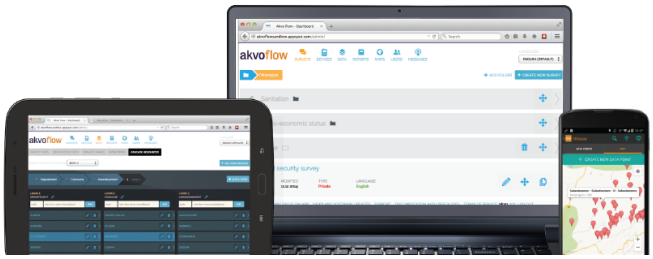
SODAQ

Building a sustainable internet of things

HAP AND SUM

USER MANUAL



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Chapter 1

Introduction

1.1 HAP

The purpose of the Household Air Polution (HAP) unit is to collect data on indoor air quality, during usage of a cook stove. The sensors measure carbon monoxide (CO) and particulate matter (PM). The Stove Usage Monitoring unit (SUM) measures the usage of the stove and transfers the data to the HAP through a wireless connection. The HAP sends data to a server every hour through a mobile network.
The unit is connected to the regular power grid with a 5V adaptor, which also charges the battery. The battery powers the unit in case of power outage.

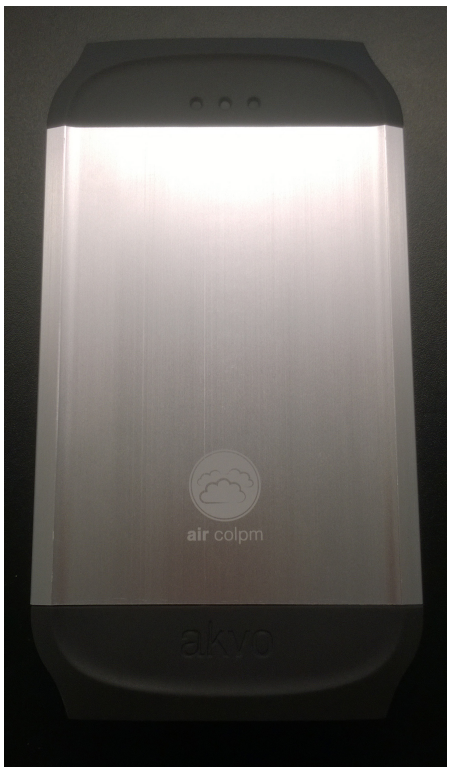

Figure 1.1: The HAP

1.2 SUM

The purpose of the Stove Usage Monitoring unit (SUM) is to collect and transfer data about usage of a stove. It uses a temperature sensor to determine, if the stove is used or not. The sensor measures temperature in degrees Celsius (°C). The stove temperature is measured with the thermocouple that is attached to the clamp. This clamp is placed on the stove.

The SUM transfers the data to the HAP which collects data on air pollution. This allows correlation analysis between usage of the stove and air pollution. The SUM data is sent wireless to the HAP after every cooking event.

Figure 1.2: The SUM

Chapter 2

Specifications

2.1 HAP

Powered by	5V adapter input, 800mAh LiPo battery or 5V micro-USB
Output	Data transmitted over GSM-network or digital, USB
Operating current	10-150mA
Operating temperature	-10℃ to 50℃
Recommended Operating temperature	10℃ to 40℃
Casing	Aluminum, polyurethane
Measurement range PM-sensor	Small particles: 1-2μm, large particles: 3-10μm
Measurement range CO-sensor	20ppm-2000ppm carbon monoxide

Datasheet PM-sensor[1]
Datasheet CO-sensor[2]

2.2 SUM

Powered by	1200mAh LiPo battery or micro-USB, 5V (for charging)
Output	Wireless communication with HAP or over USB
Operating current	600μA (in deep-sleep), 12mA (during active-mode)
Operating temperature	-10℃ to 50℃
Recommended Operating temperature	10℃ to 40℃
Waterproofing	Epoxy filled
Casing	Aluminum, polyurethane
Measurement range	0-600℃

[1] https://goo.gl/OJBHU3
[2] https://goo.gl/y5eWYf

Chapter 3

Using the devices

3.1 Setting up

3.1.1 HAP

The HAP is hung on a wall on a nail or a screw (using a hole in the casing), preferably directly above the stove.

The placing of the HAP is depending on the conditions of the location. The best placement can only be determined at the site. To find the best position for the HAP, it is recommended to start a cooking event and carefully observe the airflow.

Figure 3.1: The hole for hanging the HAP

To power the HAP, the 5V power adapter has to be connected to the round connector on the bottom of the HAP.

