-air-flow-calibrator/

A.P. Buck Bubble Flow Meter
Recommended Model: mini-BUCK Calibrator M-30B or mini-BUCK Calibrator M-30
https://bgi.mesalabs.com/tetracal-air-flow-calibrator/

IV.   UPAS SOFTWARE OVERVIEW

1. UPAS Firmware Introduction:
   a. If you are using a new UPAS, the current firmware revision will already be installed on the UPAS.
   b. If you are working with a used UPAS, follow the instructions below to verify the firmware version and update if needed.
      i. *Location 1: When connected to the "AST UPAS" App, the firmware revision number can be found in the header section of the Main Menu.*
      ii. *Location 2: The firmware revision can be found in the header section of any UPAS log file.*
   c. If the firmware revision is not current, update it per the instructions below.

2. Update the UPAS Firmware: Follow the instructions below to download and install the current UPAS V2+ Firmware.
   a. Click on the link and download the Firmware file to your local computer storage: Rev127 Link (firmware file name: *UPAS_v2_x.NUCLEO_L476RG_RELEASE_20220603_rev127)*
   b. Connect the UPAS to a computer using a USB-A to micro-USB cable.
   c. Power ON the UPAS. Press and hold the pushbutton until the computer recognizes the device "DAPLINK(D)," and then release the pushbutton.
   d. Drag and drop or copy and paste the firmware file onto the device. Approve any permissions, and wait for the process to complete (~30 seconds).
   e. Power the UPAS OFF, then Back ON.
   f. Disconnect the USB cable from the computer and UPAS.
   g. Follow the instructions in Step 1.b. to verify the firmware was successfully installed.

3. "AST UPAS" Mobile Device App Introduction:
   a. The UPAS V2+ is configured using a mobile device and free App: AST UPAS.
   b. The mobile device is not included with the UPAS V2+.
   c. The UPAS V2+ App is available for IOS mobile devices only (Android coming soon).
   d. The UPAS V2+ and UPAS V2.0 require different Apps for programming samples.

4. Install the "AST UPAS" App:
   a. On the IOS mobile device, visit the Apple App Store and search for "AST UPAS". Install the App to your mobile device.
   b. Enable Bluetooth on your mobile device.

AST UPAS

V. UPAS SAMPLE CONFIGURATION AND THE MOBILE DEVICE APP

1. Pushbutton and Light Indicator
   a. **Power ON:** Press and hold the pushbutton for 5 seconds until the UPAS light shows BLUE, then release the pushbutton.
   b. **Power OFF:** Press and hold the pushbutton for 5 seconds until the UPAS light turns off.
   c. **Power Cycle:** Power the UPAS OFF, then ON.

PRESS AND HOLD for 5 seconds

ON
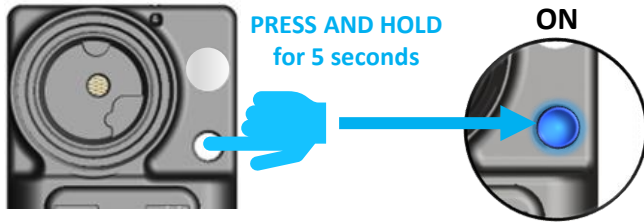
> **IMPORTANT NOTES:**
> - *Before starting a UPAS sample, ensure the filter, Filter Cartridge, and PM-Inlet are installed in the UPAS.*
> - *Running the UPAS pumps without these parts installed could cause damage.*

2. Startup Pushbutton Light Sequence

   a. When powered ON, the UPAS will automatically progress through a sequence of checks before the user can connect to the UPAS with the mobile device App.

Startup Pushbutton Light Sequence (Rev127 firmware)

Sequence	Pushbutton Light Indicator	Significance
a. UPAS powering ON	(B) , (G)	Firmware is initiating
b. Battery State of Charge (%SOC) status	(B, B, B, B, G)	100% (SOC)
	(B, B, B, B)	~70% (SOC)*
	(B, B, B)	~40% (SOC)*
	(B, B)	~20% (SOC)*
c. Micro SD card installation status	(Solid ORANGE)	SD card is properly installed.
	OR (Blinking ORANGE)	SD card is *NOT* installed.
d. GPS status	(B, P)	GPS signal is available
	OR (Flashing P)	GPS signal is NOT available**

*Charge the UPAS battery before starting a sample.

** Place the UPAS outside for 5-15 minutes until the light is solid PINK before trying to connect with the App.

Light Key: BLUE = (B), GREEN = (G), PINK = (P), ORANGE = (O)

3. Connect to a UPAS with the "AST UPAS" App:

NOT PAIRED WITH UPAS
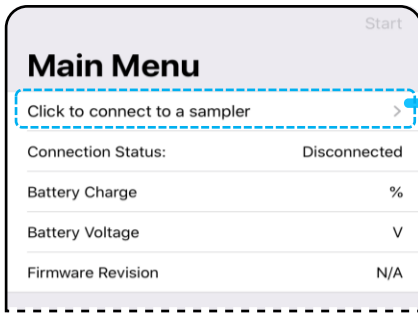
a. Select "Click to connect to a sampler". The App will direct to a new screen and automatically start "*Scanning"* for UPAS available to connect (Solid Pink LED). The user can also manually "Scan" at any time with the button in the top right corner.
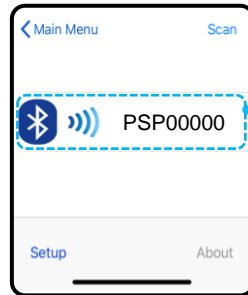
b. Select the UPAS ID to pair and program for a sample. If more than one UPAS are available, all will appear on the screen to choose from. The App can only connect to one UPAS at a time.

c. When successfully paired, the "Connection Status" in the Main Menu will update to reflect the UPAS Serial ID, and the UPAS light will turn from solid PINK to solid BLUE.
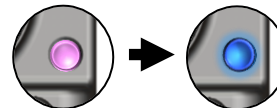
NOT PAIRED → **PAIRED**

4. App Main Menu Overview:

PAIRED WITH UPAS

Press "START" after configuring the sample.

Click to disconnect from the current UPAS and return to the "Scan" screen.

The connection status shows the UPAS Serial ID when connected.

