

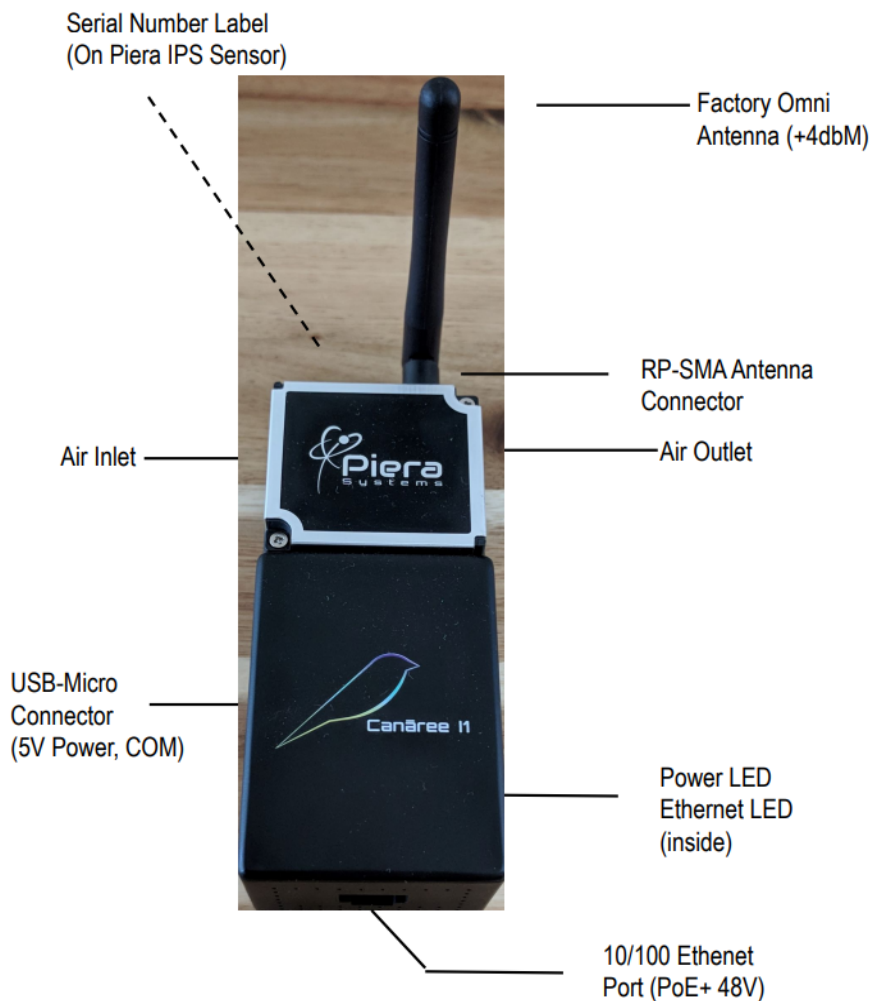


Canaree i1 Configuration Guide

Real-Time Air Quality Monitoring IoT for Piera Sensors

Initial Configuration Guide – Version 1.0 updated 4/20/21

CANAREE i1 OVERVIEW DIAGRAM



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Canaree i1 Deployment Options

Canaree i1 supports a variety of deployment scenarios to IoT-Enable Piera IPS-Series Particle Counting sensors in most common networking environments including:

Wired Ethernet / PoE Powered -

Operating as a Class 1 PoE+ Device @ 48VDC the device will receive power and internet access from an Ethernet Switch using either DHCP (Default) or Static IP Addressing.

Wired Ethernet / USB Powered -

If your Ethernet Switch does not support PoE+ the device can be powered via the included USB 5V Adapter and access the network from the Ethernet connection.





Wireless / USB Powered -

The device can be programmed for your 802.11n (2.4ghz) Wireless network using WPA2 / PSK and will operate remotely via the included 5V USB Adapter.

Wireless / PoE Powered -

The device can be programmed for Wifi and still receive power via the PoE Ethernet Port; however the Ethernet "Link" will remain down while operating in this mode unless otherwise configured.



