GRIMM AEROSOL Technik GmbH & Co. KG

Manual version 2.2

Aerosol spectrometer

SERIES 1.129 “SKY-OPC“

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General

Annotation

Many soft- and hardware denominations which will be mentioned within this manual are registered trademarks and have to be treated this way. The author´s intention is to give you a complete and accurate information through this manual. Grimm Aerosol Technik does not guarantee completeness and accuracy of the following available information which therefore excludes entitlement to damages which result either collateral or directly from the usage of this manual and/ or the usage of the soft- and hardware. Grimm Aerosol Technik moreover is not responsible for damages which result from patent infringement or abuse of a third's party rights.

Due to continuous improvements and increments differences regarding instruction and illustration of this manual compared to available hard- and software may happen. If so, please ask for the current version of this manual.

Put hard- and software only after precise study of this manual into operation! The producer is not liable for damages which are caused through inappropriate initial operation, usage, cleaning, or operating errors.

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Available manual refers to:
The aerosol spectrometer series.129 “Sky-OPC“
M_E_1129-Sky-OPC_v2p1

Meaning of used symbols

In this manual following graphical symbols are being used in order to ease finding important hints and advices.

This symbol gives you useful hints which alleviate and optimize your work.

This symbol warns you against potential dangers which may lead to malfunctions or even breakdown of the hardware and how to avoid such mistakes.

1 Important hints for the customer

Laser class 3B in open state of the measurement device

- **The producer declines any direct or indirect liability if the operator opens or manipulates the devices!**
- This devices was built and inspected according to EN 61010 (DIN VDE 0411 T1), electrionic protection measures, and left the factory in a safety-related faultless condition. In order to keep up this condition and to guarantee a safe operation the operator has to mind following hints and warnings which are contained in this instruction.
- Operate the dust monitor only with the designated voltage (external power supply, 12V).
- Check if the power supply voltage is within the permitted range before you operate the power supply.
- The lithium-battery (SL-389; 3,6V; 1Ah) on the digital conductor board which is essential for the operation of the internal clock must not be charged and has to be replaced only by an authorized service technician when empty. The operation duration averages several years.
- Similarly charging of the lithium-battery inside the storage card (depends on model: CR-2016 with 3V and 60mAh or CR-2325 with 3V and 200mAh) is not allowed.
- If you expect that the device cannot be run safely anymore put it out of operation and ensure it cannot be run accidentally anymore. Expect a not safe operation if the device has apparent damages, is not working anymore, after long-term storage, or after heavy exposure during transport.
- **Attention! Laser class 3B in open condition of the measurement device!** Laser of class 3B emit a maximum of 0.5 Watts output during CW-operation. The direct look into the laser beam or a reflexion can lead even at a short exposure time to damage of the eyes. The dust measurement device must only be opened by trained service staff. Opening the laser unit can set laser beams of class 3B free. You will find advices in EN 60825 (DIN VDE 0837 T1). According requirements of rules for accident prevention VBG 93 "Laser Beam" are to be obeyed!
- Laser class 1 in closed state of the measurement unit! Laser of class 1 are not dangerous and safe for eyes even in case of malfunction due to manipulation or usage of optical additivesl (e.g. binocular, microscope etc.)
- The built-in fusible cut-out Picofuse 2A (super-flink); switching capacity 300A (32V DC) must only be replaced by trained service staff with the in the circuit documents specified type. For the devices is being secured through electronical excess-current cut-out the fusible cut-out will only respond at a severe malfunction.

2 Operating mode

2.1 Introduction

The aerosol spectrometer series 1.129 exists out of two components. The actual aerosol spectrometer and a so-called docking-station. Next to that an external power supply (12V) and an external vacuum pump for sampling air is necessary for the operation. This compact device was built for continuous measurement of concentration and particle size distribution of aerosol particles irrespective of the ambient air pressure . The test results can be output as particle concentration per size channel. The typical used unit is particle/liter. Measurements in the fast mode (via terminal program) with a metering time period of six seconds or faster the particle concentration will be output as particle/100ml. Other units like as particle/cft are choose able via software while online measurement. Light scattering measurement of single particles comes into operation within every device of the 1.100 series consequently also at the model 1.129 at which a laser diode serves as light source. The 90° light scatter with an about 60° angle of beam spread is directed via mirror onto a receiving diode (see figure 1 and 2). When particles cross the laser beam they emit a light pulse. After adequate amplifying the signal of the detector is being classified in 31 size channels.

