



INTELLIGENT PARTICLE SENSOR

(IPS) FAMILY BROCHURE

Industry's First Software-Defined Family of PM Sensors for Measuring Particulate Matter and Air Quality

Sense, measure and identify particles in real-time with size-based categorization



IPS Family:

- Ultra-high sensitivity and accuracy across full range from PM0.1-PM10+
- Series 3, 5, 7 Devices measure and count particles in 3, 5, or 7 bins
- Bin sizes of PM0.1, 0.3, 0.5, 1.0, 2.5, 5.0, 10 report particle count, size and mass concentration
- Series X Devices have 7 programmable bin sizes from PM0.1-PM100
- Fast response time: < 0.5 seconds
- Low Power (< 65 mA continuous, idle, sleep modes)
- Self-Cleaning cycle
- OTA Firmware Updates
- I2C, UART, USB Interfaces enable a plug in replacement for existing sensors
- SenseIAQ software for control, measurement, reporting, analysis of PM data
- Evaluation Kit gets you started on your application

IPS Photon Counting Intelligent Particle Sensors

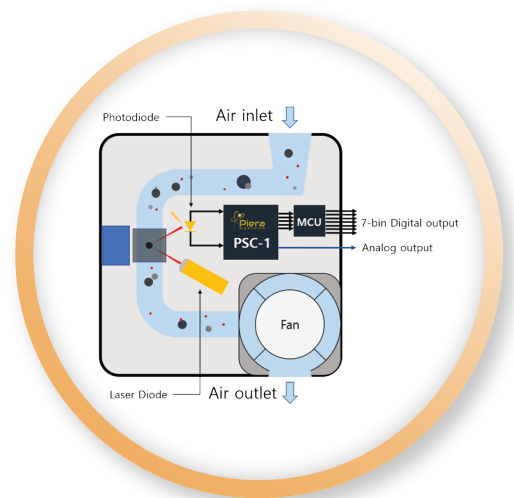
IPS devices use a breakthrough approach for detecting and measuring the quantity and size of particles suspended in air. Unlike existing PM sensors that are inaccurate¹, low-resolution and slow, IPS has superior accuracy, detects ultra-fine particles, counts every particle and its size in real-time with low power consumption. IPS uses a patented, photon-counting custom Integrated Circuit (PSC-1) to deliver a highly sensitive optoelectronic particulate sensor which correlates with expensive reference instruments at a low cost. IPS devices are available in fixed bin sizes or can be programmed over a wide range of particle sizes allowing a single sensor to be used in many applications.

For the first time, applications can take advantage of low-cost, accurate, detailed, real-time data about PM count and size. The data can be analyzed using algorithms and ML/AI to classify sources of pollution². An example is our proprietary vape/smoke algorithm which generates alerts in the presence of vape and cigarette smoke, reporting also the magnitude, duration and dissipation. Through additional testing and using data from other sensors we expect to classify additional PM sources through their unique signatures.

Detection of Ultra-Fine Particles (smaller than 1.0 micron in diameter) is unique to optical sensors at this price and will detect health threats that would otherwise go undetected and can impact people with underlying respiratory and health conditions³. Unlike other sensors, IPS accuracy and particle count distribution over its full range compensates for changes in Relative Humidity. When coupled with additional sensors for humidity, pressure, temperature, and gases, IPS devices deliver a superior Air Quality Monitoring Solution.