Power Failover

The onboard circuitry supports failover between PoE+ power and USB Power automatically. PoE+ will be used when available during power-on.

Notes on External Antenna for 2.4g Wifi Specifications

Canaree i1 supports external Wifi antennas for the 2.4Ghz Band using a single stream RP-SMA connector. The factory antenna is unidirectional and operates at +4dbM. and can operate up to 400' from a Wireless AP. Directional Antennas can extend range and coverage beyond this point and improve connectivity in poor Wifi coverage areas.

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Getting Started Guide

If using Wired Ethernet deployment option, your device is immediately ready to deploy. The factory default settings for the device will attempt to DHCP on the Ethernet link for an IP Address, DNS and Gateway IP and if successful it will phone home to the SenseiAQ Cloud Service. and will be visible on sensei.pierasystems.com

During bootup the device will fetch time via NTP using a server from pool.ntp.org. In order for this to occur NTP (TCP/123) and HTTPS (TCP/443) for the Azure IoT Hub Connectivity.

If using Wireless deployment mode, the device will need to be configured to your Wireless Networks settings before bringing online. The tools below are provided to help setup the device.

Wifi Configuration Using Canaree-i1 Python Tools

These tools allow you to set the basic Wifi settings on your Canaree i1 device and can be downloaded from the following link

<https://github.com/PieraSystems/wifiset/>

For Windows 10 platforms, a specific USB-to-Serial driver must also be downloaded from this link.

<https://www.olimex.com/Products/Breadboarding/BB-CH340T/resources/CH341SER.zip>

- Connect Canaree i1 to USB Port of your PC or Mac.
- run 'python wifiset.py' from the command-prompt
- The program will detect your Canaree i1 Device, to confirm press enter
- You will be prompted for your Wifi SSID (Name) and a WPA2 / PSK (Password) press enter
- The program will apply the Wifi settings and restart your Canaree i1 device.

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CLI Configuration using Terminal Software

Configuration of the Canaree i1 can also be done through CLI Configuration via the provided USB-Adapter cable and your favorite Terminal Emulation Software for Windows or MacOS such as PuTTY, HyperTerminal, Zterm or TerraTerm to access the device via the USB-Serial port. If you're unsure of which tool to use, we recommend PuTTY. <https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>

For Windows 10 platforms, a specific USB-to-Serial driver must be downloaded from this link. <https://www.olimex.com/Products/Breadboarding/BB-CH340T/resources/CH341SER.zip>

Once connected via USB to your PC/Mac, Canaree will become available as a COM Port with your terminal emulation software. The settings are 115200 bps / 8 / n / 1

Below is an example configuration for Wireless connectivity for you to modify and paste into your device via Terminal emulation software.

```
%Wwifi=myWifiSSID,myWifiPASS
```

To Enable the Wired Ethernet port for network connectivity via DHCP and disable Wifi

```
%Wnetmode=1
```

To Disable the Wired Ethernet port for network connectivity and force Wifi Connectivity

```
%Wnetmode=0
```

[Wait 20 seconds for the device to reboot]

```
%Wwifi=myWifiSSID,myWifiPASS
```

[The device will reboot once again and attempt the new Wifi connection]



Other Useful CLI Commands

- `%Rnetwork`
Show network information (Including Static IPs and Network mode)
- `%Rrssi`
Show WiFi signal strength (Wireless Received Signal Strength Indicator (RSSI as dbM)
- `%Razure`
Show Azure IoT Hub settings
- `%Rrelay`
Show WebRelay settings
- `%Wreset`
Reset device (soft power cycle)

Write Configuration Commands

- `%Wnetmode=[0/1]`
Set network mode. 0 for Wireless mode, 1 for Wired Ethernet
Example (set Wifi mode):
`%Wnetmode=0`
- `%Wwifi=[ssid],[pass]`
Set WiFi Network Name (SSID) and WPA2 / PSK (Pass)
Example:
`%Wwifi=mywifi,pass123`
- `%Weth=[local_ip],[gateway_ip],[network_ip],[dns_ip],[dns2_ip]`
Set ethernet options.

