Multi-Sensor Array = MSA, Operation Notes

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Power

Power the MSA with the Raspberry Pi power adapter when possible. Battery life is about 4 hours with a fresh charge. Minimize the time when power is provided by BOTH the batteries (power on switch) AND the wall power supply through the RPi. Use only 18650 Li+ batteries. For safety reasons, "protected" batteries are recommended.

It is best if the sensors have been pre-warmed up prior to use. Plugging in the RPi power supply (micro-USB) will automatically power the sensor board and the GPS.

Operation

Text version of these instructions:

Using a laptop, phone, or tablet open the WiFi settings. Connect to the MSA-x SSID where "x" is the unit you wish to start collecting data with. If you are asked for a password use "raspberry". If you are asked to share drives and/or questions about a public vs. private network, select "No".
Open a browser tab and enter the following IP address into the URL line:

msa.local

If that doesn't work, try:

192.168.4.1 — or — 192.168.4.1:8080

A webpage will open. There are two tabs on the left, the Dashboard is where you should start.
Follow the directions. To start data collection press "Start".
The data collection LED will light approximately every 5 to 7 seconds. Each time this LED illuminates, a data point is being collected.
To stop data collection press "Stop". Wait about 10 seconds before doing anything else. This allows the files to be saved and closed. Watch for the data collection LED to make sure it has stopped flashing.

Hint, you can make occasional "time markers" in the data by breathing on the sensors and noting the time that you did that. Your breath will leave a spike in the data, especially the CO_2 data.

You can download the data by selecting "Download Data", this will place a zip file of ALL data onto your local device. (Using a laptop is recommended.)

Power down by turning off the battery switch (if using battery power) and/or unplug the wall power connected to the micro-USB port on the RPi. We'll update with a shutdown switch later.

Here is the graphical version of these instructions:

1. Open your WiFi internet access or Settings >> WiFi, etc. then select the MSA that you want to connect to.
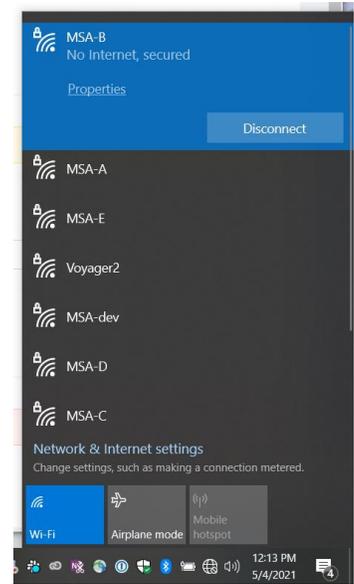
2. Once you are connected, open a browser window and connect to msa.local/

3. Enter a description if you wish. I suggest maintaining a logbook as well so that you can keep track of notes and events associated with the measurement. Then press "Start Data Logging."
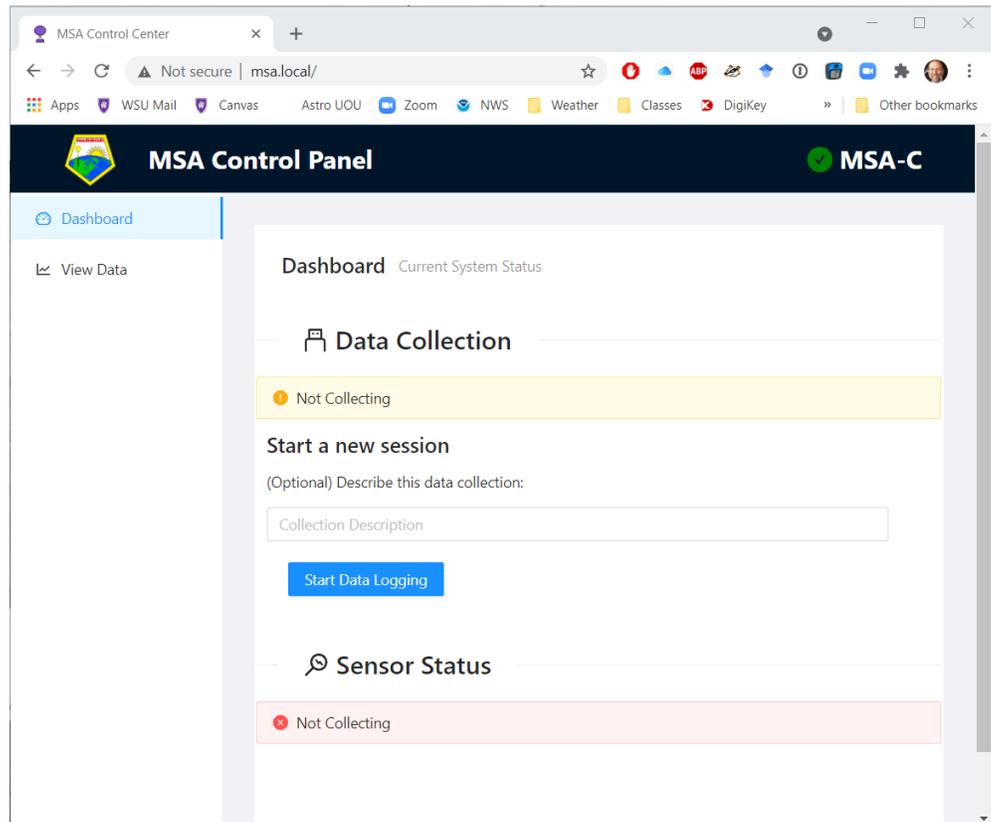
4. You can now view your raw data as it comes in live. When you wish to stop collecting data click on the stop button. Give the system a good 10 to 15 seconds before you remove power so that files can be closed safely.