The sample air is drawn via an external pump through the measurement cell. The flow rate of 1.2 liters per minute is guaranteed through a built-in critical orifice irrespective of the ambient air. A second integrated pump conveys the rinsing air which is extracted out of the sample air via a BQ back-up filter after the aerosol flow passed the measurement cell. Even the volume flow of the rinsing air is controlled by a critical orifice. By the use of rinsing air the fouling of the laser optics is being avoided. Moreover it is being used as particle-free reference air while the self-test of the device.

Previous to every measurement the device executes a self-test. Hereby also the function of the optical and pneumatic components is being assayed. The self-test takes approximately 30 seconds. Afterwards the actual measurement takes place which collects continuously every 6 seconds the aerosol particle concentration within the complete size range. Measurement settings with an even higher temporal resolution are possible via software. At this though the respectively lower or upper 16 size channels will be collected. Thus real-time measurements are possible. All test-results are being transmitted onto a storage card which you insert into the dust monitor. Through the built-in RS-232 interface the measurement device can be controlled and data can be sent to an external PC or printer. The data output can be effected according to the settings selectively within a temporal resolution of 1, 2, or 3 seconds just as in intervals of 6 seconds (fast mode) or as averaged values with a staged resolution from 1 minute up to 60 minutes (normal mode).

It is absolutely important to have knowledge of the existing board power supply (voltage, frequency) for operation inside airplanes!

2.2 The measurement principle

The sample air is directly lead into the measurement chamber through the aerosol air inlet or through the custom-designed sampling probe. The airborne particles are measured inside the optical chamber by light scattering. The scattering light pulse of every single particle is being counted and the intensity of the scattering light pulse classified to a certain particle size. The measurement principle is demonstrated schematically in the figure below:).