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Example:

%Weth=192.168.0.71,192.168.0.1,192.168.0.0,8.8.8.8,8.8.4.4

- *%Wautoreset=[0/10]*

Set number of retries before auto-reset. Less than 5 not recommended to avoid restart loop, 0 to disable auto-reset.

Example:

%Wautoreset=10

- *%Wrelayactive=[0/1]*

Toggle relay mode on or off.

Example:

%Wrelayactive=1

- *%Wrelayurls=[relay_start_url],[relay_stop_url]*

Set relay start and stop URLs.

Example:

%Wrelayurls=http://192.168.1.2/stateFull.xml?relayState=1,http://192.168.1.2/stateFull.xml?relayState=0

- *%Wlimits=[pm1.0],[pm2.5],[pm10]*

Set relay PM limits.

Example:

%Wlimits=35.5,35.5,155.0



Using SenseiAQ to Remotely Monitor

Once connected to the Internet your Canaree i1 will begin reporting AQI information and alerts to the SenseiAQ Cloud Dashboard. Login at <https://sensei.pierasystems.com> to view your AQ data from any web-browser anywhere in the world.

Figure 2 – Initial Dashboard view with Piera Sensor detected.

The AQI will be updated every minute and a bar graph will build out the minute averages for AQI. Colors are based on the US EPA AQI Recommendations outlined below:

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0-50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51-100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101-150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151-200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201-300	Health alert: everyone may experience more serious health effects.
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

Figure 2a EPA Recommendations for AQI impact on health (source epa.gov)

Dashboard View

Once SenseiAQ has run for several minutes, it will begin to calculate AQI Values every 60 seconds. The results for larger particle sizes are displayed on the dashboard. Historical values will be displayed in the bar graph over time, and placing your mouse pointer over any bar graph value will show the details about AQI during the selected timeframe. The PM Values detected update every 1 second and display the PM concentrations in ug/m3.

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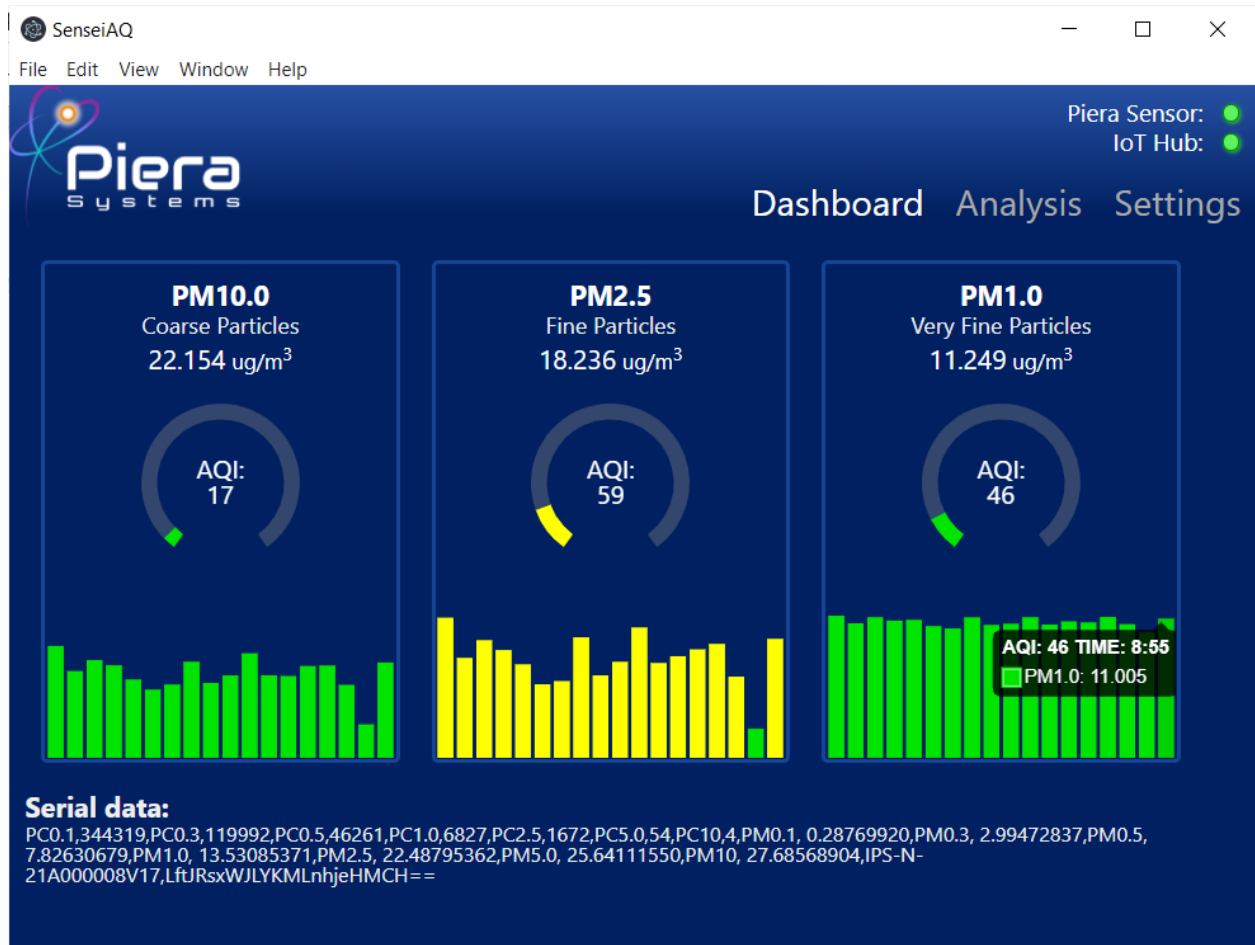