Figure 3.2: USB and 5V connectors, end cap screws

To insert the SIM-card, one of the end caps has to be unscrewed and the PCB has to be slid out. The SIM-card slot is located on the back side of the PCB.

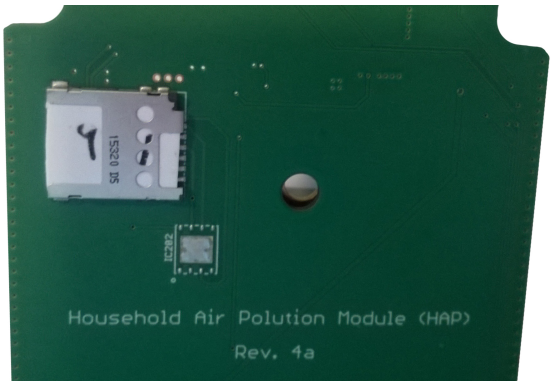

Figure 3.3: The SIM-card slot

After placing the SIM-card, the settings of the HAP need to be changed according to the network provider (see annex A2 & A3).

3.1.2 SUM

SUM is placed on the stove, using the integrated stainless steel clamp, with the module hanging on the outside of the stove.

To charge the battery of the SUM, a 5V USB charger (with a micro-USB cable) can be connected to the bottom of the SUM. The rubber cap has to be folded open to get access to the USB-connector. The SUM must not be charged while it is attached to the cookstove.

Figure 3.4: Correct placement of the SUM

3.2 Using

The HAP and the SUM run autonomously and do not require any user input to function after setup.

When using the stove and starting the cooking process, it is important to **let the coals or fuel-wood start before placing any pots or pans on the stove.** Cookware placed on the stove helps to direct the heat to the SUM and will enable the temperature to rise faster, which in turn will trigger the cooking event in the software.

Appendix A

Settings and Debugging

Use the following steps to change the settings of the HAP and perform simple debugging:

A.1 Installing the Arduino IDE and drivers

Info on `www.support.sodaq.com`

1. Download the Arduino IDE `https://www.arduino.cc/en/Main/Software`
2. Install the Arduino IDE and start it
3. Click on File → Preferences and at the bottom you should see 'Additional Boards Manager URLs'. This is where you need to paste the following URL: `http://downloads.sodaq.net/test/package_sodaq_index.json`
4. When you have pasted the URL, click 'OK' and you are ready for the next step.
5. Click on Tools → Board → Boards Manager
6. Scroll all the way to the bottom, you should see SODAQ SAMD Boards. Click on it, and install the latest version.

Now it is possible to use the built in serial monitor of the Arduino IDE (Tools > Serial Monitor) or use a different serial monitior i.e. PuTTY.

