



IPS-Series, Canaree, SenseiAQ FAQ

General Questions brought in from Customer FAQ V1.5

How is the conversion from number concentration to mass concentration being done?

We'll use a statistical model to calculate this, details are proprietary. Most MC's from competitors are estimates and use assumptions about shape (sphere), porosity/density and particle size distribution. We have more detailed information on distribution of particle size. More details are in the test report and in the testing questions below.

Could you please briefly describe how you calibrate your sensor?

We test every sensor in a test chamber and perform final calibration and test before shipment, additional details available under NDA.

Does IPS support wireless communication or some internal storage unit?

The only communication is by USB cable or the UART/I2C interface, there is limited internal storage in the MCU. You could connect to an Aruba AP, Arduino, Raspberry Pi, or other IoT device for remote monitoring. Canaree I1 and I6 devices will have Wifi included.

While evaluating IPS, does it need to be always connected to the PC for data acquisition?

Yes or some other device that provides power and control, such as Aruba AP, Arduino, Raspberry Pi/

Can we switch the IPS sensor in the eval kit with another ? Can we order & kit and 2 or 3 sensors?

Yes, you can but Sensei AQ software communicates to one sensor at a time. You can use a USB hub to monitor multiple sensors and control them with your own hardware and software. SenseiAQ software currently only supports a single sensor running on each PC. Example Python code is available to run multiple sensors simultaneously on a PC for logging purposes only.

What does it mean by "Adjustable gain control for different applications"?

This is a feature on our ASIC to provide an option to customers who want to either use different type of photodiode with different sensitivity, or for detecting other particles/matters beyond IPS pre-programmed detection range of PM0.1-10.0 for example, pollen. It provides a measure of programmability that allows us or our customers to modify the sensor. It requires recalibration and testing by Piera.

Testing

For more information about testing see our white paper, [Testing, Testing, 1 2 3 ...](#) and our test report available under NDA.

What substances were used to calibrate the sensor (Cigarette smoke, A1, KCL etc.)?

Piera used a smoke detector tester spray as shown on the right. It produces particles in range from 0.1um to 10um with unknown distribution. The standard substance to calibrate optical particle sensors is Polystyrene Latex Sphere particles however, low-cost sensors calibrated with PLS particles tend to be inaccurate in real-life practice. The smoke detector spray produces random sized particles with various shape within the range, which is better representation of the actual environment.



What are the differences between TSI instruments and GRIMM?

TSI DustTrak is a nephelometer, and GRIMM 11D, Met One BT620 are spectrometers. In nephelometry, you would obtain mass concentration data. Spectrometry yields particle count data. The conversion between those two is done by algorithm but the particle count data is more accurate for spectrometric devices however, it takes a longer time to get data updated (ex. GRIMM 11D updates data every 6 seconds). To compare you'll need to adjust the real time data using RMS or some kind of moving average

What is the definition of mass concentration and particle number concentration?

Mass concentration is the combined weight of particles, measured by the gravimetric method which is weighing the particles fall within a certain size range. The high-end reference devices have a filter to sort out particles that are less than or equal to 2.5um from larger particles up to 10um. It is not possible to obtain an exact particle count number with the gravimetric method, and it takes hours to get a result because the instrument needs time to accumulate particles. Laser scattering method can yield particle count data much quickly but does not guarantee accuracy when it comes to mass concentration. It is an inherent limitation of optoelectronic sensors like IPS and other low-cost sensors because it is hard to estimate particle densities. In sum, if your system is getting mass concentration data, then particle count number needs to be estimated. If you measure particle counts, you would need to estimate the mass concentration.

Multiple factors influence particle concentration and particle concentration related calculations such as temperature and humidity. How does the strategy being leveraged by Piera account for the above or any other additional factors?

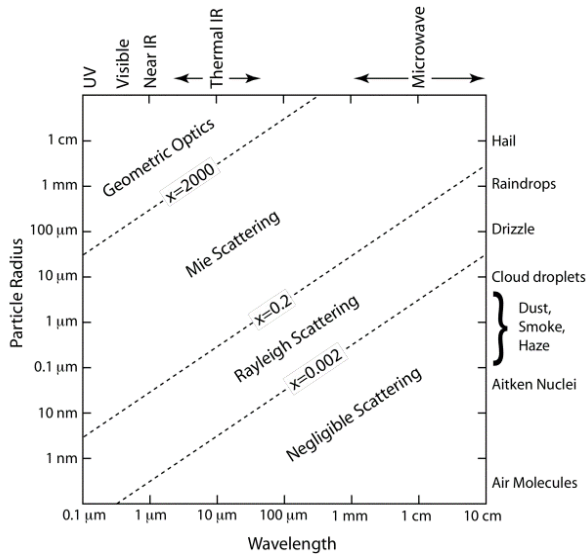
It is designed to minimize the effect of other factors such as relative humidity and temperature. In a typical indoor condition, temperature does not affect sensor performance significantly, but humidity can. We are working on refining our algorithm with further testing. [This paper](#) describes a method for doing so that leverages Particle Count, size and distribution.