Battery percent state of charge (SOC%)

Battery Voltage (V)

Current Firmware Revision running on the UPAS

Click here to enter a unique "*Sample Name*" up to 15 characters (or scan QR Code)

Click here to enter the "*Cartridge ID*" up to 10 characters (or scan QR Code)

Program when the sample starts (*Now*, *At Next Power On*, or *Set Date/Time*)

Program the sample duration (*Indefinite* or *Set Duration*)

Set the flow rate based on the "*Filter Inlet*" (*No Flow Sample* or preset for PM inlets)

Check the flow rate with a primary meter and adjust the offset

Set the "Duty Cycle" (DC) to sample a fraction of a 30 second interval (100% DC = continuous pumping)

Set the PM sensor operation state (*Off*, *Continuous*, or intervals from 2-15 minutes)

Toggle the "CO2 Sensor" operation state ON or OFF during the sample

Calibrate the CO2 Sensor and view the date of the last CO2 Sensor Calibration

Toggle the "VOC/NOx Sensor" operation state ON or OFF during the sample

Toggle the "*GPS*" operation state ON or OFF during the sample

Toggle the "LED" operation state ON or OFF during the sample

Toggle the "Power Save" operation state ON or OFF during the sample

Set the "*Log Interval*" to write to the SD card every 1 second or every 30 seconds

Select the "About" tab to verify the App Version and Build

> **IMPORTANT NOTE:**
> *Before starting a sample run, make sure the filter, Filter Cartridge, and PM Inlet Cap are installed into the UPAS. Running the filter sample pumps without these parts installed could cause damage to the UPAS.*

5. Program the Sample Parameters

PAIRED WITH UPAS
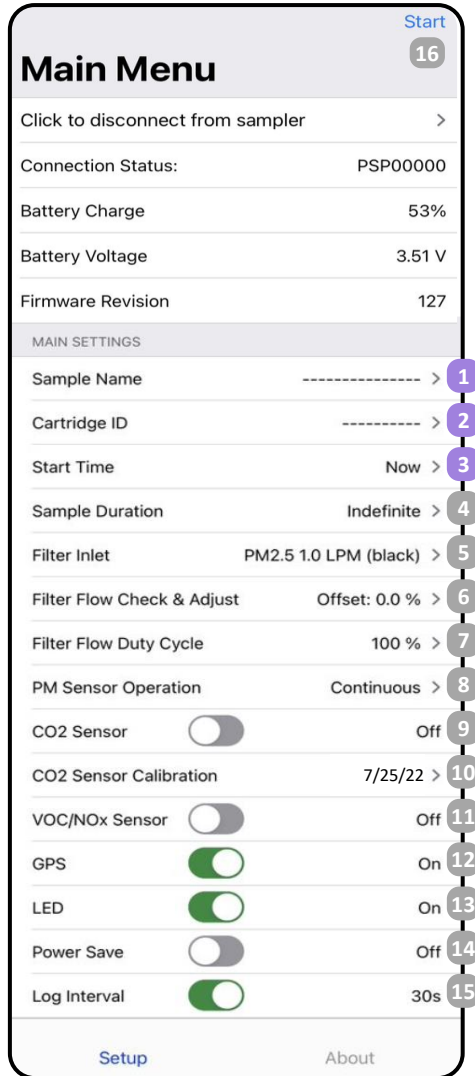
SAMPLE IDENTIFICATION SETTINGS

1 **Sample Name:**
When selected, the user will be directed to a screen where the "Sample Name" is entered. The user can enter text up to 15 characters, excluding "\" and "/", using the keyboard or by scanning a QR code. The "Sample Name" becomes part of the log file name and is also recorded within the log file.
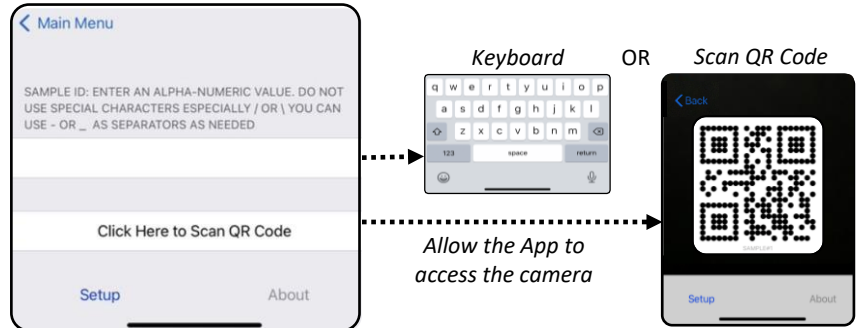
2 **Cartridge ID:**
When selected, the user will be directed to a screen where the "Cartridge ID" is entered. The user can enter text up to 10 characters, excluding "\" and "/", using the keyboard, or scan a QR code. Each UPAS Filter Cartridge has a unique 3 digit alphanumeric that can be entered or scanned. The "Sample Name" becomes part of the log file name and is also recorded within the log file.
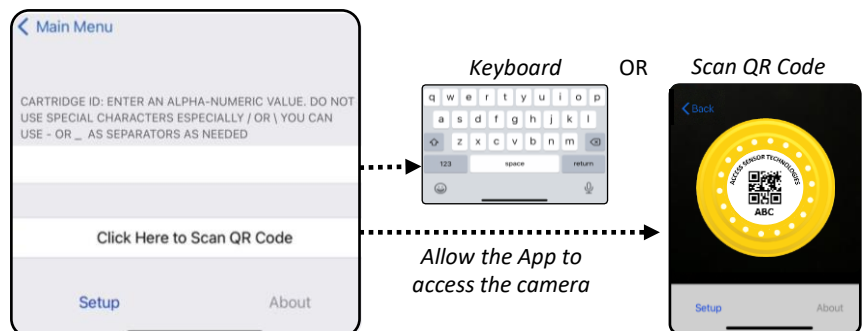
TEMPORAL SAMPLE SETTINGS

3 **Start Date/Time:**
When selected, the user will be directed to a screen with three options for "Start Date/Time" pertaining to the UPAS sample. When the "Start" button is selected from the *Main Menu*, each option will have the following effect:
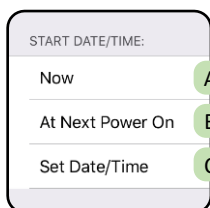
A **Now:** Sample starts immediately.

B **At Next Power On:** The UPAS light will turn off, then the sample starts automatically next time the UPAS is powered ON by holding the pushbutton for 5 seconds. There is no further user interaction needed, wait up to 30 seconds for the pumps and sample to start.

> **APPLICATION NOTE:** *This feature allows the UPAS to be programmed before deployment, only requiring the in-field user to Power-ON the UPAS with the pushbutton to start the pre-programmed sample (the mobile device used to program the UPAS is not needed after starting the sample). This feature can save time in the field and reduce risk of programming error.*

C **Set Date/Time:** The UPAS light will flash BLUE until the start date/time are due. The sample will start automatically with all pre-programmed settings in place.