Figure 4 – Dashboard view of SenseiAQ operating normally.

Analysis View

This view allows for more detailed analysis of the data in real-time and provides the ability to include or exclude certain PM resolutions on a historical line chart. The charts can be updated by clicking the Refresh button or automatically by enabling the Auto-Refresh checkbox. Selecting a PC size value will exclude that data from the chart.

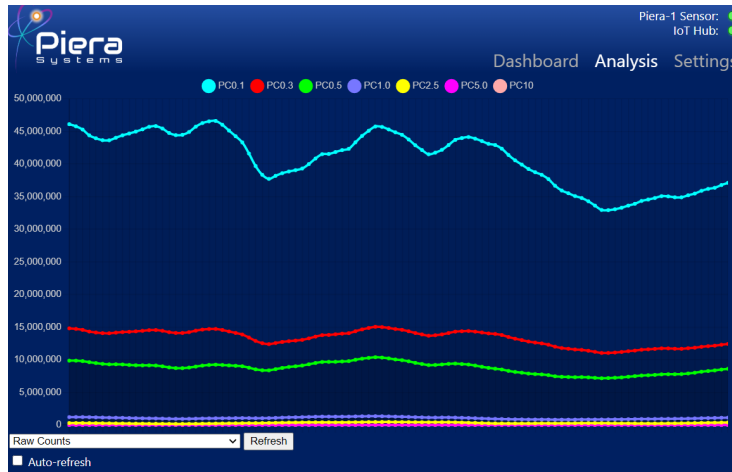
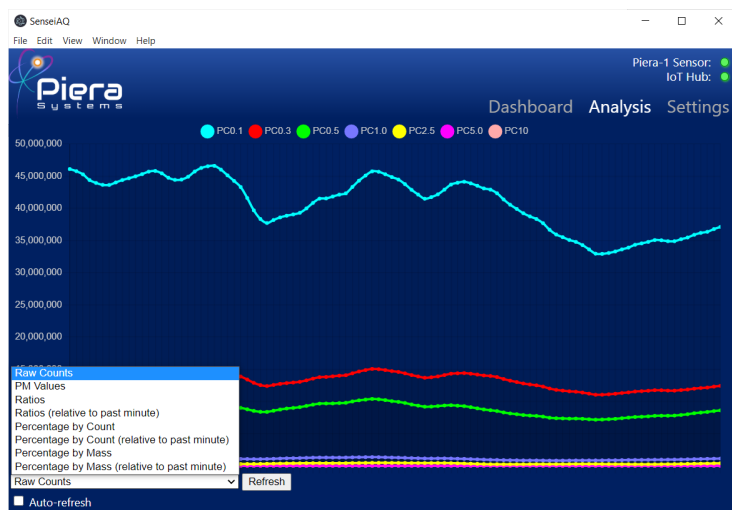


Figure 5 – Analysis View showing all PM Size raw counts.

