

# Multi-Sensor Array = MSA, Service 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.

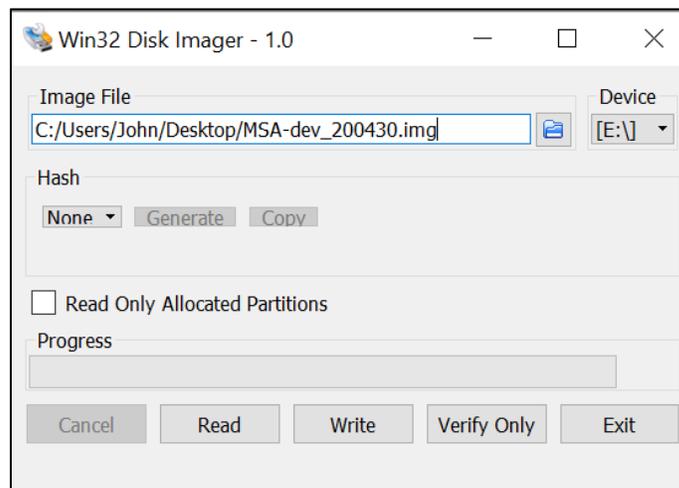
It is best if the sensors have been pre-warmed up prior to use. Plugging in the RPi power supply (micro-USB) will automatically power the sensor board and the GPS.

## Updating the disk image

Use Win32DiskImager to create the original image. You can write with this software as well, but using balenaEtcher (see below) will be about twice as fast.

Note: If you have a “mounted drive” it will not work. Google Drive likes to mount itself to the file system. Go to the task tray and click the Google Drive icon then select the settings gear then select Quit. Now Win32DiskImager will work.

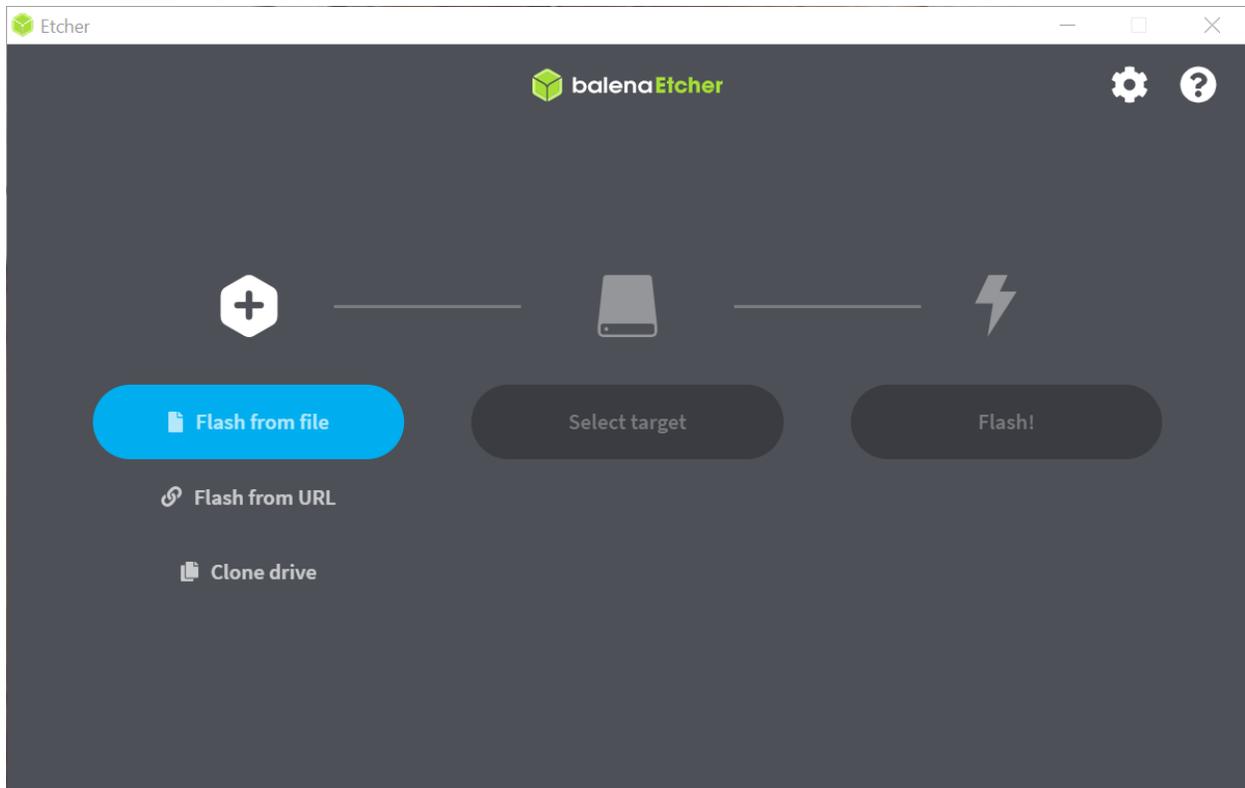
Run Win32DiskImager and you should get a window like this one. Select the image file to read or write (make sure the file ends in “.img” when reading a new image) and select the Device.



