A nanoparticle dosimeter for easy workplace exposure monitoring

naneos
particle solutions gmbh

Partector
Aerosol Dosimeter

Operation Manual
English

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CE RoHS Compliant ✓

Document information

Related device versions :   V2_3, V2_4
Related firmware versions : >397

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Abbreviations

DC   diffusion charging, diffusion charger
HV   high voltage
LED   light-emitting diode
LDSA   lung deposited surface area
μSD   micro Secure Digital memory card

Safety information

General notes and warnings

This operation manual must be read completely before using the partector. Incorrect use or handling and any consequences arising from this may damage the device or endanger personnel.
The manufacturer declines all liability resulting from incorrect use and handling.

Safety notes

Never operate the instrument at condensing conditions.

Do not blow into the instrument.

Do not open the partector as you may damage it.

Do not operate the partector with an open charger hatch.

The partector is a sensitive instrument made for measuring nanoparticles. Sampling too much coarse dust will eventually lead to deteriorating instrument performance. Use a cyclone when measuring in environments where large number of microparticles might be present.

Do not operate the partector in an explosive atmosphere or in the presence of flammable gases or fumes.

Have your instrument recalibrated once a year.

Instrument specifications

Measured value:	LDSA (Lung Deposited Surface Area)
Concentration range:	0-20'000 $\mu m^2/cm^3$
Particle size range:	10 nm to 10 μm
	Displayed LDSA value is only accurate in the size range of 20-400 nm; however, the instrument can be used to measure micron-sized particles too.
Accuracy:	± 30 %
Noise floor:	~ 1 $\mu m^2/cm^3$ in particle-free air
Time resolution:	4s (standard, faster as an option)
Airflow (active):	0.5 l/min
Battery power:	10h approximately
Charging:	via USB
Data storage:	μSD-card
PC Interface:	USB/serial by virtual COM-Port
Dimensions:	7.8 x 13.4 x 2.9 cm
Weight:	400 g

Checking the shipment contents

When unpacking the device, verify that you have received the following items. If any of the components are missing or damaged, contact naneos.

Type	Items
Standard	Partector device
	USB cable
	μSD-card 2 GB
	μSD/SD-card adapter or μSD/USB-adapter
	Neoprene sleeve (optional)
	USB charger
	Peli case

Getting started

Instrument description

The partector is a portable, battery powered instrument to measure the lung deposited surface area (LDSA) of nanoparticles. It displays the measured data on a graphical display and stores it on a µSD card. A user-defined LDSA alarm level can be set. If the alarm level is exceeded, the instrument's internal buzzer is turned on to produce an audible warning.
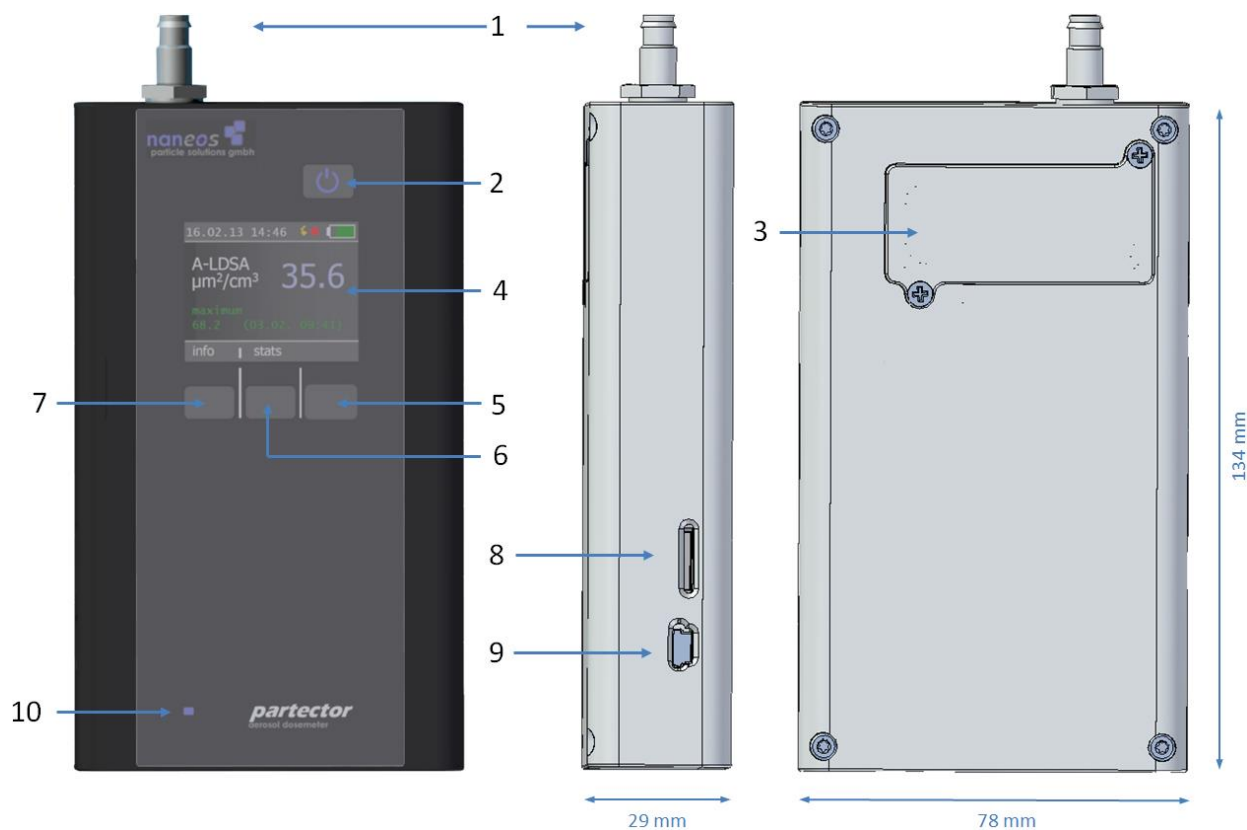