In addition to Raw Counts the Analysis tab can also display PM Values, Ratios between PM Values or Percentage by Particle Count or Mass. A “Relative to last minute” option is to compare minute averages.



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WebRelay Integration Notes



Canaree i1 Supports sending HTTP Commands to a WebRelay device via the Ethernet or Wifi network. WebRelay is an electrical relay (or electrical switch) with a built-in web server. The relay can be turned on, off, or pulsed using a web browser or Canaree i1. It has a long history of reliable operation in many applications including remote reboot, industrial control, security, and remote control and monitoring for more information visit <https://www.controlbyweb.com/webrelay/>

In this solution each Canaree i1 can be configured to connect to a WebRelay's URL to start or stop the relay, and this can be done automatically at specific PM Limits for PM1, 2.5 10. In this configuration the relays will be turned ON whenever the PM Thresholds are exceeded, and turned OFF only when the PM Thresholds are no longer exceeded. This can be used to control Exhaust Fans, Air Purification Systems or UV Lighting devices.

A manual Relay On/Off mode toggle is provided for testing the relay. To configure Canaree i1 for a Web-Relay you must enter the stop-start URLs before enabling Relay Mode on the device. The following commands are provided as examples when configuring WebRelay using their default values.

- `%Wrelayurls=http://192.168.1.2/stateFull.xml?relayState=1,http://192.168.1.2/stateFull.xml?relayState=0`

ON and OFF URLs to HTTP GET for your specific Web-Relay use its real IP Address.

- `%Wrelayactive=1`

Enable the Web Relay controls by setting this value to 1.

- `%Wlimits=[pm1.0],[pm2.5],[pm10]`

Set relay PM upper-limits to auto-enable relay ON URL, for example Example:

`%Wlimits=35.5,35.5,155.0`



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Appendix C: Useful information on how to interpret data provided by SenseiAQ

SenseiAQ provides a lot of information. If you are knowledgeable on how Air Quality is measured, how the EPA reports Air Quality you might not need to read this section. If not, here are some helpful hints and some additional sources to help you interpret the data and take appropriate actions.

Figures 13, 14 show the values in micrograms/m³ for PM_{2.5} and 10 which are used to calculate the AQI values reported in SenseiAQ. Note that the values displayed by SenseiAQ are every minute (and can be adjusted) whereas the EPA index itself is calculated over a 24 hour period and is outdoors.. Nevertheless the AQI index itself serves as a simple, easy to understand scale together with mass concentration and particle count.