> **APPLICATION NOTE:** *This feature allows multiple UPAS to be programmed before deployment, then the UPAS will automatically wake up and start sampling at the pre-programmed date and time. When multiple samples are programmed to start at the same date, this method provides temporal syncing.*

PAIRED WITH UPAS

Main Menu

	Start 16
Click to disconnect from sampler	>
Connection Status:	PSP00000
Battery Charge	53%
Battery Voltage	3.51 V
Firmware Revision	127

MAIN SETTINGS

Sample Name	-------------- >	1
Cartridge ID	---------- >	2
Start Time	Now >	3
Sample Duration	Indefinite >	4
Filter Inlet	PM2.5 1.0 LPM (black) >	5
Filter Flow Check & Adjust	Offset: 0.0 % >	6
Filter Flow Duty Cycle	100 % >	7
PM Sensor Operation	Continuous >	8
CO2 Sensor	Off	9
CO2 Sensor Calibration	7/25/22 >	10
VOC/NOx Sensor	Off	11
GPS	On	12
LED	On	13
Power Save	Off	14
Log Interval	30s	15

Setup	About

SAMPLE SETTINGS - continued

4 **Sample Duration:**
When selected, the user will be directed to a screen with two options for the "Sample Duration". When the "Start" button is selected from the Main Menu, each option will have the following effect:

SAMPLE DURATION

Indefinite — A

Set Duration — B

A **Indefinite:** The sample will run until the user manually stops it by powering the UPAS OFF with the pushbutton or the battery is depleted (2.8 V = depleted battery).

B **Set Duration:** The sample will run for the set duration of time and then automatically power OFF when the sample duration has expired.

PM-INLET PARAMETERS

5 **Filter Inlet:**
When selected, the user will be directed to the screen below where the "Filter Inlet" can be selected. Each PM Inlet System is designed to operate at a specific flow rate to achieve the correct PM size selectivity. There are five options that correspond to the following flow rate setpoints.

No Flow Sample	A
PM2.5 1.0 LPM (black)	B
PM2.5 2.0 LPM (green)	C
PM10 2.0 LPM (gold)	D
Respirable 2.0 LPM (purple)	E
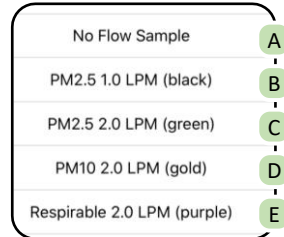
A The UPAS will not pump air through the PM-Inlet during the sample and will not collect PM onto the filter media

B OR PM 2.5-1.0 LPM Inlet (black)

C PM 2.5-2.0 LPM Inlet (green)

D PM 10-2.0 LPM Inlet (gold)

E Respirable-2.0 LPM Inlet (purple)

PAIRED WITH UPAS

Main Menu

	Start
	16
Click to disconnect from sampler	>
Connection Status:	PSP00000
Battery Charge	53%
Battery Voltage	3.51 V
Firmware Revision	127

MAIN SETTINGS

Sample Name	--------------- >	1
Cartridge ID	---------- >	2
Start Time	Now >	3
Sample Duration	Indefinite >	4
Filter Inlet	PM2.5 1.0 LPM (black) >	5
Filter Flow Check & Adjust	Offset: 0.0 % >	6
Filter Flow Duty Cycle	100 % >	7
PM Sensor Operation	Continuous >	8
CO2 Sensor	Off	9
CO2 Sensor Calibration	7/25/22 >	10
VOC/NOx Sensor	Off	11
GPS	On	12
LED	On	13
Power Save	Off	14
Log Interval	30s	15

Setup   About

FILTER SAMPLE SETTINGS

6 **Filter Flow Check & Adjust:**
When selected, the user will be directed to a new screen to test and adjust the flow offset if needed. To achieve high accuracy volumetric flow rate relative to a primary flow rate meter, use this feature. Measure the flow rate through the PM Inlet System then adjust in real time using the offset. This process is referred to as Pre-Sample Flow Rate Calibration.

FILTER FLOW CHECK & ADJUST: CONNECT UPAS TO EXTERNAL FLOW METER (NON PISTON-TYPE) AND ACTIVATE FLOW BELOW. WAIT >15S FOR FLOW TO STABILIZE AND READ FLOW METER VALUE, AND ADJUST FLOW OFFSET AS NEEDED. WHEN SATISFIED, ENTER FINAL FLOW METER VALUE AND EXIT

Activate Flow   N/A   **A**

Flow Offset Adjustment (real-time)

–3.0 %
–2.0 %
–1.0 %
0.0 %   **B**
1.0 %
2.0 %
3.0 %

Enter Final Flow Meter Value (LPM)

LPM   **C**

UPAS with filter, Filter Cartridge, PM Inlet, and Flow Adapter Installed

HEPA

Primary flow rate meter example: Alicat MWB-5SLPM model (HEPA Filter installed to protect meter and UPAS)

A i. "Activate Flow" through the PM-Inlet by toggling the switch to ON. The UPAS will start pumping and targeting the flow rate corresponding to the selected PM-Inlet. The UPAS will not log data to the SD card during the "Filter Flow Check & Adjust".

Flow Initializing = Blinking RED (R)

i. The UPAS light will flash RED to indicate the flow is initializing. The LED will flash green intermittently with RED as the UPAS approaches the target flow rate.

ii. The UPAS light will be solid GREEN when the flow rate has reached the target and is stable. Wait more that 15 seconds.

BEFORE FLOW OFFSET ADJUSTMENT

Flow Stable = Solid GREEN (G)