Most reference grade equipment requires calibration to specific test aerosols. Would you say Piera is calibrated to tackle multiple aerosols or that there is a need for calibration/ a calibration factor for each aerosol we would want to test in the future? If the sensor is capable of providing accurate data without calibration what strategy is Piera leveraging to avoid calibration requirements that reference grade equipment recommend?

As of today, IPS is calibrated to tackle multiple aerosols and our internal evaluation was conducted with Met One's BT620 device with good correlation. However, we are planning to use specific test particles (PLS particles) to refine our calibration with other reference devices. Calibration is embedded within our algorithm and firmware, so no further calibration is required from the customer's end. However, accumulated dust will affect the performance of the sensor and thus regular cleaning is required.

There is advertised difficulty detecting particles below 2.5 µm especially ranges falling below .3µm in diameter, because they fall below the visible spectrum. What methods are Piera using to overcome this challenge?

Detecting particles smaller than 0.3um with accuracy is hard due to the difficulty in discriminating noise from the actual signal resulted by the particles. Also, the sensitivity of AFE is important. IPS has an advanced noise cancellation feature along with high gain AFE which allows the sensor to detect small particles with accuracy.



The datasheet for IPS states that it can be used for smoke detection, but you also advertise the canāree for this application, what is the difference between these 2 advertised products?

IPS can sense smoke particles and vape particles along with many others that fall within its detection range. Canāree is an Air Quality Monitor that has an IPS 7100 sensor which has a Vape, Smoke Detection algorithm (VSD) in firmware on the device. Both devices distinguish between smoke and vape signatures by analyzing their data pattern.

Your user manual states that we have the ability to adjust key features such as threshold voltage and AFE gain. How do these affect the performance of the sensor, what is the trade-off for either increasing or decreasing these values, what is the default setting and why?

Depending on our customers' needs, the AFE sensitivity can be adjusted via gain control. Higher gain setting is ideal for smaller particle detection focusing on instantaneous changes in concentration however, the overall detection range will be capped below 10 μm. AFE gain can be set too low for applications involving detecting larger particles such as pollens but, will be unable to detect submicron particles.

The threshold voltage control can be used to set the effective particle size detection range, or discrimination resolution. For example, a customer might change the threshold levels to focus on 0.1 μm – 0.5 μm with step size of 0.1 μm.

The default setting for gain control voltage is 1.8V but this may change at final test and calibration.

Piera states that they use Direct photon counting. Could Piera give top level description of what this details and what are the advantages to applying this strategy?

IPS can be considered as a hybrid of nephelometer and spectrometer, incorporating advantages of the both detection methods: Quick but accurate particle counting, especially for small particles.

I am assuming that data independence infers that that you are independently measuring each particle as opposed to using a transfer function for estimation. If I am correct, how does your algorithm perform compared to the competitor, do you have test results? If not, what does this characteristic refer to?

	Amphenol	Cubic	Honeywell	Omron	Panasonic	Plantower	Sensirion	Sharp	Winsen	Piera
Photo										
Model	SH-UART-64L	PM2105	480PMMA15C0	B591-LD101	SN-GCJA5L	PM25003	SPS30	GP2Y1022AU0F	ZH03	Piera-1
Unit price (USD) MOQ: 1000	18	28	35	8	19	24	20	8	35	25
Number of lens	2	3	4	1	3	3	4	1	3	5
PM categorization (PM)	2.5, 10	1.25, 10	1.25, 4, 10	2.5	1.25, 10	1.25, 10	1.25, 4, 10	2.5	1.25, 10	0.1 - 10
Data independence				✓				✓		✓

Yes, your assumption is correct. We have tested our sensor against Sensirion's SPS30 with Met One's BT620 reference device. The results are illustrated in our test report. IPS captures a unique distribution for each particle bin as opposed to SPS30 which states the accuracy for only PM2.5 data according to their datasheet.

Does the benefit of your tech lie in the algorithms used for processing / the front-end strategy that you are implementing or the combination?

It is the combination of AFE and the algorithm. Our unique AFE enables IPS to extract more detailed information related to particle size based on peak value, pulse width of analog signal after removing noise. The information is processed interactively by our proprietary algorithm to provide accurate data.

Business

What is the price of an evaluation kit?

\$199 plus shipping (US, \$25.00, Europe \$75.00, ROW \$100.00). This includes one sensor, cable, documentation and SenseiAQ software. Support is remote for 90 days after shipment.

Other

What is the lead time for delivery?