5. Clicking on the "View Data" tab on the left will show you the data files currently on the MSA.

6. Clicking on one of the files in the View Data tab will open that file with a graphical view of the data. Clicking specifically on the "Download" button will download that file.
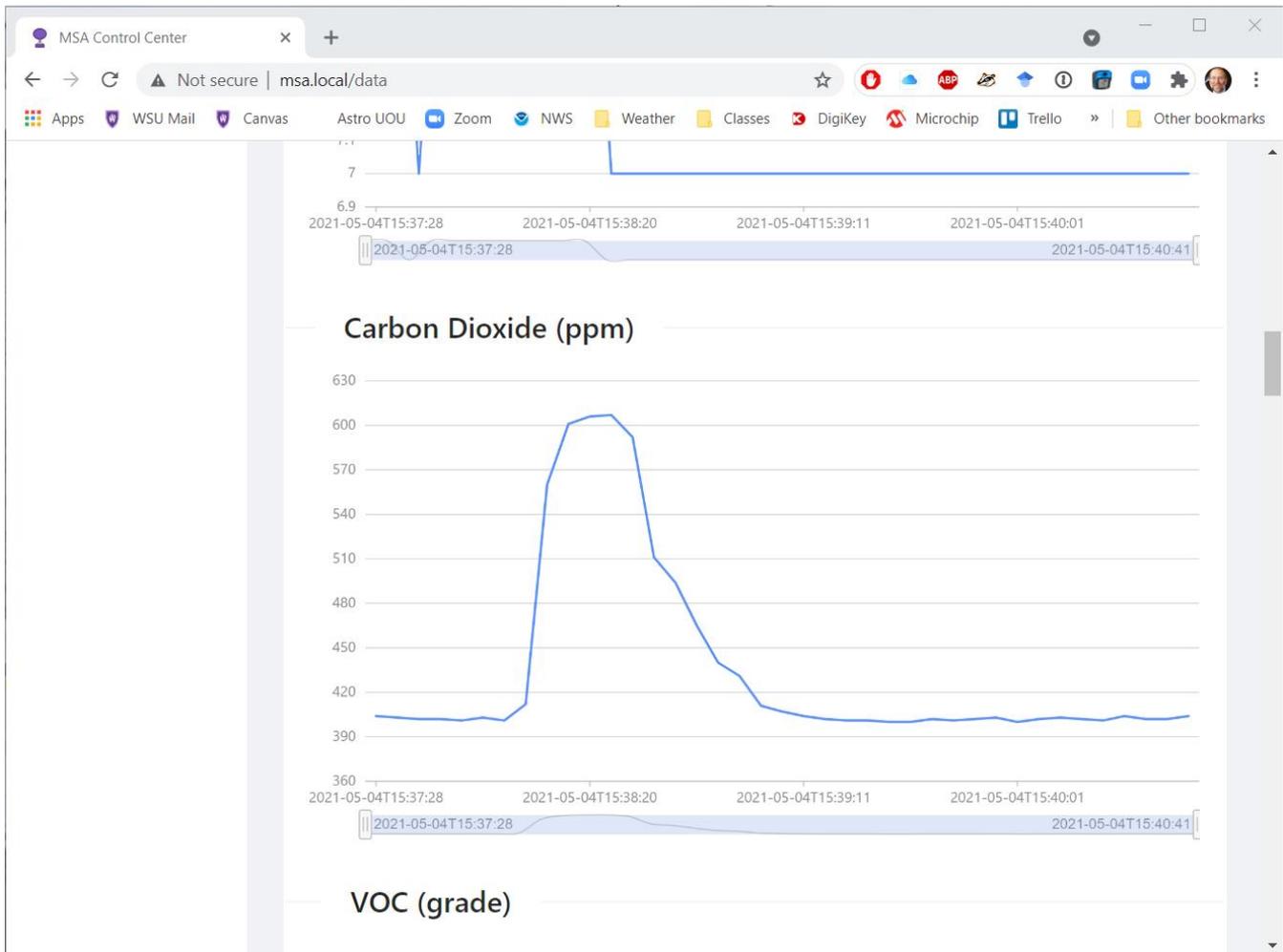
Live data will continue to update here if you have a WiFi connection.