To write the source (master) image to the new microSD card you can use Win32DiskImager but balenaEtcher is much better and twice as fast. You can obtain that app here:

<https://www.balena.io/etcher/>

Open the app and follow the straightforward directions. It will look like:



Note: If you use Win32DiskImager you will need to do several steps before doing the image. You need to open up Windows Disk Management (Win-x, then press “k” to get there via keyboard shortcuts). You will need to “delete volume” for all partitions on the microSD card before you can then use Win32DiskImager. None of that is needed if you use balenaEtcher.

Once the image is on the card, it needs to be “personalized” to that MSA unit.

1. Plug an active Ethernet cable into the RPi.
2. If the RPi is plugged into a keyboard and monitor, you can jump to step “d” below. (No need for a mouse.) Otherwise, SSH into the MSA
  - a. Connect to the MSA via WiFi, it will probably be “MSA-dev”
  - b. Run PuTTY and enter: 192.168.4.1 leave everything else as is.
  - c. A terminal will open.
  - d. Login name is pi and the password is MSA.
3. Run the following codes:
  - a. `sudo ~/Documents/configure_msa.py MSA-x` where “x” is the MSA letter. You may need to run it a few times (wait about a minute between runs) to get it to run without an error.
  - b. When you get a message that says: Configuration Successful, please reboot. Run the following command: `sudo reboot now`

4. The MSA is now ready for use. It will take about a minute for the RPi to reboot, startup, and serve an SSID that you can find.
5. At the command prompt window (i.e., the terminal window) you can do a controlled shutdown if you wish by entering: `sudo shutdown -h now`

## Firmware Updates

Firmware updates should happen automatically when the MSA is plugged into an Ethernet cable. You might need to leave it connected for an hour or so.

To force a firmware update log into the MSA as described above and get into a command prompt window. Login with “pi” and “MSA”.

Change directories then pull the new firmware then reboot:

1. `cd MSAPublic`
2. `git pull https://github.com/WSUHARBOR/MSAPublic.git` (It should show that you have successfully downloaded the updates.)
3. `sudo reboot now`