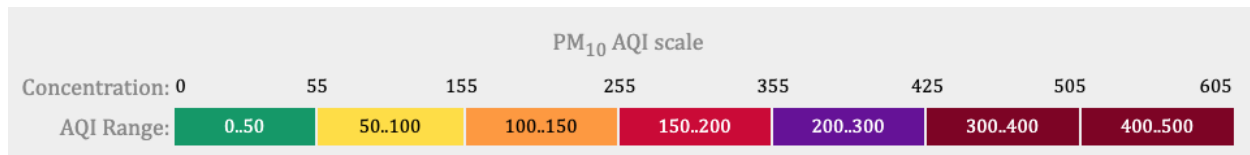


Figure 13 - PM 10 AQI Scale and Mass Concentration

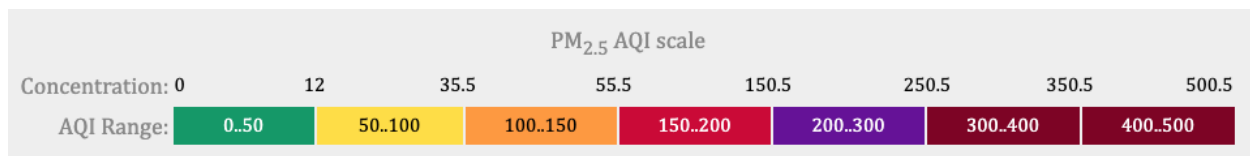


Figure 14 - PM 10 AQI Scale and Mass Concentration

SenseiAQ's Dashboard has 3 PM 'dials', for PM₁₀ (Coarse), PM_{2.5} (Fine), PM_{1.0} (Very or Ultra Fine) reporting mass concentration, the AQI and a minute by minute display for the last 60 minutes. See Fig. 13

Sample rate is controlled by software commands per [the data sheet](#) on our website.. The factory defaults are every second and the dashboard updates every minute. By default, the IPS starts to send data automatically via UART every 1 second as the device is powered up: a series of data strings containing particle counts (PC) and mass concentration (PM) data followed by both device serial number and its network serial key. The PC data is in #/L, and the PM is in ug/m³. Allow at least 5 seconds to obtain stable data. The IPS will run a self-cleaning cycle for 10 seconds once a week by default.

PM_{10.0} includes ALL particles 10.0 and below so it includes the PM_{2.5} and PM_{1.0} data. Ideally all 3 will be green but because PM_{2.5} and 1.0 are more dangerous the Mass Concentration (and particle count) limits are lower for the smaller particles per Fig 11, 12.. Good for PM₁₀ is < 55 ug/m³, for PM_{2.5} it's <

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12 $\mu\text{g}/\text{m}^3$, for PM1.0 there is no recommended MC value so we are using PM2.5. The EPA and other regulatory bodies will likely establish PM1.0 values that are lower than PM 2.5 For reference the WHO PM2.5 value is 10.0. Many countries have their own AQI scales with most higher but a few lower than the EPA.