Notice the scroll bar, that will let you zoom in on a specific range inside that data file. (During live data collection, the scroll bar will immediately return to full when the next data point arrives.)

Placing your cursor over the graph will report values at that point in the graph.

Data Analysis

The data columns are:

UTC Timestamp (yyy-mm-ssThh:mm:ss)	MET = Mission Elapsed Time (s)	Latitude (dd.d)	Longitude (dd.d)	Altitude (m)	Position Dilution of Precision (unitless)

PM1.0 ($\mu g/m^3$)	PM2.5 ($\mu g/m^3$)	PM10 ($\mu g/m^3$)	CO_2 (ppm)	VOC "grade"	Temp (°C)	RH (%)	CH_2O (mg/m^3)	CO (ppm)	O_3 (ppm)	NO_2 (ppm)

The PDOP is a measure of uncertainty in the GPS. Generally, you want this value less than about 4.

System and Sensor Details

System mass = 370 grams in the Rubbermaid sandwich box, with two 18655 batteries installed.

The GPS is from SparkFun: https://www.sparkfun.com/products/15210

The Winsen sensor board information can be found here:
https://www.winsen-sensor.com/sensors/co2-sensor/zphs01b.html
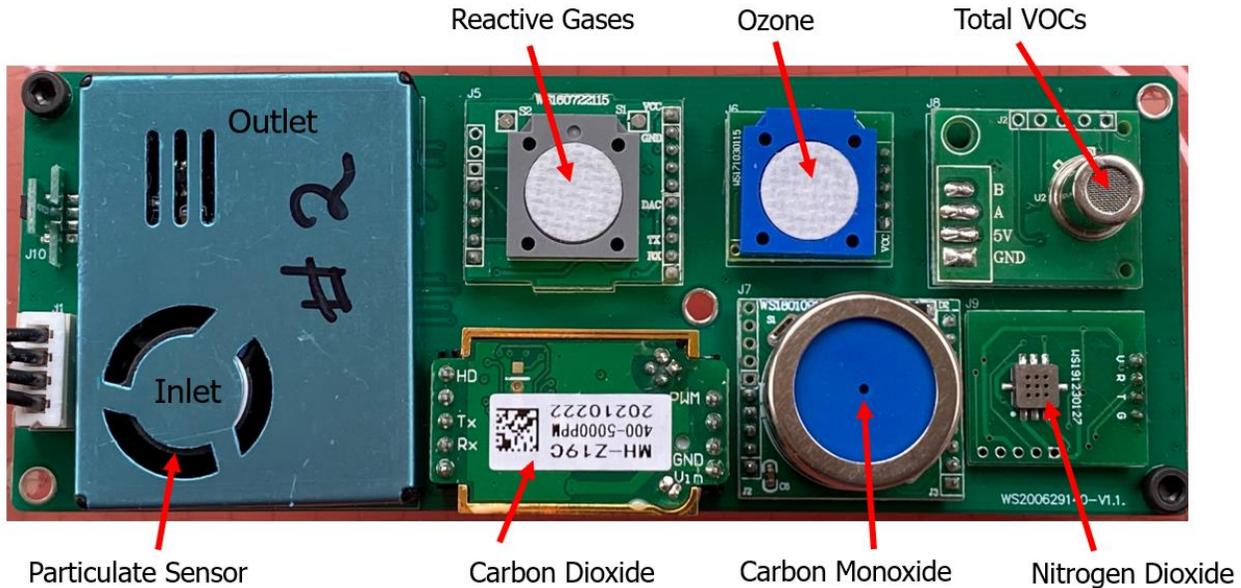
The sensors on the Winsen board are:
Carbon Monoxide sensor: https://www.winsen-sensor.com/sensors/co-sensor/ze07-co.html
Datasheet: https://www.winsen-sensor.com/d/files/PDF/Gas%20Sensor%20Module/CO%20Detection%20Module/ZE07%20CO%20Module%201.3V.pdf