NEEDS FLOW OFFSET

B i. When the flow is stable, compare the flow rate (LPM) on the primary meter to the preset target flow rate. In this example the target flow ra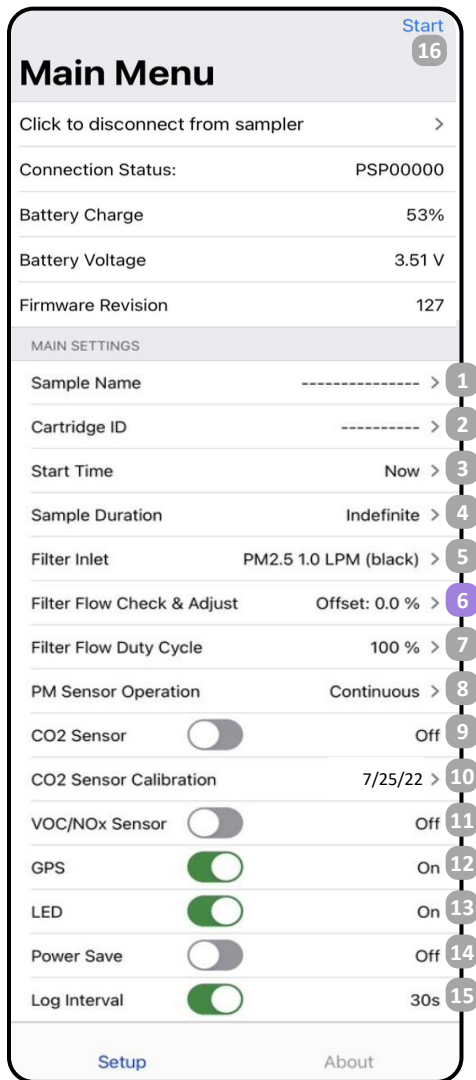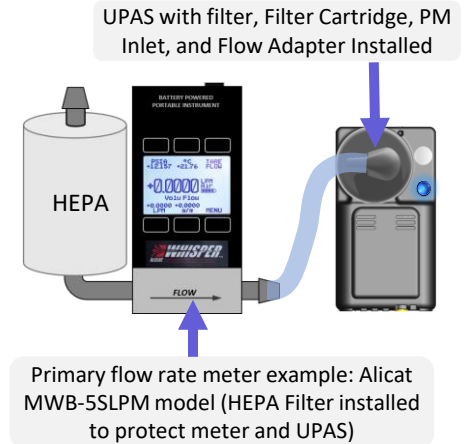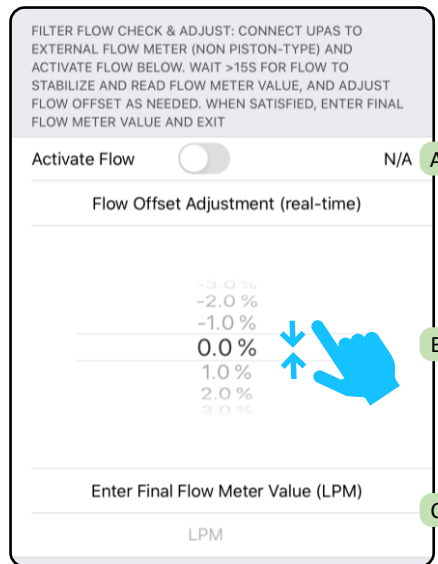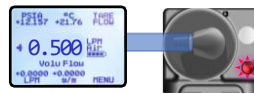te is 1.0 LPM and the Flow Offset % needed is approximately -2.0%. Use this equation to predict the Flow Offset % needed.

ii. Adjust the Flow Offset (%) to reduce the error between the primary meter and the internal flow rate of the UPAS. In this example, the Flow Offset would be set to -2.0%. When adjusted, the UPAS pumps will pause momentarily, then restart with the new flow offset in place. Wait for the UPAS flow rate to stabilize, indicated by the solid Green LED on the UPAS.

iii. Repeat this step as many times as needed until the flow rate error is minimized.

Flow Offset Approximation:

$$\text{Offset (\%)} = \frac{(Target\ LPM - Measured\ LPM)}{Target\ LPM}(100)$$

Flow Stable = Solid GREEN (G)

GOOD (Flow Offset = -2%)

The Primary Flow Rate meter matches the target flow rate of the UPAS with the Flow Offset % in place.

AFTER FLOW OFFSET ADJUSTMENT

C Enter the Final Flow Meter Value (LPM) into the box at the bottom of the screen, this represents the pre-sample flow rate measurement. Deactivate flow with the toggle at the top of the screen or return to the Main Menu. Remove the Calibration Adapter from the UPAS. Reinstall the PM-Inlet for the G1 PM-Inlet System. The Final Flow Meter Value (LPM) will be stored in the UPAS Log File. If the method requires a post-sample flow rate measurement, record it outside of the log file (by hand). The process for post-sample flow rate calibration is described in Step VII (pg. 23).

PAIRED WITH UPAS

Main Menu

Start
16

Click to disconnect from sampler	>
Connection Status:	PSP00000
Battery Charge	53%
Battery Voltage	3.51 V
Firmware Revision	127
MAIN SETTINGS	
Sample Name	--------------- > **1**
Cartridge ID	---------- > **2**
Start Time	Now > **3**
Sample Duration	Indefinite > **4**
Filter Inlet	PM2.5 1.0 LPM (black) > **5**
Filter Flow Check & Adjust	Offset: 0.0 % > **6**
Filter Flow Duty Cycle	100 % > **7**
PM Sensor Operation	Continuous > **8**
CO2 Sensor	⬤ Off **9**
CO2 Sensor Calibration	7/25/22 > **10**
VOC/NOx Sensor	⬤ Off **11**
GPS	⬤ On **12**
LED	⬤ On **13**
Power Save	⬤ Off **14**
Log Interval	⬤ 30s **15**
Setup	About

‹ Main Menu

PM SENSOR OPERATION

Off
Continuous
2 Min Interval
3 Min Interval
4 Min Interval

FILTER SAMPLE SETTINGS (continued)

7 **Duty Cycle:**
When selected, the user will be directed to a screen to select the filter duty cycle. Use the duty cycle to set the pumps to sample a fraction of a *30 second interval*. 13% to 100% duty cycle options are available.

‹ Main Menu

DUTY CYCLE

90%
93%
96%
100%

a. **Duty Cycle (DC) Examples:**

i. 100% Duty Cycle will pump continuously for the duration of the sample.

ii. 50% Duty Cycle will pump for 15 seconds, then go idle for 15 seconds. This will repeat for the duration of the sample.

b. **Duty Cycle Calculation:**

$$Pump\ Time\ ON\ in\ 30\ second\ interval$$
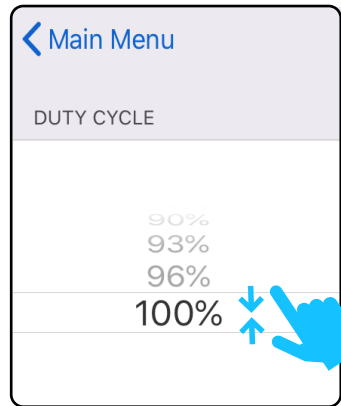$$= 30\ s\ \left(\frac{Duty\ Cycle\ \%}{100}\right)$$

*Round up to the nearest second

c. ***Example for 15% Duty Cycle***

$$= 30\ s\ \left(\frac{15\%}{100}\right)$$
$$= 4.5\ seconds\ Pumps\ ON, 25.5\ seconds$$
$$pumps\ OFF, then\ repeat$$

APPLICATION NOTE:

Duty Cycle can be used to extend the achievable sample duration with respect to UPAS battery capacity and filter loading.

