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Pegasor PPS-G2
Technical Specifications

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1 Description

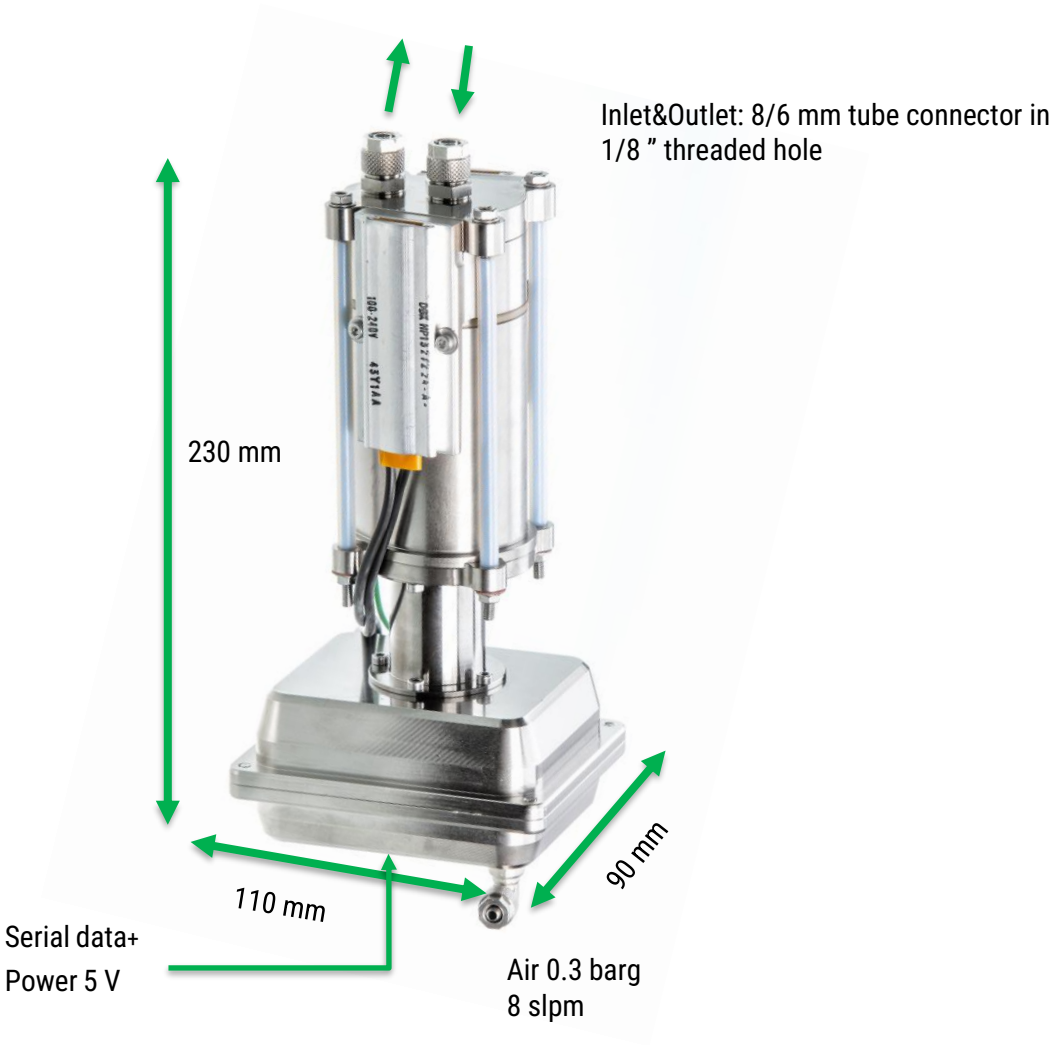
The Pegasor PPS-G2 sensor offers a comprehensive solution for precise and consistent particle number concentration monitoring. Originally designed for periodic technical inspection (NPTI) measurements, the PPS-G2 now comes with a range of features that make it an ideal choice for a variety of ultrafine particle monitoring applications. Designed for OEM integration, the PPS-G2 offers a range of data communication options that allow seamless integration into larger systems.

The PPS-G2 operation is based on the unique Pegasor patented technology using the escaping current technique to detect particles. In this technique, the particles are first charged in a corona-ionized flow and then detected electrically as they exit the sensor. The unique design of the PPS-G2 sensor ensures continuous and stable sample flow and it keeps critical parts of the sensor clean, eliminating the need for frequent maintenance even during long-term measurements and high-concentration environments. The PPS-G2 sensor additionally uses an advanced form of dynamic trap sequencing to fulfil the detection efficiency requirements at different particle sizes.