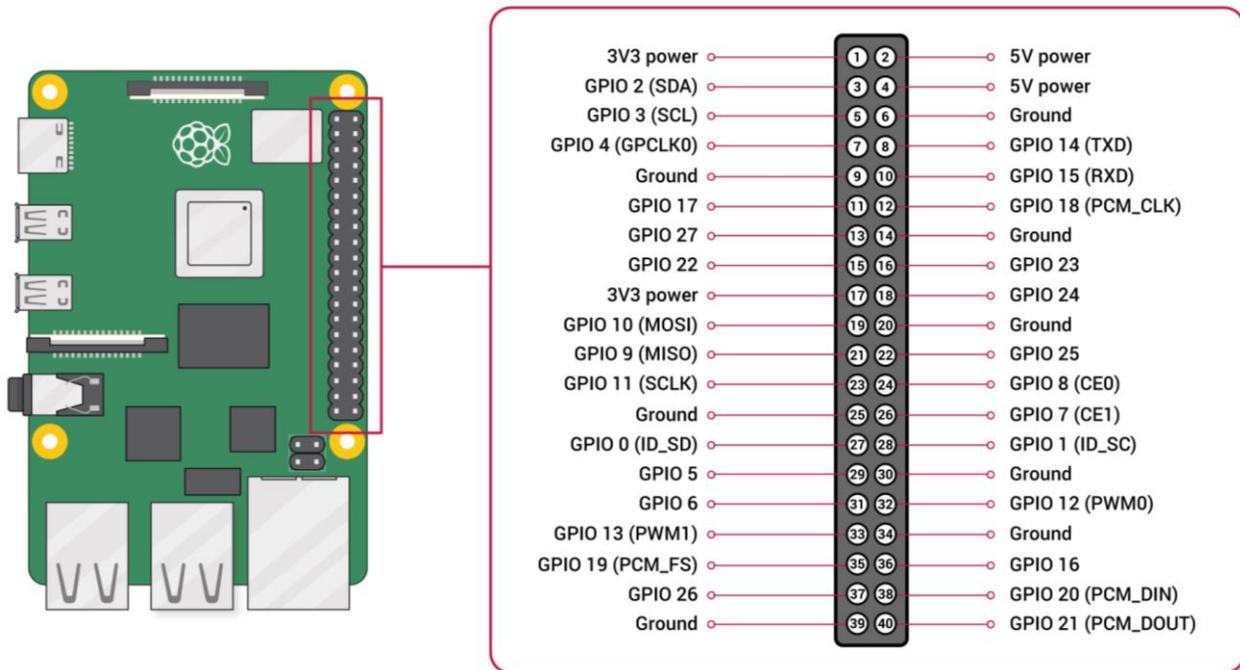
Allow the process time to complete and you should now have the newest firmware.

**NOTE: in the MSAv2/api folder there are some utilities that I should probably make note of in this document.**

## System and Sensor Details

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

## Raspberry Pi pinout



The pinout used for the MSA is:

Function	RPi pin	RPi pin	Function
3.3 V to GPS	1	2	5.0 V from battery power
I2C SDA to GPS	3	4	5.0 V to Winsen sensor board
I2C SCL to GPS	5	6	GND to Winsen sensor board
	7	8	UART Tx to Winsen sensor brd
GND	9	10	UART Rx to Winsen sensor brd
GPS PPS (High = signal lock)	11	12	
	13	14	GND for LED
	15	16	LED for measurement indication
	17	18	Power button
	19	20	GND
	21	22	
	23	24	