PM SENSOR SETTINGS

8 **PM Sensor Operation:**
When selected, the user will be directed to a screen to select the operation mode of the PM sensor. The real time PM sensing module attached to the front body of the UPAS can be controlled using this setting. See the diagram to understand the UPAS V2+ flow paths.
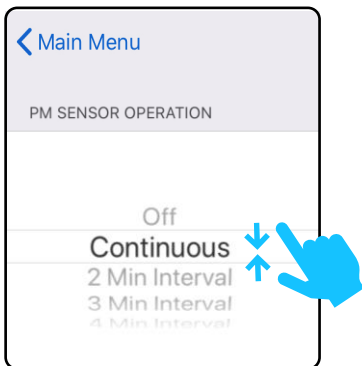
a. **Off:** PM Sensor disabled

b. **Continuous:** PM Sensor will continuously output a value at the logging frequency

c. **2-15 Min Interval:** PM Sensor operates intermittently (e.g., 5 = 30-s warm-up, followed by 30-s measurement, followed by 4-minute sleep period

d. **15s-5s-10s Interval:** 15-s warm-up, followed by 5-s measurement, followed by 10-s sleep period

e. **15s-5s-40s Interval:** 15-s warm-up, followed by 5-s measurement, followed by 40-s sleep period

f. **20s-10s-30s Interval:** 20-s warm-up, followed by 10-s measurement, followed by 30-s sleep period

Filter
Cartridge
PM-Inlet with Filter   UPAS V2+

FLOW PATH 1:
PM on Filter
IN

FLOW PATH 2:
PM Sensing

INLET **OUTLET**

OUT
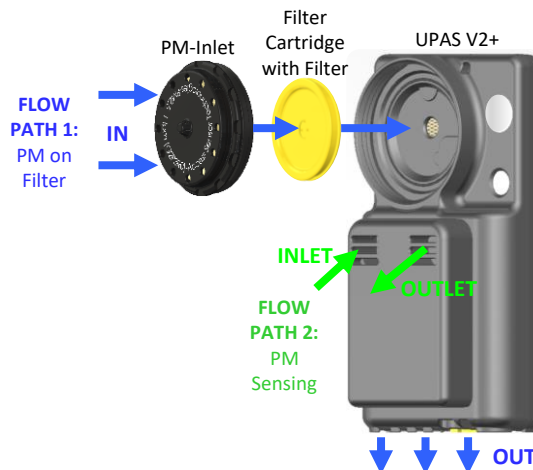
APPLICATION NOTE:
FLOW PATH 1 and 2 are independent of each other. No filtering occurs in FLOW PATH 2. The air at the outlet of FLOW PATH 1 is filtered. Make sure all inlets and outlets remain unblocked while sampling.

18

PAIRED WITH UPAS

Main Menu   Start
                                                      16

Click to disconnect from sampler	>
Connection Status:	PSP00000
Battery Charge	53%
Battery Voltage	3.51 V
Firmware Revision	127

MAIN SETTINGS

Sample Name	--------------- >	**1**
Cartridge ID	---------- >	**2**
Start Time	Now >	**3**
Sample Duration	Indefinite >	**4**
Filter Inlet	PM2.5 1.0 LPM (black) >	**5**
Filter Flow Check & Adjust	Offset: 0.0 % >	**6**
Filter Flow Duty Cycle	100 % >	**7**
PM Sensor Operation	Continuous >	**8**
CO2 Sensor	Off	**9**
CO2 Sensor Calibration	7/25/22 >	**10**
VOC/NOx Sensor	Off	**11**
GPS	On	**12**
LED	On	**13**
Power Save	Off	**14**
Log Interval	30s	**15**

Setup   About

GAS SENSOR SETTINGS

If the UPAS V2+ in use has Gas Sensing, the user can individually turn the gas sensors ON or OFF during the sample. These features will be greyed out in the App if the UPAS V2+ in use does not have Gas Sensing.

9 **CO2 Sensor:** ON or OFF
  a.   Gas Sensor Information
         Manufacturer: Sensirion
         Part Number: SCD-41
         SCD-41 Datasheet

11 **VOC/NOx Sensor:** ON or OFF
  a.   Gas Sensor Information:
         Manufacturer: Sensirion
         Part Number: SGP-41
         SGP-41 Datasheet

‹ Main Menu

CO2 SENSOR CALIBRATION: PLACE UPAS OUTDOORS (KEEP AT LEAST 10 FEET OR 3 METERS FROM CO2 SOURCES INCLUDING PEOPLE) OR IN A CHAMBER WITH KNOWN STABLE CO2 CONCENTRATION. IF THE CO2 CONCENTRATION IS KNOWN, USE THE PICKER TO SELECT THE CO2 CONCENTRATION OTHERWISE THE DEFAULT VALUE OF 417 PPM. WHEN READY TAP THE "CALIBRATE" ROW TO START THE CALIBRATION AND LEAVE THE UPAS FOR 15 MINUTES. AFTER THE CALIBRATION IS COMPLETE THE UPAS WILL AUTOMATICALLY SHUTOFF. CALIBRATION DATE, CALIBRATION CO2 TARGET, AND REQUIRED OFFSET ARE DISPLAYED IN THE LOG HEADER OF EACH SAMPLE.

Target CO2 Concentration (ppm)

414
415
416
417
418
419
420

Calibrate

Setup   About

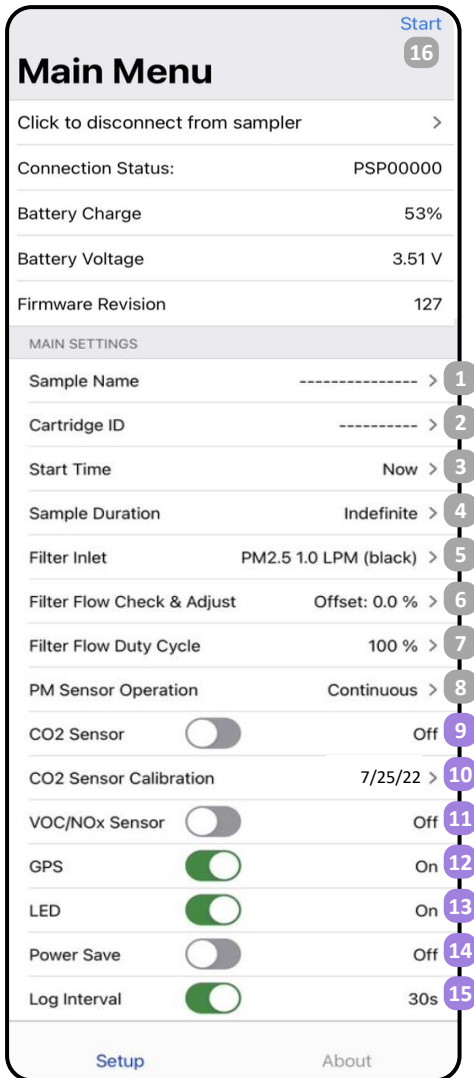**10** **CO2 Sensor Calibration:**

When selected, the user will be directed to a screen to configure and start the CO2 Sensor Calibration. It is recommended to calibrate the CO2 Sensor within 1-week of the sample start time. Calibrate the CO2 Sensor closer to the sample start time for best results.