In the Pegasor PPS-G2 sensor design, the sample treatment and particle detection are integrated to provide accurate and repeatable results for particle number concentration measurements. The sensor element in the PPS-G2 is heated and an additional VPR (volatile particle remover) is used for efficient hydrocarbon removal.

1.1 Sensor dimensions

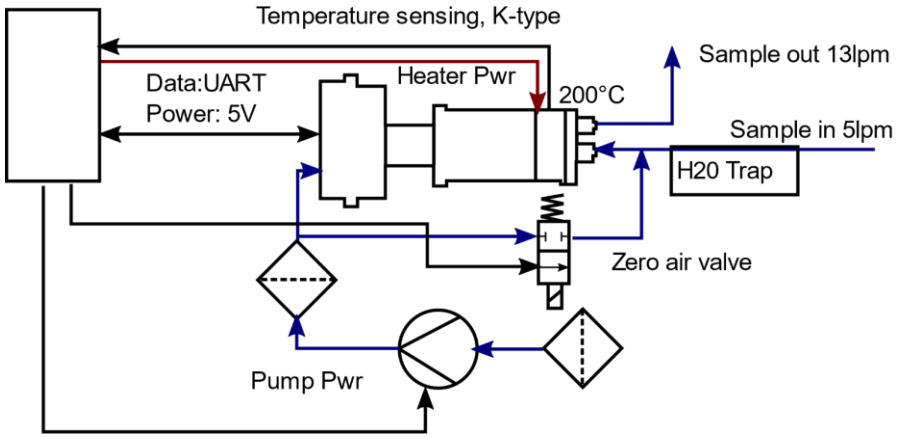
The PPS-G2 sensor dimensions (without thermal insulation) are 230 mm x 110 mm x 90 mm. The required insulation material thickness is 1.5 cm to constrain the heater power below 60 W.



1.2 Schematic and operation

The PPS-G2's unique design combines diffusion charging with an ejector pump that automatically pulls the sample into the sensor once the air supply is switched on. The sample is drawn in either via a nonheated or slightly heated (<60 °C) sampling tube to prevent any condensation. In standby mode, the zero air magnetic valve is open pushing filtered zero air into the sensor. This way, the sensor is protected from contamination and there is a possibility to perform the zero level check while the sensor prepares for measurement.

The first part of the sensor is heated to 200 °C to evaporate any volatile components from the measured particle sample. The sample is kept at elevated temperature during the entire measurement as the sensor head is kept at high temperature of 150 °C throughout the sample path. After the heater section, the particle sample is charged in the ejector operated by the corona-ionized air. After charging, the charged particle are detected when they exit the sensor and this charge is a direct measure of the particle concentration in the sample. Before the charged particles exit the sensor, the sample flows through the ion trap section which serves two purposes. Firstly, it is used to remove excess ions from the sample and secondly is used to the perform particle size measurement by switching it on and off with very short time intervals. This method improves the accuracy of of the particle number concentration measurement data as the charging efficiency is slightly dependent on particle size.



An external pump is used to drive the ejector pump, to protect the insulators from contamination and to provide zero air for the sensor. During the zeroing, the clean air from the pump is directed to the inlet of the sensor.

2 Mechanical and electrical interface

2.1 Air supply

The air from the external pump must be delivered to the sensor with silicone-free tubing and the air path must not contact silicone parts or silicone greases. The air requirement during measurement is 8 lpm at 300 mbar, and if same source is used to produce zero air and flush to the hose, a margin for additional 5 lpm needs to be provided. Lower pressure during zeroing operation is acceptable.

2.2 Temperature sensor

The temperature sensor installed in the heated section is of K-type.

2.3 Connections

Sample inlet and outlet are with 8 mm od/6 mm id conductive tubings. The connectors are exchangeable with the connectors to the 1/8” threaded holes.

2.4 Power and data connection

Electrical power and data connection to the sensing electronics is via 4-pole M8 connector.

The heater is self-regulating for maximum safety, but external control is needed to keep the measurement point at 200 °C. The power required at steady operation state is max 70 W for the heater and 2.5 W for the sensor electronics. During warm up, the heater can draw up to 700 W but only momentarily. In case the available power is limited, an external limiter can be used, or the two heating elements used sequentially until the internal temperature of the heaters rise an reduce the power draw.