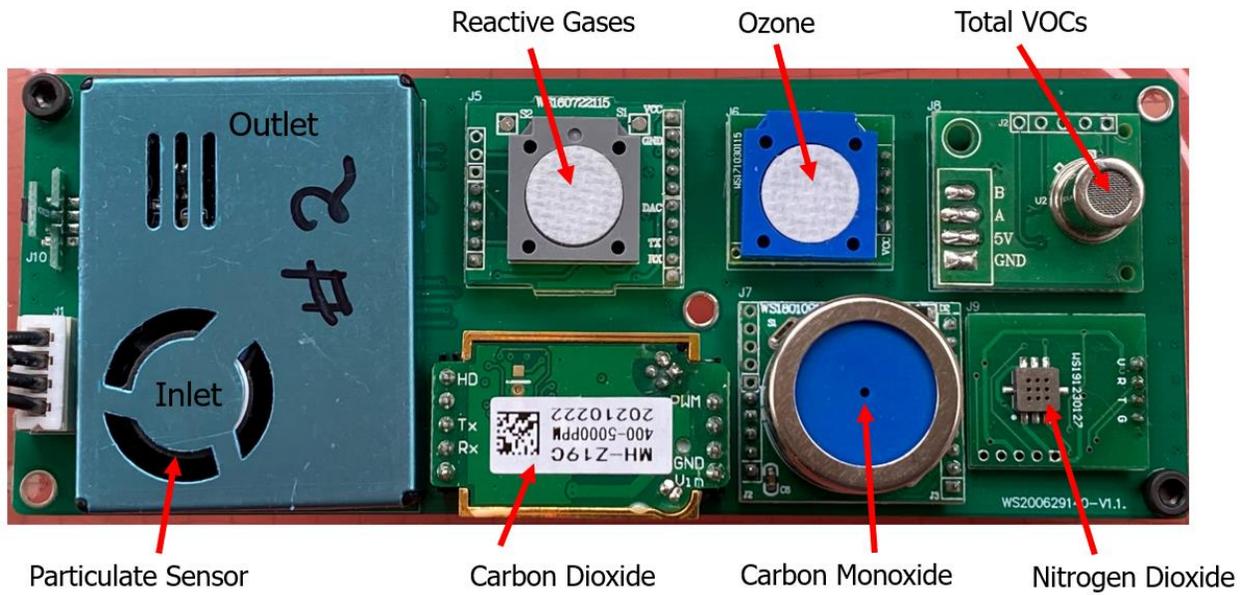
## GPS

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

## Winsen Multi-In-One Sensor Board

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-](https://www.winsen-sensor.com/d/files/PDF/Gas%20Sensor%20Module/CO%20Detection%20Module/ZE07%20CO%20Module%201.3V.pdf)

[sensor.com/d/files/PDF/Gas%20Sensor%20Module/CO%20Detection%20Module/ZE07%20CO%20Module%201.3V.pdf](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](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:

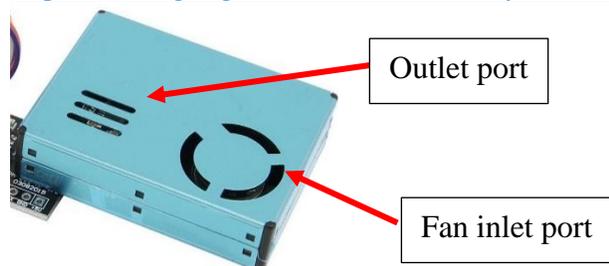
Temtop PM-900M Laser Particle Sensor for PM1.0/PM2.5/PM10

<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>



Formaldehyde (CH<sub>2</sub>O) 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-](https://www.winsen-sensor.com/d/files/PDF/Gas%20Sensor%20Module/Formaldehyde%20Detection%20Module/ZE08-CH2O%20V1.0.pdf)

[sensor.com/d/files/PDF/Gas%20Sensor%20Module/Formaldehyde%20Detection%20Module/ZE08-CH2O%20V1.0.pdf](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<sub>6</sub>H<sub>6</sub> = Benzene 1000:1 (100 ppm reads as 0.1 ppm)

Cl<sub>2</sub> = Chlorine gas 100:1

CH<sub>3</sub>Cl = Chloromethane, also called methyl chloride (a refrigerant, R-40) 50:1

C<sub>3</sub>H<sub>6</sub>O = Acetone 50:1

C<sub>2</sub>H<sub>4</sub>O = Ethylene oxide, acetaldehyde, vinyl alcohol, ethenol (this is not ethanol) 20:1

SO<sub>2</sub> = Sulfur dioxide 25:1

H<sub>2</sub>S = Hydrogen sulfide 27:1

H<sub>2</sub> = Hydrogen gas 91:1

C<sub>2</sub>H<sub>5</sub>OH = Ethanol, ethyl alcohol 26:1

CH<sub>3</sub>OH = Methanol, methyl alcohol 8:1

**CH<sub>2</sub>O = Formaldehyde 1:1 (5 ppm is 5 ppm)**