A.2 Menu

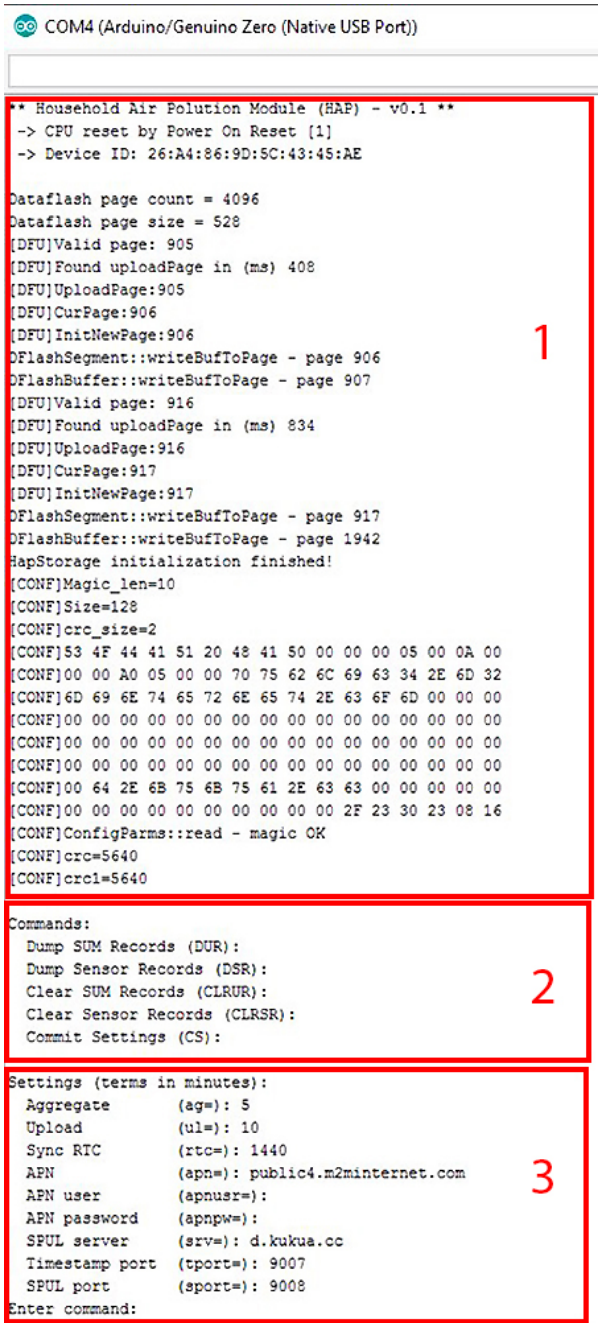

Figure A.1: HAP menu

Settings in the HAP can be changed by connecting a micro-USB cable to the HAP. After connecting the HAP, the serial monitor must be opened to get a configuration menu.

Configuring the menu:

1. General information
   (a) The device name and version
   (b) The cause for the last reset:
   (c) Device ID, a unique code for each of the HAP-s
   (d) Data used for debugging, does not concern the user
2. Extra commands:
   (a) Dump SUM Records (DUR): dump all the SUM records from the data flash. Gives all recorded sensor values to serial monitor. To choose this option type 'DUR'→ENTER
   (b) Dump Sensor Records (DSR): dump all the sensor records from the data flash. Gives all recorded sensor values to serial monitor. To choose this option type 'DSR'→ENTER
   (c) Clear SUM Records (DUR): erase all the SUM records from the data flash. To choose this option type 'CLRUR'→ENTER
   (d) Clear Sensor Records (DSR): erase all the sensor records from the data flash. To choose this option type 'CLRSR'→ENTER
   (e) Commit Settings (CS): saves the settings without starting the program immediately. To choose this option type 'CS'→ENTER
   (f) *(Hidden)* Start (OK): saves the settings and starts the program. To choose this option type 'OK'→ENTER
3. Menu configuration: [1]
   (a) Aggregate: time interval for average value of measurements, in minutes
   (b) Upload: time interval to upload the Aggregate values, in minutes
   (c) sync RTC: time interval to synchronize the real-time clock, in minutes
   (d) APN: the APN of the network/operator
   (e) APN user: username for the network APN, usually left blank
   (f) APN password: password for the network APN, usually left blank
   (g) SPUL server: server to use with the WDT
   (h) Timestamp port: port of the server for the timestamp
   (i) SPUL port: port of the server for the sending data
4. Contingencies:
   (a) If HAP says 'SUM not seen': HAP and SUM connect when both are started at the same time. If either of them has been running while the other has just started, then they will not connect immediately. If a cooking event is detected, then they will connect and no data will be lost. Without any other connection, they will connect after 24 hours.

[1] To start the HAP you should fill in the aggregate, upload, sync RTC, APN , SPUL server, timestamp port and SPUL port

A.3 SPUL connection

For connecting to the backend, the SPUL protocol is being used.

The SPUL protocol is open source and available to implement:
`https://github.com/kukua/concava-connector-spul`

Appendix B

Technical details

The main components of the HAP:

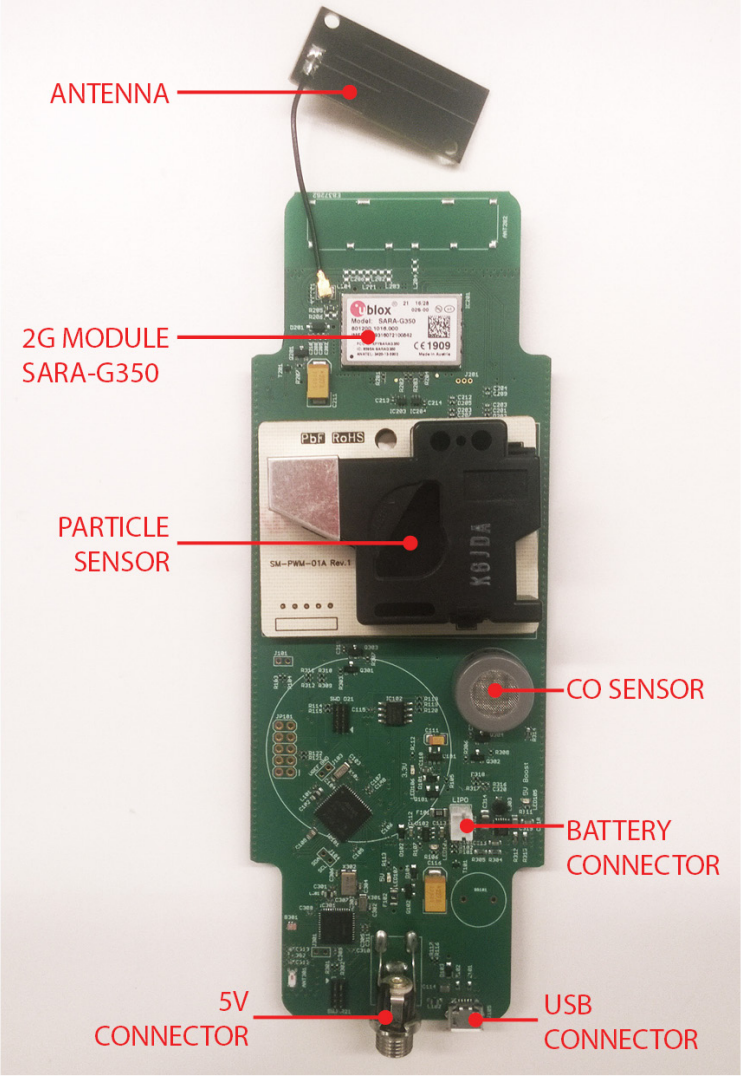

Figure B.1: HAP components

Appendix C

Validation

To validate the work cycle of the HAP and SUM combination, a cooking event was simulated.

A $3m^2$ room with a $7m^3$ volume was used to run the test. The stove with the SUM was placed in the middle of the room. The HAP was placed on the wall at 1,75m height.

Charcoal briquettes were used to fuel the stove. A flat bottomed clay pot with a diameter of 30cm was used on top of the stove. A pot is required to direct the heat to the SUM. Without the pot, the SUM does not receive enough heat to trigger the cooking event.

The serial monitor output was logged for both the HAP and the SUM and the data sent over the network was read from the dashboard. Carbon monoxide(CO), small particles(Psmall) and large particles(Plarge) are measured by the HAP and the cooking temperature(SUM Temp) is measured by the SUM.

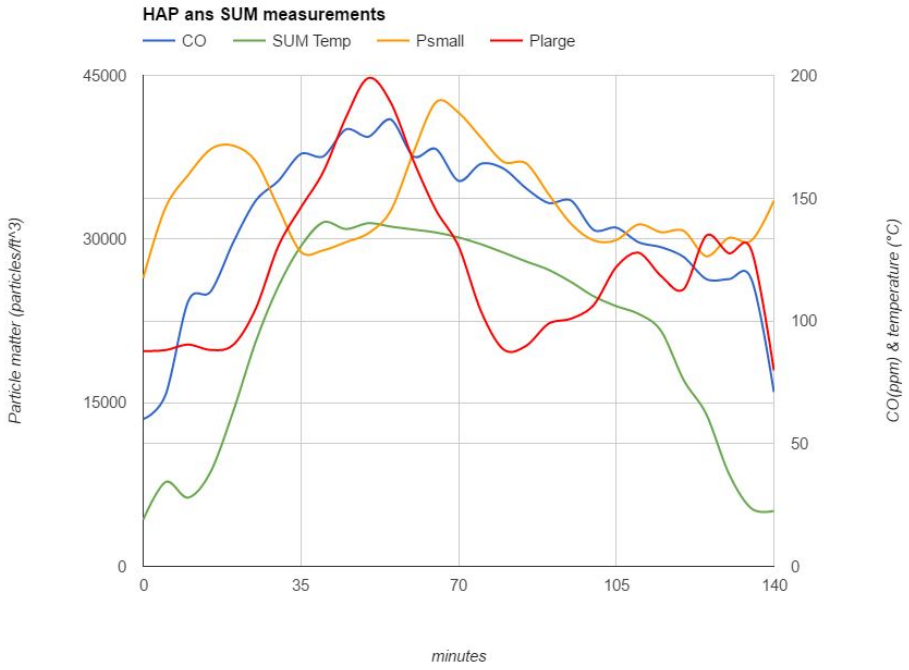

Figure C.1: Graph of HAP&SUM readings

The cooking event lasted 140 minutes from igniting the coals to the end. The pot and the SUM were removed from the oven at 110 minutes to allow for faster cooling after the coals had died.

The results of the simulation can be seen in the graph in figure C.1.