3 Sensor data interface

The sensor must be powered over 5 V DC, preferably isolated power source. All the external sensing and power interfaces must be grounded to the same level carefully and/or floating to prevent ground loops in the sensor. Ground currents caused by uneven ground levels can induce noise, drift, communication errors or damage. The sensor communication is prepared to be available with a 3.3 V RS232 interface. The information available from the sensor is:

The data message from sensor gives out following measurement and diagnostics values:

- Status
- Relative humidity of pump air (%)
- Particle concentration measurement (#/cm3)
- air pressure (0.1 kPa)
- pump air pressure (0.1 kPa)
- electronics temperature (0.1 °C)
- particle size (nm)

Status consists of:

Status bit	Meaning	Set condition
Corona current low	Requested current could not be reached	Active when corona driver can not reach the set value. Adjustment necessary if does not clear when up to operating temperature and RH.
trap voltage error	Requested voltage could not be reached	Active when trap driver can not reach set value. Adjustment necessary if does not clear when up to operating temperature and RH.
pressure low	Feed pressure out of range	Active when feed pressure is below set limit
humidity high	Feed air humidity out of range	Active when relative humidity is below set limit. Wait for system to reach operating temperature and check for water in pump lines and filters.
impedance low	Measurement quality compromised due to contaminated main insulator	Set when impedance test cycle indicates loss of impedance. If not cleared at reaching operating temperature and RH limit, maintenance is required.
flow out of range	Flow out of range	Set when flow test cycle during diagnostic cycle indicates low sample flow. Indicative of clogging of sample line, sensor or outlet line, and/or low feed pressure.
measurement not valid	Any status bit raised	Any error that compromises measurement quality, raises this bit. Cleared when all error bits are clear.
startup sequence running	Sensor running diagnostics on startup	Set while startup diagnostics of the sensor are running. Cleared when diagnostic tests are done.
impedance test running	Sensor is testing main insulator impedance	Set while running impedance testing. Cleared when finished testing.
zeroing running	Command “ZERO” in progress	Set while running zeroing. Cleared when finished.
High voltage disabled	Corona and trap voltages disabled by command	Set when corona and trap drivers are disabled by external command, for example at standby mode to reduce wear and contamination.

These internal diagnostics ensure no measurement can be performed under fault condition, such as:

- short circuit caused by contamination
- pump or air line failure
- electronics failure
- electronics overtemperature
- contact failure
- water in pump intake
- filter failure in pump air

The data is transferred over serial data packet frame with a constant header and variable payload size. Every measurement value package is numbered with a running index and every frame is checked with a 16 bit checksum. The data interface documentation is available separately.

	Start	length	DATA	Chksum	End of frame
Format	1 char	2 chars	0-255 chars	4 chars	1 char
Example	STX (0x02)	28	0107F02200000EC903F2011D023201F712345678	08B7	ETX (0x03)

length = num of characters in data-field, 2 character hex number, uppercase letters
data = printable characters, 0 to 255 characters
chksum = 16bit sum of ascii values of <data> and <length> -fields, 4 character hex number (uppercase)

4 Specifications and ratings

Parameter	Test Conditions	Min	Typical	Max	Unit
Sample flow	25°C, VPR 200°C	5.0	5.4		lpm
Stagnation pressure	25°C, VPR 200°C	27	32		hPa
Flow sensitivity	25°C, VPR 200°C, change from nominal sample flow		-3		%/hPa
Supply voltage		4.96		5.3	V
Sensor current			0.1	0.5	A
Supply air pressure	25°C, VPR 200°C	285	300	315	hPa
Air consumption	25°C, VPR 200°C 300mbar		7.3	8	lpm
Heater Power	VPR 25°C to 200°C		60	700	W
Sensitivity (PN noise std/noise/conc)	1Hz, 25°C, VPR 200°C 100Hz, 25°C, VPR 200°C		200/1% 1500/5%	2000/10% 15000 / 20%	#/cm^3
Range	25°C, VPR 200°C	0		100 000 000	#/cm^3

4.1 Additional specifications

Particle size	10 nm – 1 µm for PN and LDSA. 10 - 300 nm for PM and Dp.
Response time	0.2 s
Sample flow rate	5.5 lpm
Optional data outputs	Serial, USB, Ethernet, CAN-BUS, Modbus
Power requirements	5 VDC, optional heater 230 V or 12/24 V
Dimensions	230 x 110 x 90 mm
Weight	1.4 kg

4.2 External requirements

- Filtered air < 8 lpm @ 300 mbar during measurement (+possible margin for zero air)
- Heater control (and VPR temperature measurement)
- Sensor power + data channel
- Sampling lines

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