  a.   Place the UPAS outdoors at least 10 feet (3 Meters) away from CO2 sources for the whole calibration. For example, people. Alternatively, the calibration can be done in a chamber with known and stable CO2 concentrations.

  b.   The default *"Target CO2 Concentration (ppm)"* is 417. If the CO2 concentration is known, select it from the options.

  c.   When ready, select "Calibrate. The UPAS light will flash ORANGE.

  d.   Leave the UPAS for 15 minutes.

  e.   After the calibration is complete, the UPAS will automatically power OFF (light off).

  f.   The CO2 Calibration Date, Target CO2 Concentration, and required offset will be stored in the header of the log file.
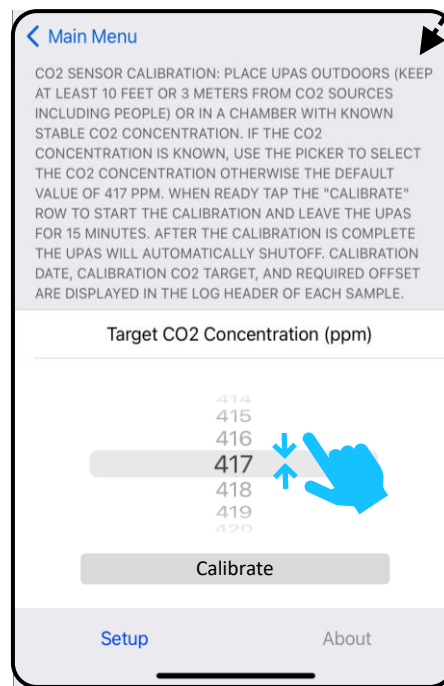
OTHER SETTINGS

12 **GPS:** ON or OFF

Toggles the GPS receiver in the UPAS ON or OFF during the sample. When ON, the UPAS writes GPS location data to the log file at the logging frequency. When OFF, the UPAS does not log GPS location data.

  a.   GPS is not available when the UPAS is indoors.

  b.   If the GPS is OFF, the UPAS battery will support a longer sample run.

13 **LED:** ON or OFF

Turn the UPAS light ON or OFF during the sample. This option defaults to ON at each power cycle and App reconnection. Please note, if the indicator light is turned OFF, the user may miss status indications during the sample

14 **Power Save:** ON or OFF

In power-save mode with the GPS turned off, the PM Sensor Operation mode will automatically be set to "15 Min Interval" between 9 PM and 4 AM local time.

15 **Log Interval:** 1s or 30s

Set the write frequency of the UPAS to the log file during the sample. 30 second and 1 second log interval options are available via the toggle.

VI.   CONFIGURE THE UPAS FOR A SAMPLE

1. Install the filter media into the Filter Cartridge

   a.   Separate the Upper and Lower half of the Filter Cartridge.

   b.   Use tweezers to place the filter media, 37mm diameter, in the center of the Filter Cartridge Lower (see application note below).

   c.   Place the Filter Cartridge Upper on top of the filter media, and evenly press the Upper and Lower halves together.

   d.   Make sure the O-ring in the Upper Filter Cartridge is not pulled out of the grove when the halves are pressed together.
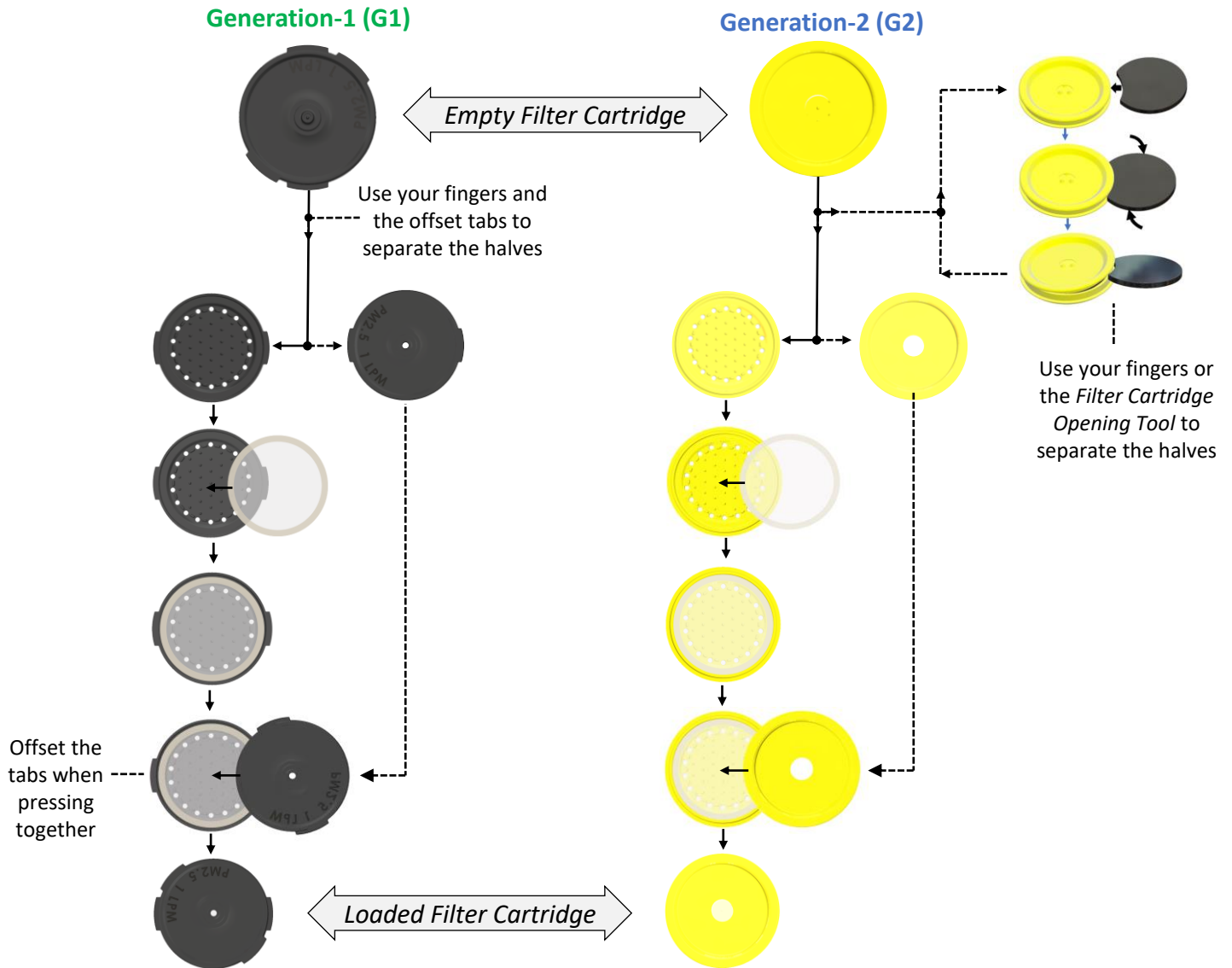