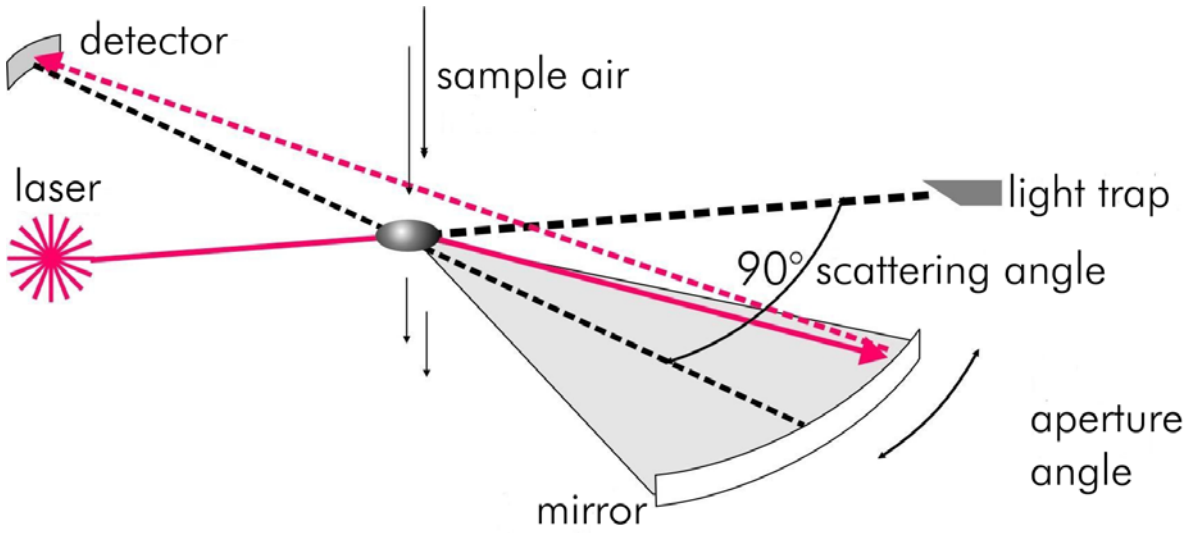


Figure 1: Measurement principle series 1.129, Sky-OPC

The light source for the aerosol spectrometer model 1.129 is a laser diode with a wave length of 655nm. The laser beam focuses by dint of a astigmatic illumination optic to a flat band. In the focus the laser beam illuminates a small measurement volume evenly and consequently is lead into a light trap. The sample air is focused aerodynamically and lead as particle flow through the inner area of the measurement volume. The total particulate matter of the sample air during environmental measurements in particular is so low that statistically there is only one particle within the measurement volume. Every particles´ scattering light is collected through a second optic using a scattering angle of 90° and is lead via a mirror with an about 60° aperture angle focused on a detector diode. The detector signal will be classified after amplification against the intensity into size channels. Figure 2 shows the assembly of the laser measurement chamber. The sample air duct into the measurement volume occurs perpendicularly to top view.

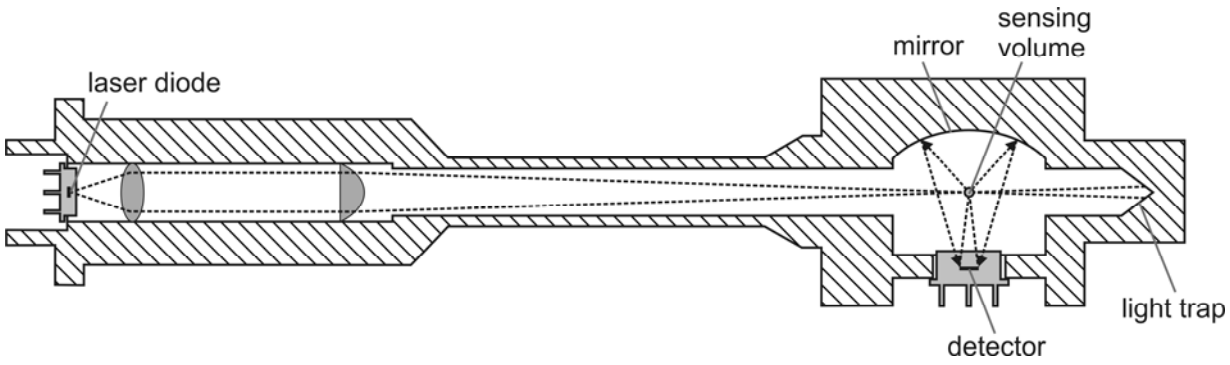


Figure 2: Laser measurement chamber series 1.129, Sky-OPC

The count rate results from particle count divided by volume flow rate. The particle size is proportional to intensity of the detected scattering light signal whereas the scattering light intensity is not only being influenced by particle size but also by the refractive index of the aerosol particle, particle shape, and the orientation of the particle inside the measurement volume. The positioning of the detector in a 90° direction enables minimizing the influence of the particles´ refractive index in order to determine the particle size. The aperture angle of the detector optic was chosen that way for ambiguousness of the scattering light intensity – they emerge inevitably from the usage of monochromatic light (laser) – will be compensated. Thereby a definite classification of particle size in sufficient narrow size classes is possible. The model 1.129 provides 31 size channels. By capture of the particle size and concentration the size distribution of aerosol particles can be determined.

2.3 Calibration

All devices are delivered with a certificate of calibration!).

The calibration condition of the spectrometer has to be checked annually. Therefore the device has to be sent back to the producer. There the device will be checked with help of a reference device (“mother device”). If required you can order a calibration stand and a reference device. In order to run the calibration stand a by the producer trained staff has to be appointed. The reference device has to be checked certified annually by the producer with a mono-disperse latex aerosol.