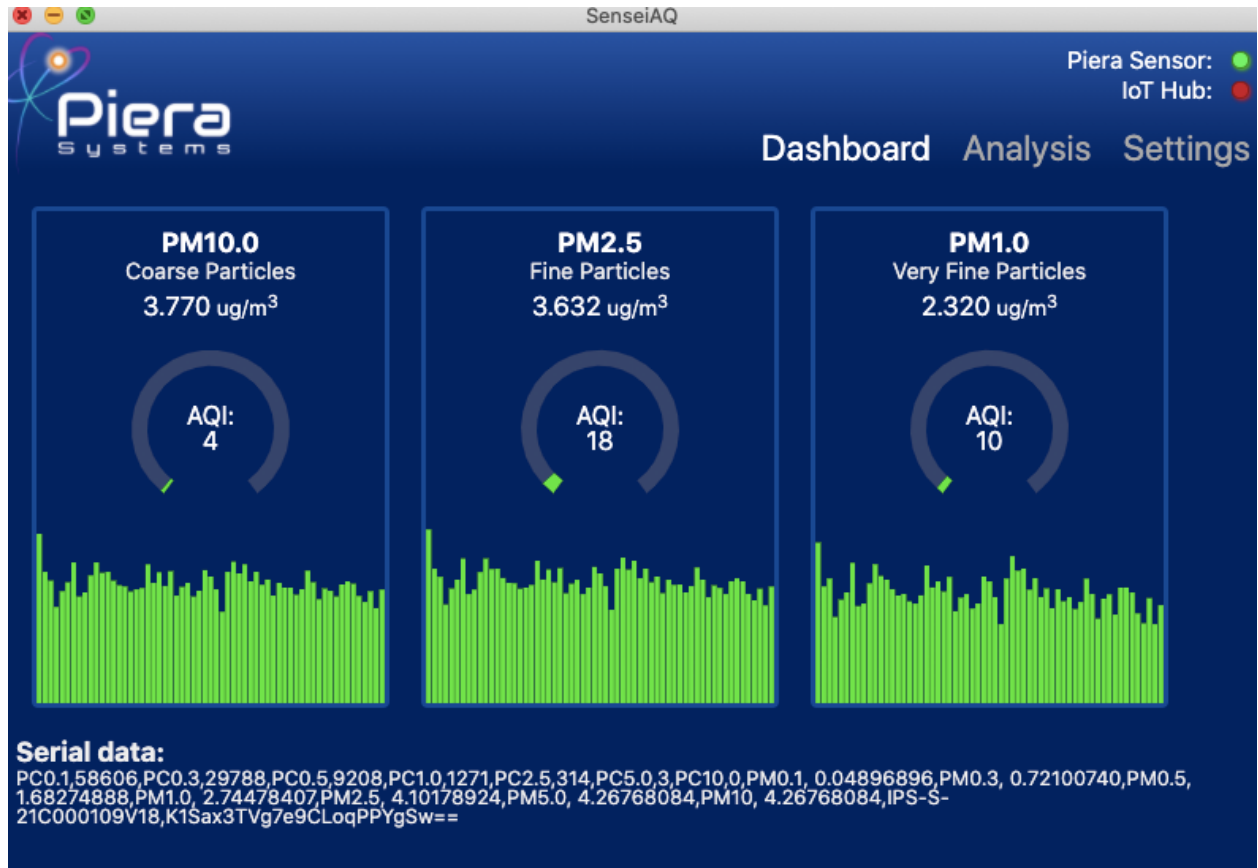


Figure 15: Good Air Quality for all PM values



Figure 16 Was taken in a home that had Hazardous Air due to Air Filters that were very dirty. The purple shows the Hazardous readings with MC ~500 ug, then the sensor was taken outdoors while the filters were replaced and the AC unit turned on (the green period) then it was brought back indoors and you can see the gradual clearing of the air. Since the filters were MERV-6 quality they don't filter out the Fine and UFP particles as well so they decrease but don't come down completely. You can see that while the PM10 is good (green bars on the right), the PM2.5 is still unhealthy. Note that of the 41.468 ug/m³ reported as PM2.5, 24.559 of that is PM1.0. It is only yellow because we are using the same scale as PM2.5. The point is that most of bad air is PM1.0 and below which is more dangerous and requires much higher MERV rating filters.