APPLICATION NOTE:
Alternatively, if the filter analysis requires a pre sample measurement (i.e. gravimetric weight), contact your local lab to arrange installation of the filters directly into the UPAS Filter Cartridge per the instructions above. After the sample is complete, the lab may also be able to remove the sample filter from the UPAS Filter Cartridge for direct analysis. This method may reduce the risk of sample collection error if the lab can accommodate the use of the UPAS Filter Cartridge.

VI. CONFIGURE THE UPAS FOR A SAMPLE (continue)

2. Install the micro-SD card:

   a. On the the bottom of the UPAS, locate the micro-SD card slot. Gently press and release the SD card using a coin, paperclip, or fingernail. When successfully installed, the SD card should not extrude past the housing.

3. Install the Loaded Filter Cartridge in the UPAS:

   a. If you plan to enter the filter cartridge alphanumeric in the UPAS App, do this now.

   b. Place the loaded Filter Cartridge in the center of the UPAS Inlet Socket. Ensure the QR code is facing down.
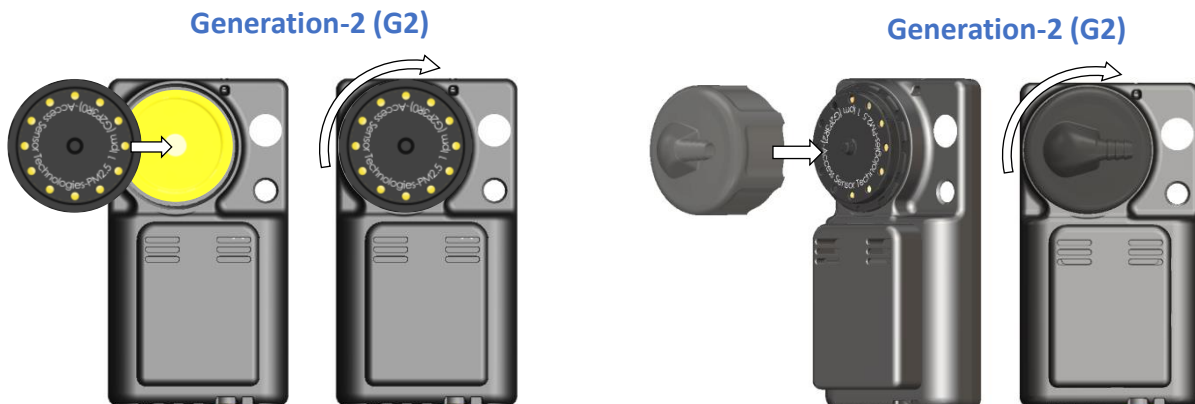
Generation-1 (G1)

Generation-2 (G2)
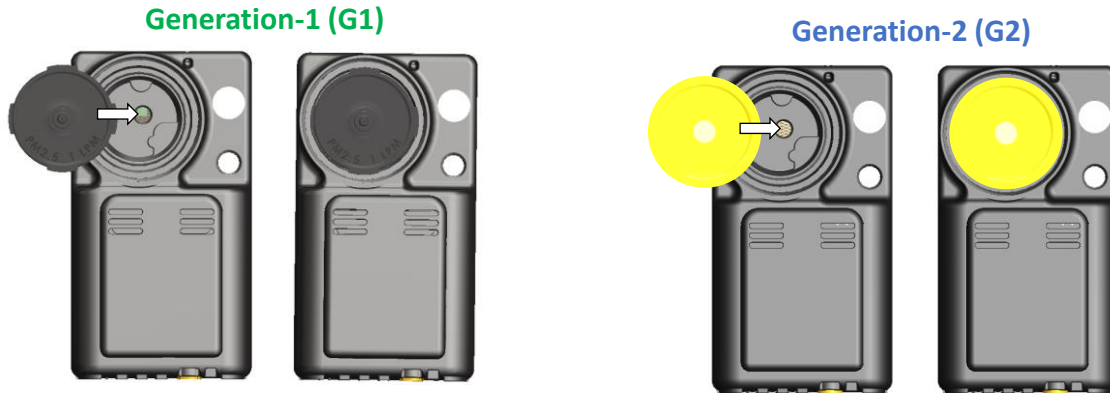
4. Configure the UPAS for Performing Pre-Sample Flow Rate Calibration: If you plan to perform a pre-sample flow calibration with a primary flow rate meter, configure the UPAS per the instructions below. Skip to Step 5 if you are not performing a pre-sample flow calibration with a primary flow rate meter.

   a. G1: Place the FC-Adapter on top of the loaded Filter Cartridge and thread clockwise to hand tighten with the textured collar.
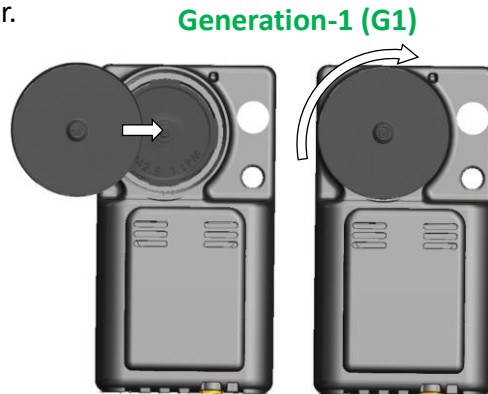
Generation-1 (G1)

   b. G2: Place the PM-Inlet on top of the loaded Filter Cartridge and thread clockwise by hand to start. Place the FC Adapter on top of the PM-Inlet and align the feet of the FC Adapter with the notches of the PM-Inlet. Press the FC Adapter down firmly until it fully seats onto the PM-Inlet. Turn the FC Adapter clockwise to firmly tighten the PM-Inlet.