Figure 1: Partector main parts

1 inlet	5 right soft key	9 USB Port
2 power button	6 middle soft key	10 charge LED
3 DC charger hatch	7 left soft key	
4 display	8 µSD card slot	

Aerosol inlet and outlet

The aerosol inlet is located at the top of the instrument. The internal pump provides an air flow of about 0.5 l/min. The standard aerosol inlet has a 6 mm barb for tubing connection and contains a coarse wire mesh to keep coarse dirt and small insects out of the instrument.

The air exits the device via the USB-port and μSD-card opening in the housing. Note that the air is not filtered internally, so do not connect the instrument to hazardous nanoparticle sources!

Tubing

When using the Partector with tubing (to attach the optional cyclone, or for other purposes), make sure not to use conductive silicone tubing. This type of tubing is frequently used because with conductive tubing, there are no electrostatic losses of particles, and the silicone tubing is very flexible. Unfortunately, this type of tubing releases silanes which leed to rapid fouling of the Partector's corona wire. We recommend using PVC tubing instead – a nice flexible version is Tygon S3 E-3603. If in doubt about using tubing, please contact us. In any case, tubing should only be as long as necessary to prevent particle losses in the tubing.

Supplying power

To charge the partector or to operate it for periods longer than the battery lifetime, connect the partector USB port to a PC or Laptop or to a USB-Charger to charge the device.

While charging, the blue charge LED on the front panel lights up. When the partector is fully charged, it turns off.

Turning the device on and off

To turn the device on, press the power button. To turn it off, press and hold the power button for two seconds and release it when the goodbye message appears.

Insert / remove µSD-card

To store data on the microSD-card, insert it in the partector as shown in the graph till it snaps in.
To remove the µSD-card, press on the inserted card which will force the release. To insert the card in your SD-card slot on a PC you need to insert the card first in the µSD/SD-card adapter or µSD/USB adapter provided.
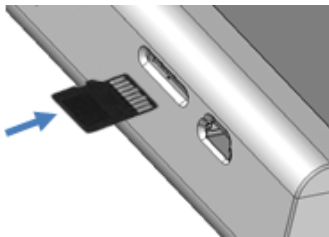

Figure 2a: Inserting the µSD-card

Figure 2b: Inserting the µSD-card into the adapter

Recording measurements on the µSD-card

If a µSD-card is inserted in the partector at startup, the device automatically starts recording on the µSD-card when the device is turned on. It automatically generates a filename depending on start date, time and device serial. For more information about this, read the "partector data file" section.