Eval Kits are available and typically ship within 5-7 days of order. Production units available now with 2-8 week delivery depending on volumes

How much inventory do you have?

Typically 1-3k units.

Where do you manufacture and who does it?

We manufacture in China, final testing is in Korea where units ship from. CM is proprietary, glad to discuss under NDA.

Can we update the firmware in the sensor? How is this done? Do you provide updates?

OTA (over the air updates) are available. We also support upgrading firmware directly. Details under NDA.. We do provide updates and enhancements to our algorithm.

What is the calibration process for IPS?

We are glad to provide details under NDA. In short, every sensor is tested in a comprehensive way in a test chamber, final calibration is done at that time.

Is IPS mechanically compatible to Plantower PMSA003 or Sensirion SPS 30?

It's physically a bit larger, the inlet and outlet are on opposite sides, the same connector is used. Details are on the data sheet.

Start of Product-Technical-FAQ's

How can I validate my sensor is working properly?

We recommend using SenseiAQ Software on Windows 10 or MacOS 10.15+ Platforms using the Piera-Evaluation Kit provided USB Cable to validate a sensor. SenseiAQ will factory-reset your sensor and validate proper and PM readings from all PM Size bins.

Can I use any Serial Terminal Program to communicate with the sensor?

When using the Piera-provided USB Cable your sensor becomes accessible on a COM Port using HyperTerminal, PuTTY or any other standard terminal emulation program.
See the IPS-Series Datasheet for serial commands and connectivity options.

What are the serial port settings for communicating with the sensor in UART mode?

115200 / 8 / N / 1 (No Flow Control)

Is there a way to restart the device directly in UART Mode?

Entering `$Wreset=` will soft power-cycle the device

What does the Factory configuration do?

Default configuration spits out PC and PM Data every second to serial port, as well as the sensors Serial number and IoT Keys. By default - PM values are displayed in ug/m3, PC values are in #/Liter

How do I reset to factory-defaults?

Each time you launch SenseiAQ App it will factory-reset the sensor. If using serial program Entering the following and your sensor will reboot with factory-default settings.

`$Wfactory=`

Can I change the units for PM Values output?

To change measured data unit, use the following command: `$Wunit=n` where $n=0, 1, 2,$ or 3
1 for PC/PM values per ft³ ,
2 for PC/PM value per m³ ,
3 for PC/PM value per liter.

Does SenseiAQ Support multiple Piera sensors simultaneously?

Example Python code is available to run multiple sensors simultaneously on a PC for logging purposes only.

Is there a program to communicate with multiple sensors on a PC/Mac ?

SenseiAQ software currently only supports a single sensor running on each PC/Mac. Piera offers a Python-serial based tool to read data from multiple sensors, each to a separate log file while displaying events and PC Averages. It can be modified to send commands to sensor for large-scale provisioning.

I was testing my sensor in I2C mode and suddenly its not returning any commands, can I reset it?

You may have changed the configuration to disable the sensor, connect it via UART or SenseiAQ to factory-reset it.

Is there an I2C \$Wfactory method?

Yes, the command is **0x2e**.

I want to connect my sensor to ESP32-based boards, do you have example code or libraries?

Piera can provide ESP32-IDE based libraries for sensor communication (both UART and I2C) and data conversions upon request.

Some are available on Github including:

<https://github.com/PieraSystems/7100-UART-example>

<https://github.com/PieraSystems/7100-I2C-example>

Does your sensor auto-clean? What about the high fan-speed setting?

The default factory setting is to initiate the auto-cleaning cycle for 10 seconds every week. It can be done manually with the cleaning command, or set to a different time interval. The fan runs about twice as fast during the cleaning cycle.

How do I stop the sensor from sending data continuously in UART Mode?

Enter `$Winterval=0` to stop auto streaming of data after bootup

Use `$Rget=` to retrieve a dataset for all PC and PM for previous seconds reading.

Use `$Wvsds=0` turns off the Vape / Smoke detection alerts on the Console.

Is there a warm-up time required to get accurate PC/PM Readings?

No specific warm-up time; however it takes about 6 seconds to sensor bootup and full fan speed to occur.

If dust has concentrated in the airstream, we recommend ignoring values for the first minute while the fan blows-thru any particles that may have settled.

SenseiAQ Software ignores the first 30 seconds of data after sensor is connected.

I tried issuing `$Won=200` in UART mode but nothing happened?

This command has been retired as of firmware version V1.6 For an updated list of UART commands please see the Piera IPS Datasheet

Is the Piera-1 or legacy Piera devices supported by SenseiAQ?

The Piera-1 is no longer supported in SenseiAQ Software, Cloud or Aruba solutions.

How much power draw will a Canaree require from USB Port?

0.08amps @ 5V continuous operation with fan running normally.