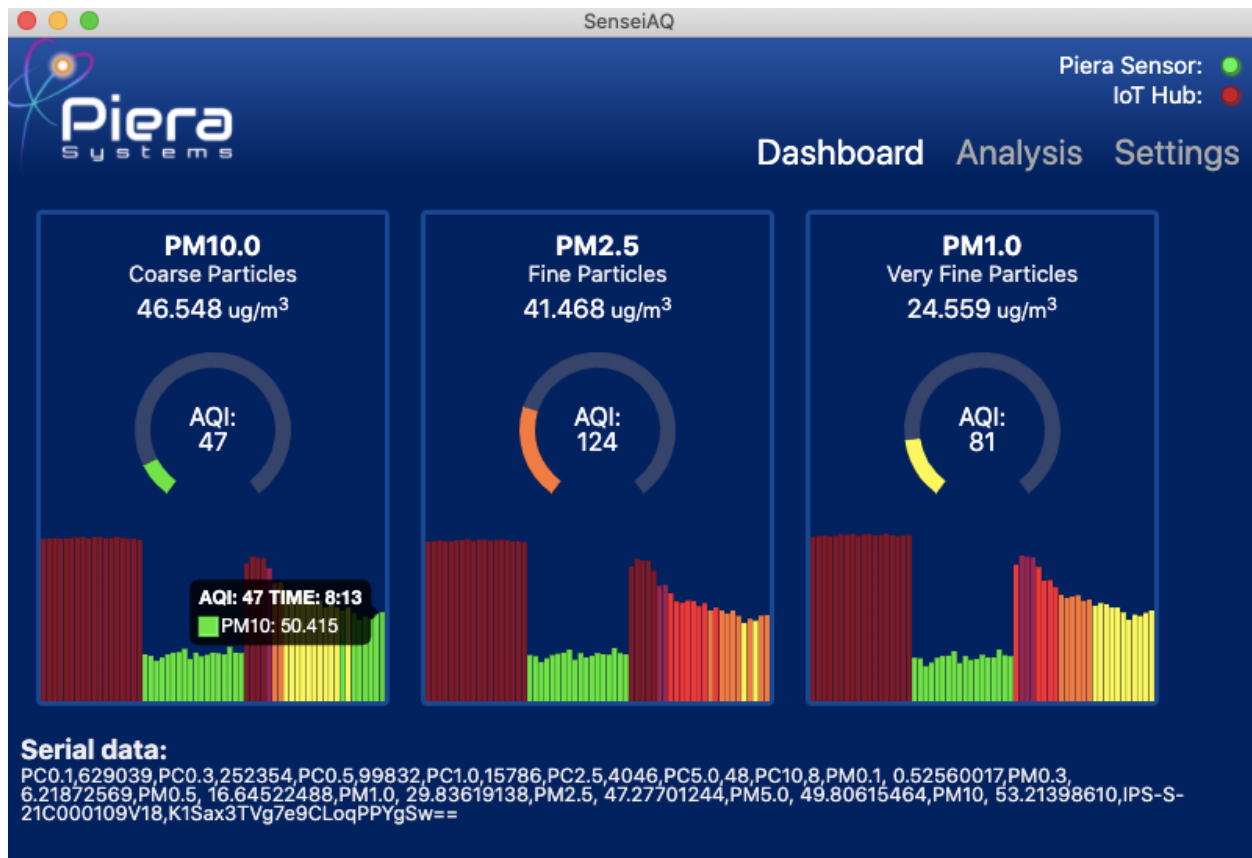


Figure 16: Poor Air Quality air due to poor filtration example

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Appendix D: Additional Reference Information on measuring Air Quality

[This White Paper](#), "Testing, Testing, 1.2.3.. discusses the EPA's test method for PM sensors and the IPS Test Report.

[California's South Coast Air Quality Monitoring District](#) which covers southern CA and Los Angeles has an excellent website and a program for testing and reporting on sensors and Air Quality monitors.

The EPA's [Airnow.gov](#) website and application shows real-time AQI data and also a Fire and smoke map and several other useful tools and educational material.

[LocalHaze](#) is a free application that displays outdoor Air Quality from a number of sensor networks including the EPA, Purple Air, etc.

The [EPA's Ai Sensor Toolbox](#) provides insight into the EPA's initiatives to help educate on low cost sensors.

The [Encyclopedia of the Environment](#) is a wealth of information regarding Particulate Matter and its health effects.



Appendix E: Canaree i1 Hardware Specifications

Software Specifications	Rating
Power Specs	PoE+ 48VDC via Ethernet Cat5 Port 5VDC @ 0.1 AMP Max via USB Adapter Auto Power failover from PoE+ to USB Onboard Power Isolation
Ethernet Specs	10/100 Ethernet Support via Cat5 Cable PoE Class 1 Device (1.5 watts max draw) Auto MIDI / Crossover
Wireless Specs	802.11n Support on 2.4Ghz Frequency Bands Supports Channel 1,6,11,13 (no 5ghz bands) WPA2 / PSK Wifi Authentication Factory Omni Antenna @ +4dbM Support via RP-SMA connector
USB Interfaces Specs	Type Micro - USB 2.0 Max Length 10m / 32'
Physical Dimensions	113mm x 50mm x 41mm
Piera Hardware Supported	Piera-IPS-3100™ Series Piera-IPS-7100™ Series
TCP/IP Specs	DHCP Support for Wired and Wireless Static IP Support for Wired Ethernet Static DNS, NTP Servers supported
Cloud Reporting Support	Native support for Microsoft Azure IoT Hub*
API Support	Direct Serial API (CSV format) Azure IoT via REST API in JSON format
3rd Party Relay Support	Support for 3rd Party Web-Relay https://www.controlbyweb.com/webrelay/
Web-Interface Language Support	English, Spanish, French, Italian

*1 Year subscription included with purchase of device. Extended subscriptions available with maintenance contract.