If you insert the µSD-card while the device is running, the data logging will not start automatically. You need to turn the device on after inserting the card.
Do not remove the µSD-card while the device is running. The data file needs to be closed properly, otherwise it will be corrupt.

Keypad functions & symbols

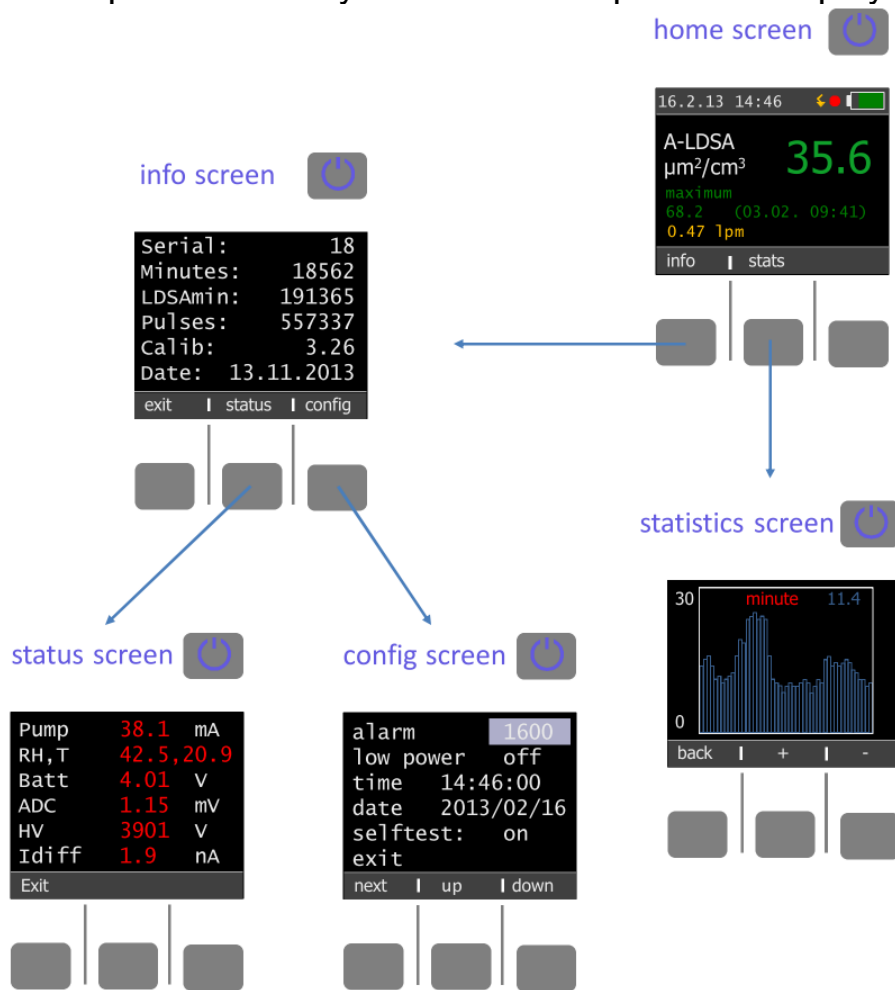In the picture below you can see the partector display screens:

Figure 3: Partector menu screens

Home screen

On the home screen you can see the LDSA concentration, date and time and also the charge state of the battery. If no key is pressed for more than one minute, the display goes dark to prolong battery life. By pressing any key, the display turns on again.

⚡	The lightning symbol indicates that the high voltage in the charger is on and working properly.
🔴	The blinking red dot indicates that data is being written on µSD-Card.
!	The exclamation mark indicates that an error occurred at some point during the current

measurement.

Below the measurement value, you can see the maximum value since turning on the device.

The approximate flow rate is displayed in yellow. The flow is measured from the time delay between charging pulse and electrometer signal; therefore, at low measurement values, it cannot be determined accurately. In this case, the display changes to --- lpm.