What is an acceptable range (lower and upper limits) of airflow rate for the specified sampling rate of 0.5 s?

0.05 - 0.1 CFM

Is there a specified angle in which the LASER/Photodiode has to be oriented to measure the scattered light in that angle? Is the orientation of LASER/Photodiode a trivial thing and could have any orientation? We ask this question because Shinyei sensor must be positioned vertically to ensure the right airflow and thus is not appropriate for mobile devices.

Our current design adopts a 90-degree angle. We can explore different angles according to your needs, but it will take ~2 months of testing and algorithm modification to assure that it does not affect the performance. The orientation of the sensor module is irrelevant. Shinyei and Sharp's sensors have to be oriented upright due to their air flow mechanism based on heat convection.

Does the LASER diode provide an Infra-red beam (at what wavelength range)?

We are using a 658nm red laser.

The laser we are using is Class 3B, with 160mW power, from a company called Quantum Semiconductor International Inc., Korea.

The company address is:

17, Cheonheung 8gil, Sungger-eup,
Seobuk-gu Cheonan-city,
Chungnam-do,
Korea 31044

There is no min or max limits in the datasheet, all PM values get displayed as cumulative for PMs for less than a certain size, all understandable. (By the way you have a typo on the datasheet, sensor specifications table, PM binning, condition 2 should read PM1.0)

Can you please share data on binning accuracy or parametrically collected PC and PM bin histograms so that I have a better understanding of the performance?

Confidential. The data sheet specifies overall PC accuracy of +/-10 %. Every sensor is tested and calibrated to meet this spec. There is a distribution of individual bins and devices however they are all tested to spec. Details are CONFIDENTIAL

Related to the above, **do you have any empirical data on crosstalk or isolation (however you would like to call it) between bins.** I acknowledge that is a pretty challenging test and this is the first question that we will get. This will help me remove any ambiguities right away.

The details would be CONFIDENTIAL

Except for the bin 0.1, every other bin is independent from each other.

Do you have I2C support / examples / API?

I2C libraries are here:

<https://github.com/PieraSystems/7100-I2C-example/blob/main/lib/lpsI2C/lpsI2C.cpp>

I2 example is here: <https://github.com/PieraSystems/7100-I2C-example>

Do we have any compensation for humidity?

Not at this time. It is planned in future product releases.

Do I have to wait 6 seconds after power-up / boot-up before I can read data?

Yes. The sensor needs to finish powering up before sending valid data. Always wait 6 seconds before reading data every time the sensor is powered on.

What is the power draw of the IPS-7100?

power draw in 'measurement mode' is 65 mA while it's 67 uA in sleep mode

What speed is the I2C interface running at?

100 KHz is the default

What's the sensor range? How far apart should the sensors be?

about 30 m³ for real-time event detection; 200 m³ for general purpose monitoring; and everything else is in between

What is the resistance of the internal pullups?

Our internal pullups are 4.7kohm. No extra pullup resistors are required on an I2C Bus.

What is the lowest voltage the sensor will accept before turning off? The data sheet says 4.5V, but we have seen the fan running on about 3.3V.

Our fan runs on 3.6V, but we do want a minimum power of 4.5V to the sensor.

Is there cross-talk or cross-pollination between our various bins?

No as our bins are distinctively measuring different sized particles.

What is the airflow rating for the fan?

0.2CFM

Aruba FAQ

I connected Canaree to my Aruba AP USB Port; however the device does not appear to power-on and I see no LED Lights.

If your Aruba AP is not receiving full PoE Power (30W @ 48V or uPOE+) the AP will shutdown the USB Port until available power becomes available. You can validate your Canaree powers on using a standard USB 5V Charger.

Can the Canaree be remote-mounted to an Aruba-AP using a USB-Extension cable?

Yes, a high-quality USB Type-A Extension cable up to 10 feet in length can be used.

How much Bandwidth does each Piera Sensor take up when communicating thru an Aruba AP to the Piera Cloud?

Approximately 8Kbps per sensor using 1 second update intervals.

That means 100 Sensors Connected to 100 Aruba APs would send 800Kbps

Does your solution support Aruba Instant-Access-Point (IAP) or Aruba Central

Yes, this is officially supported in the same 8.8 release as Aruba MC/VMC using the same configuration.

Where should Canaree be located?

Areas where AP's are already located that have high activity or foot traffic, entrances (lobbies), meeting rooms, bathrooms, cafeteria's, labs or industrial machinery in operation. In short, anywhere air quality can be impacted by people, machinery or ingress from outdoors. Canaree can be moved at any time so you can reconfigure as needed.

Can Canaree be used outdoors?

It's not designed for outdoor use. If the conditions warrant you could plug it into a sheltered patio or other space where it's protected from the elements however we don't recommend leaving it for extended periods.