Generation-2 (G2)

Generation-2 (G2)

5.   Configure the UPAS without Performing Pre-Sample Flow Rate Calibration: If you do not plan to perform a pre-sample flow rate calibration with a primary flow rate meter, configure the UPAS per the instructions below.

    a.   G1: Place the PM-Inlet on top of the loaded filter cartridge and turn clockwise to hand tighten with the knurled collar.

Generation-1 (G1)

    b.   G2: Place the PM-Inlet on top of the loaded Filter Cartridge and thread clockwise by hand to start. Use one of the tools below to fully tighten and install the PM-Inlet.

        i.   FC Adapter (G2): place the FC Adapter on top of the PM-Inlet and align the feet of the FC Adapter with the notches of the PM-Inlet. Press the FC Adapter down firmly until it fully seats onto the PM-Inlet. Turn the FC Adapter clockwise to firmly tighten the PM-Inlet.
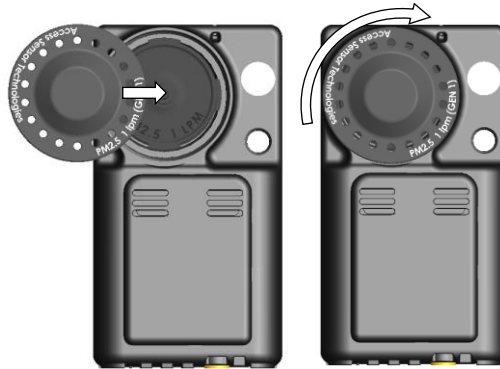
        ii.   Inlet Installation Tool (G2): Place the Inlet Installation Tool on top of the PM-Inlet and align the feet of the Inlet Installation Tool with the notches of the PM-Inlet. Press down and turn clockwise to firmly tighten the PM-Inlet.
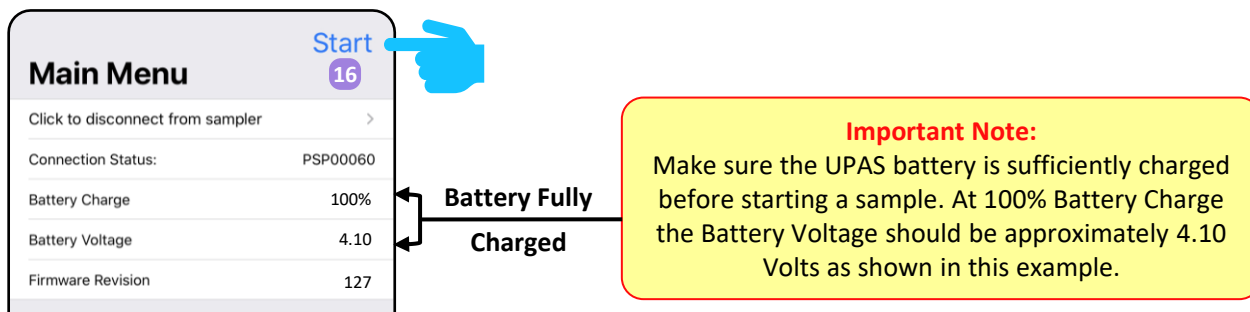
**Generation-2 (G2)**   **Generation-2 (G2)**

VII.   START THE UPAS SAMPLE

1. Start the sample from the App

a. After completing the UPAS configuration settings, press **"Start"** in the top right corner of the Main Menu to start the sample.

Important Note:
Make sure the UPAS battery is sufficiently charged before starting a sample. At 100% Battery Charge the Battery Voltage should be approximately 4.10 Volts as shown in this example.

b. When the sample is started, the UPAS light will change from solid BLUE to solid RED, indicating the pumps are initiating and targeting the programmed flow rate. When the flow rate is stable, the UPAS light will show solid GREEN. Alternatively, if you are actively charging the UPAs during the sample, the UPAS light will show solid BLUE.
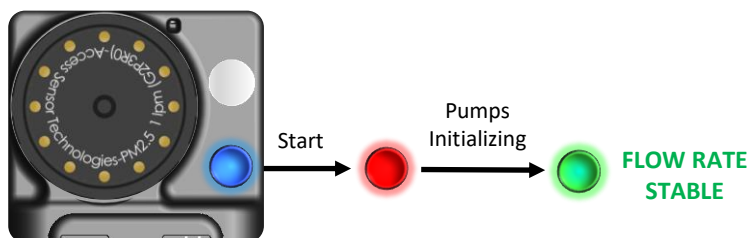
c. The UPAS will automatically turn OFF, indicated by no UPAS light, when the set Sample Duration is complete. Alternatively, the UPAS sample can be manually stopped by holding down the pushbutton for 5 seconds until the UPAS light tuns off.

VIII.   POST-SAMPLE FLOW RATE CALIBRATION

4. Configure the UPAS for performing Post-Sample Flow Rate Calibration (primary flow rate meter required).

    a. G1 Configuration

        i. *Remove the PM-Inlet, turn counterclockwise.*

        ii. *Leave the Filter Cartridge and filter in place.*

        iii. *Install the FC-Adapter, turn clockwise and tighten.*

        iv. *Connect the UPAS FC-Adapter to the primary meter.*

    b. G2 Configuration

        i. *Install the FC-Adapter on top of the PM-Inlet.*

        ii. *Align the pieces and press together until fully seated.*

5. Start the Post-Sample Flow Rate Calibration

    a. Power the UPAS ON, wait for the solid PINK light.

    b. Connect to the UPAS with the "AST UPAS" App.

    c. Enter the "Filter Flow Check & Adjust" setting.

    d. Toggle the switch to ON, do not adjust the flow offset.

    e. Allow the flow to stabilize for more than 30 seconds.

    f. Record the post-sample flow measurement outside of the App (e.g., by hand). This value will not be stored in the log file if it is entered in the App at this point.

IX.   UPAS SAMPLE LOG FILE

1. Download the log file from the UPAS SD card:
   a. Remove the micro-SD card from the bottom of the UPAS. Gently press and release the SD card using a coin, paperclip, or fingernail.
   b. Insert the micro-SD card into a PC or MAC computer, the adapter included with the UPAS may be needed.
   c. Navigate to the SD card on the computer to see the sample log files, organized in folders by date (YYYYMMDD).
   d. Save and/or remove the log files needed from the SD card.

X.   UPAS LOG FILE VISUALIZATION TOOL

1. UPAS Log File R-Shiny Tool: AST offers a web-based tool that allows the user to visualize UPAS log file data with configurable plots and summary tables. Follow the directions at the top of the web-page.
   a. R-Shiny Link: https://accsensors.shinyapps.io/shinyAST/
   b. R-Script Public Repository: Access our public repository to view the script used to load and format the UPAS log files. You can also post "Issues" here and our team will work to address them. https://github.com/accsensors/astr