Color coding of LDSA values

The LDSA display is color-coded to provide a quick assessment of air quality. LDSA values below 50 $\mu m^2/cm^3$ are displayed in green, values above 250 $\mu m^2/cm^3$ in red, and values in between in yellow.
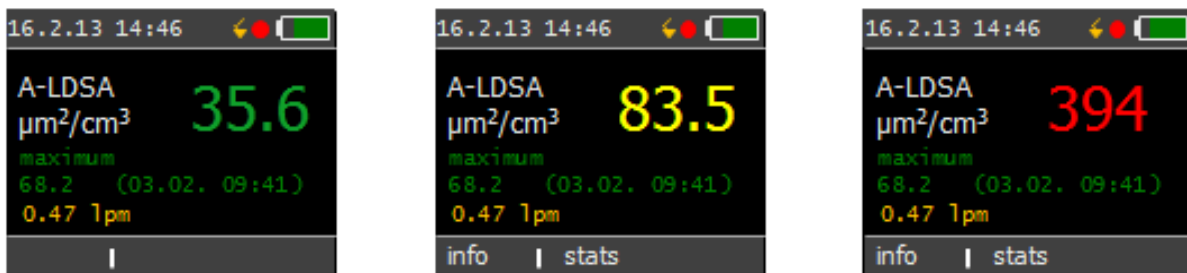
Figure 4: color coding of LDSA values

Electrometer gain calibration

The partector contains an in-circuit electrometer gain measurement, which is executed once per hour. The gain measurement takes 20s, and during this time no LDSA measurement is possible. During the gain measurement, the LDSA value is displayed in white in a sequence of first 000, then the gain value in % (approximately 100) and finally again 000.
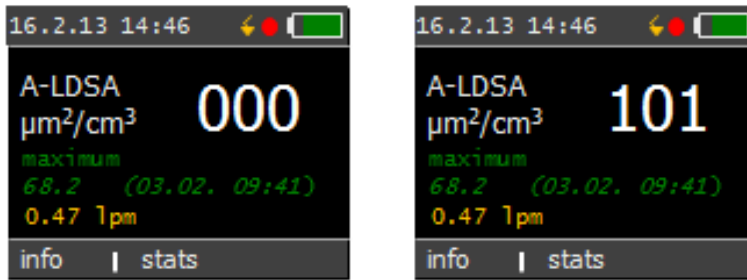
Figure 5: Display during gain measurement.

Measuring the gain periodically ensures that your data is correct, and that the aging of the instrument is taken into account properly.

Info screen

The info screen displays device specific system information:

Serial: serial number of the device
Minutes: total operating time in minutes
LDSAmin: LDSA value integrated over time
Pulses: number of high voltage charging pulses
Calib: calibration factor
Date: date of calibration

Pressing the "status" soft button brings you to the status screen. Pressing the "alarm" soft button brings you to the alarm screen.

Status screen

The status screen shows the most important device data.

RH,T   internal relative humidity [%] and temperature [°C]
BATT   battery voltage
ADC   electrometer signal
HV   charger corona voltage
Idiff   charger diffusion current

Config screen

In the config screen, you can change some settings of the partector

Alarm level: use the "up" and "down" soft key to change the alarm level to the desired value. When the measurement value exceeds the alarm level, the internal buzzer of the partector will produce an audible warning.

Low power mode: you can choose whether the device should operate in low-power mode or not. In low power mode, the display turns off automatically after a few minutes of inactivity to increase battery lifetime. Pressing any button (also the power button) will turn on the display again. The display will also turn on automatically if an error message is displayed.

Time and Date: the internal clock of the partector has an accuracy of about 1s per day. It does not change to daylight saving time and back automatically. Therefore, you may need to set the clock from time to time. Press the "next" soft button until you are on the field you want to modify, then use the "up" and "down" soft buttons to change the field's value.

Selftest: if the periodically electrometer gain calibration is incompatible with your measurement process, you can turn it off here.

Statistics screen

The statistics screen allows you to view events detected in the past. By pressing + and – you can change the shown time axis from minute to hour and day.

Extended operation information

Different inlet options

The partector comes with a standard inlet – a 6mm tube fitting with a steel mesh. You can use either this or you can add a cyclone in front of the tube inlet to remove coarse particles. The internal pump cannot support high pressure drops, so you should not use an impactor.

The partector is a miniature instrument with an extremely sensitive internal electrometer. Fibers or dust particles which are larger than about 1mm in size can produce short circuits in the instrument. Therefore, the tube inlet has a steel mesh to prevent really coarse dust particles or small insects from entering the instrument. If you do not use the inlet, you risk aspirating coarse dust that may result in a deteriorated instrument performance.