APPLICATIONS

- Air Quality monitoring/reporting and treatment systems
- HVAC equipment purifiers
- Smart Spaces (home, office, retail, industrial)
- Vape/smoke detection (pollen, silica dust, and other pollutants)
- Supplementary to spectrum analyzer for noxious gases
- Digital Health Applications
- Silica Dust Dosimeters
- Masks for mining and other industrial uses



FEATURES, BENEFITS, AND ADVANTAGES

| | Benefits | Advantages |
|---------------------|---|-----------------------------|
| Accuracy | High Correlation to Reference Instruments | Trusted |
| Real-Time Data | Rapid changes in AQ | Alerts, Notifications |
| High Resolution | Measure PM Count and Size | Identify PM Composition |
| Mass concentration | Report Air Quality Indices (US, EU, WHO) | Compare with Gov't Networks |
| PM0.1-10+ | Wide Dynamic Range | One Sensor vs Multiple |
| Low Cost | Cheaper to Deploy | More Sensors, Local Data |
| Low Power | Battery or Wired | Portable, Remote Devices |
| Small Size | Fits Easily into Other Devices | Add PM to Any Device |
| Programmable Bins | Customization | Differentiation |
| Standard Interfaces | Quickly Integrate | Upgrade existing products |

1 Common low-cost sensors are typically calibrated for PM2.5 and estimates other particle size data by extrapolation. Such devices are known to have issues with accuracy and reliability of data depending on environmental conditions.
 2 Can distinguish certain types of pollutants, not based on their chemical compositions.
 3 Ultrafine particles' contribution to weight is almost insignificant even with huge particle counts and thus, far under represented when it is converted to mass concentration data in PM. Recent studies show that the number of particles rather than combined weight of particles can have greater impact on human health.

SENSOR SPECIFICATIONS (see Family Table for specific devices)

| Particulate Matter Sensor Specifications | Conditions | Value | Units |
|--|----------------------------------|--|-------------------|
| Particle Count (PC) accuracy ¹ | - | ±10 | % |
| Particle Count (PC) resolution | - | 1 | #/Liter |
| Particle Count (PC) limit | Referenced @ 2.5um PC bin | 1,000,000 | #/Liter |
| Mass Concentration (MC) limit ² | Reference @ ≤2.5um particle size | 6,000 | ug/m ³ |
| Particle detection size bins | Mass and Number per bin | 0.1 ³ , 0.3, 0.5, 1.0, 2.5, 5.0, 10.0 | um |
| Lower limit of detection | - | <0.1 | um |
| Minimum sampling time | - | >0.1 | s |
| Startup time | - | 6 @0.2 s sample time | s |
| Lifetime ⁴ | 24h/day operation | >8 | years |
| Dimensions | - | 4.6 x 4.15 x 1.24 | cm |
| Weight | - | 26 | g |
| Operating temperature range | - | -10 to +60 | °C |
| Operating humidity range | - | 0-95% (non-condensing) | RH |
| Storage temperature range | - | -40 to +80 | °C |
| Electrical Specifications | | | |
| Interfaces | - | I ² C, UART, USB | - |
| Supply voltage | - | 4.5 - 5.5 | Vdc |
| Average supply current | Measurement-mode | 65 | mA |

1 Deviation from reference counter (GRIMM 11D model year 2006) based on average readings over a 3-minute period. The accuracy is verified after calibration using a Smoke Detector Tester Spray, SDI LLC. Contact Piera Systems for further details.

2 Mass concentration detection limit is estimated for PC2.5. May vary depending on size and density of particles.

3 PC0.1 and PM0.1 are estimated by extrapolation.

4 Lifetime might vary depending on different operating conditions.

DEVICE FAMILY TABLE (see Datasheets for complete specifications)