Carbon dioxide sensor: https://www.winsen-sensor.com/sensors/co2-sensor/mh-z19b.html
Datasheet: https://www.winsen-sensor.com/d/files/infrared-gas-sensor/ndir-co2-sensor/mh-z19b-co2-manual(ver1_6).pdf
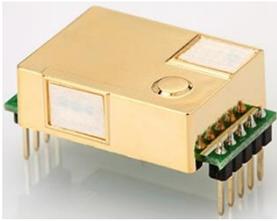
TVOC sensor ZP07-MP503: https://www.winsen-sensor.com/sensors/voc-sensor/246.html
(Could be the ZP01-MP503, might be only the PCB that is different,)
Datasheet: https://www.winsen-sensor.com/d/files/ZP07-MP503.pdf

Ozone sensor: https://www.winsen-sensor.com/sensors/o3-gas-sensor/ze27-o3.html
Datasheet: https://www.winsen-sensor.com/d/files/ZE27-O3.pdf
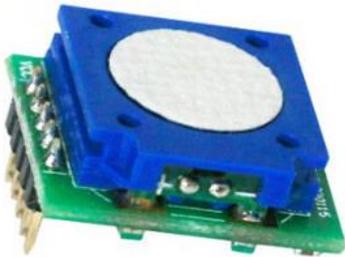
NO2 sensor:
Might be a SGX Sensortech MICS-2714: https://sgx.cdistore.com/products/detail/mics2714-sgx-sensortech/333416/

PM sensor:

Temtop PM-900M Laser Particle Sensor for PM1.0/PM2.5/PM10

https://temtopus.com/products/temtop-pm-900m-laser-particle-sensor-for-pm1-0-pm2-5-pm10

(Very similar to the Plantower PMS5003.)

Sort of a manual (in Google docs): https://drive.google.com/file/d/1aJ3KSyDuwa6LfTuBYYWg5u0JsP-gIoia/view

Outlet port

Fan inlet port
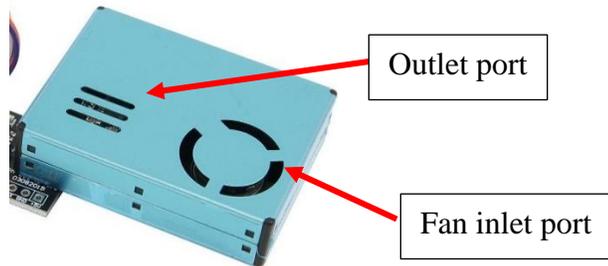
Formaldehyde (CH2O) sensor: ????

The ones they have on line don't seem to match. Those are (like this one) are cross sensitive to "Alcohol, CO &etc."

Probably this one: https://www.winsen-sensor.com/sensors/ch2o-gas-sensor/ze08-ch2o.html

Datasheet: https://www.winsen-sensor.com/d/files/PDF/Gas%20Sensor%20Module/Formaldehyde%20Detection%20Module/ZE08-CH2O%20V1.0.pdf

This has known (in the datasheet) sensitivity to:

C_6H_6 = Benzene 1000:1 (100 ppm reads as 0.1 ppm)

Cl_2 = Chlorine gas 100:1

CH_3Cl = Chloromethane, also called methyl chloride (a refrigerant, R-40) 50:1

C_3H_6O = Acetone 50:1

C_2H_4O = Ethylene oxide, acetaldehyde, vinyl alcohol, ethenol (this is not ethanol) 20:1

SO_2 = Sulfur dioxide 25:1

H_2S = Hydrogen sulfide 27:1

H_2 = Hydrogen gas 91:1

C_2H_5OH = Ethanol, ethyl alcohol 26:1

CH_3OH = Methanol, methyl alcohol 8:1

CH_2O = Formaldehyde 1:1 (5 ppm is 5 ppm)