We recommend the use of a cyclone if you are measuring in environments where a large number of coarse particles are present. For example, the

SKC GS-3 cyclone would be useful for this purpose. http://www.skcinc.com/prod/225-100.asp
If you are certain that you have no coarse particles in your air (which is normally the case in ambient air), then you can also use the tube inlet.

The partector data file

To view the measured and stored partector data, remove the µSD and insert it in your PC as described in a previous section. Now you either download the partector data analysis tool from the naneos website to view the data or you open the data file with your favourite data analysis program (Excel, Origin, Igor etc). The data file is a simple tab-delimited text file. File names encode the recording time and device serial no. For example, if you start recording a file on 2nd August at 12:35 with a device with the serial no. 19, the file name will be stored in the folder 08_02 with the file name 019_1235.txt. Parameters like relative humidity, temperature, battery voltage etc. will only be recorded every 10 seconds.

The partector analysis tool allows you to quickly view graphs of all instrument parameters, to average data in different intervals, and to combine measured data with a GPS signal and plot it in Google Earth. Read the separate quick guide on our website for more information.

Error messages

Error conditions

Whenever an operation parameter of the partector is outside of its normal range, a warning message appears on the partector screen. The warning shows up in red on the home screen:

Figure 6: generic warning message on home screen

There are different reasons for warnings to appear, and a click on the "show" soft button will display details on the warning. Some error conditions may disappear again by themselves (particularly such related to high humidity), upon which the warning message will also disappear again. However, it can be important to know that an error occurred, and therefore, a red exclamation mark remains in the title bar as a reminder that an error occurred at some point:

Figure 7: home screen after recovery from an error condition

The following table gives an overview over the possible error conditions and on what to do to remove them.

message	possible cause	what to do
SD card error: "Card missing?" "file_fopen" "mkdir" "efs_init"	- no SD card inserted - SD card initialisation problem - bad card format	- insert SD card - reboot device - format SD card
Pulse low error	- too high relative humidity - device contamination	- try measurement with lower humidity - contact naneos
Pulse high error	- diffusion current does not reach setpoint	- open charger hatch and clean corona wire as described in the next section. If the message still appears, contact naneos.
Buffer overflow	- software loop time delayed.	- report error to naneos. You can still measure with the device if it only appears infrequently.
RH error	- relative humidity is very high and may hinder measurement	- if possibly, measure at lower RH (dryer)
EM zero offset high	- high RH - device contamination	- if possibly, measure at lower RH (dryer)

Some of the error conditions are rather harmless (e.g. high electrometer zero offset, high RH error), whereas especially the pulse errors will interfere with a correct measurement. If you experience frequent errors, please contact us by email, and send us a description of the error message, what you were doing when it occurred, and if possible, the data file of that measurement.

Maintenance

Cleaning the corona wire of the charger

Turn the device off before cleaning the corona wire! During operation, the corona wire is at high voltage and you will receive a slight shock if you touch it.

Open the two screws marked in figure 7 with a philips screw driver. Remove the charger hatch. Check condition of sealing o-ring. Contact naneos for a replacement if it is brittle or has visible cracks. Take an artist's brush and carefully slide it along the thin HV wire. Too much force can break the corona wire!

Figure 8: Charger hatch closed (left) and opened (right)

Disposal

The device contains a lithium ion battery and must be disposed of accordingly. Under no circumstances should it be disposed of with domestic refuse, nor crushed or burnt. Naneos offers to take products back for correct disposal.

Standards, approvals and patents

The partector is in conformity with the provisions of the following European Directives:

2004/108/EC	Electromagnetic compatibility (EMC) (successor of 89/336/EEC with amendments)
2011/65/EC	Restriction of hazardous substances (RoHS)

The technology of the partector is patent pending.

Related documents

Partector quick start guide:
www.naneos.ch/pdf/partector_quick_guide.pdf

Partector data analysis tool quick start guide:
www.naneos.ch/pdf/javatool_quick_guide.pdf

In-depth explanation of lung-deposited surface are (LDSA)
www.naneos.ch/pdf/LDSA.pdf

Customer service & contact

naneos particle solutions gmbh

Dorfstrasse 69
5210 Windisch
Switzerland

Mail: info@naneos.ch
Phone: +41 56 560 20 70

www.naneos.ch