| IPS Family | | Eval | Series 3 | | Series 5 | | | Series 7 | Series X | |
|--------------------|---|---------|-----------|------------|-----------|------------|------------|------------|----------|-----------|
| | | Piera-1 | Piera-305 | Piera-3100 | Piera-525 | Piera-5100 | Piera-5500 | Piera-7100 | Piera-X7 | Piera-X7U |
| # of Particle Bins | | 7 | 3 | 3 | 5 | 5 | 5 | 7 | 7 | 7 |
| Dynamic Range | Binning Output Mass Concentration (PM) | <0.1 | X* | X | X | X | X | X | X | X |
| | | 0.3 | X | X | X | X | X | X | X | X |
| | | 0.5 | X | X | X | X | X | X | X | X |
| | | 1.0 | X | X | X | X | X | X | X | X |
| | | 2.5 | X | X | X | X | X | X | X | X |
| | | 5.0 | X | X | X | X | X | X | X | X |
| | | 10 | X | X | X | X | X | X | X | X |
| | | 50 | X | X | X | X | X | X | X | X |
| | | 100 | X | X | X | X | X | X | X | X |
| Features | Output in Particle Counts | X | X | X | X | X | X | X | X | X |
| | Serial Key for Networking | X | X | X | X | X | X | X | X | X |
| | OTA Firmware Updates | X | X | X | X | X | X | X | X | X |
| | Limited Programmability | X | X | X | X | X | X | X | X | X |
| | Full Range Programmability | X | X | X | X | X | X | X | X | X |

SenseiAQ Software for Real-Time Air Quality Monitoring

SenseiAQ software for Piera Systems collects live-data from USB-connected Piera IPS sensors for real-time logging and analysis of Particulate Matter (PM) as well as alerting on Air Quality Index (AQI) fluctuations over time. SenseiAQ can be installed on a PC or also Cloud-Enables a locally-connected sensor providing an IoT Gateway functionality on a Client PC, Mac or Android device ensuring the data can be stored, viewed and analyzed remotely through the Piera Systems Cloud Solution based on MSFT IoT Hub.



Fig. 1. SenseiAQ dashboard

SenseiAQ Software displays the data on a dashboard including Air Quality Index (AQI) Scores, color-coded based on EPA Limits and alerts for vape/smoke and particle count thresholds and distributions. The software is provided with all Piera sensors while the Cloud-reporting functionality is included for all customers under a yearly subscription / maintenance agreement.

Features

- Displays Real-Time Particulate Mass concentrations PM0.1 – PM10
- Auto Calculates and displays latest AQI scores every 60 seconds
- Dashboard displays PM1.0, PM2.5 and PM10.0 values in $\mu\text{g}/\text{m}^3$ and corresponding AQI for each PM Size
- Color-Coded AQI Values correspond to EPA Guidelines for PM concentrations
- Fast data acquisition and sampling (1 sec.)
- Supports Windows, MacOS, Android OS
- IoT-Enables USB-connected Piera sensors
- Supports Export to CSV for local data logging, backup or analysis in MSFT Excel

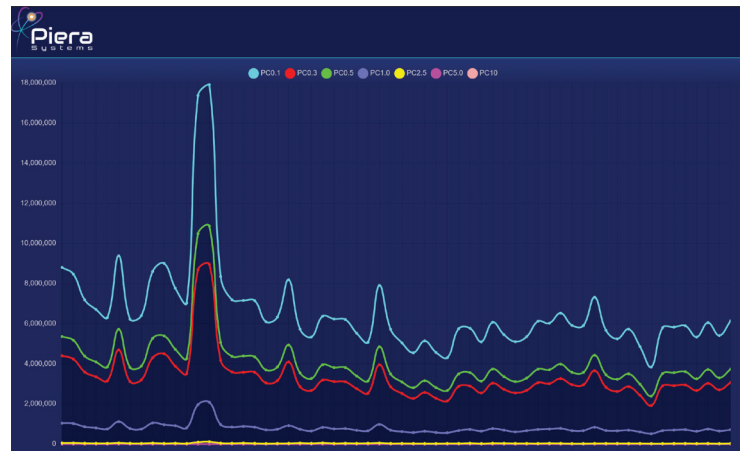


Fig. 2. SenseiAQ analysis charts

Testing, Calibration, Correlation, Certification

All IPS devices are tested and calibrated with Grimm 11-D reference instruments prior to shipment. Certification completed at PM1.0, 2.5, 10 by Korea Electronics Technology Institute. For details, contact Piera Systems.