How does Grimm calibrate?

Calibration of aerosol spectrometers is done by all manufactures in a different way; let's call this method house standard - Why? There is no worldwide calibration standard for aerosol spectrometers, but all manufactures are to use same standard aerosol particles for size calibration (Poly styrene Latex, PSL). Our Grimm calibration house standard is based on a comparison between a well PSL-calibrated "mother unit" and a "candidate".

What's a Grimm "mother unit"

For the mother unit we calculate a calibration response curve with all the relevant parameters of our spectrometer (laser wavelength, position of detector, aperture of detector, PSL refractive index m = 1,60 +i0, etc..). Then we "feed" the mother unit with different mono disperse PSL samples and validate the particle sizing for this standard material. The original mother unit, let's say the grand mother also was validated against a reference laser aerosol spectrometer model LAS-X from PMS, Boulder Colorado. By this procedure, we assure correct particle sizing in the given size channels, e.g. 15 for a model 1.108 and 31 for the model 1.109.

Calibration, physics background

Particle sizing is calibrated with traceable Poly-Styrene Latex (PSL), Duke Scientific. So we measure Optical latex equivalent diameters. The size channels are related to electronic thresholds. A single particle passing the laser beam will scatter the incident laser light. This scattered light is collected by a mirror in a given angle and focused to the detector. The photons collected by the detector will give a "raw-signal", which will be amplified and classified in a particle size channel. So one can derive number and size of the aerosol particles.

Grimm Calibration procedure

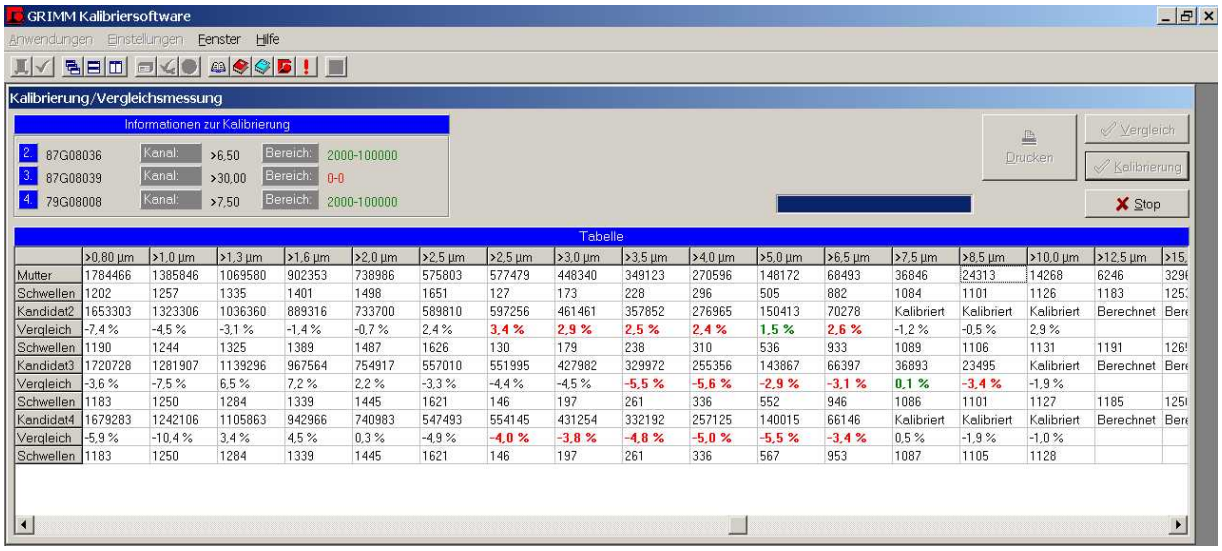
The calibration between a candidate and the mother unit is done by use of a fully computer controlled and automated "Grimm Calibration Tower" and poly disperse dolomite dust as a standard aerosol. Why dolomite dust? Dolomite dust is cheap, anoxic, not hygroscopic, poly disperse and very stable during

storage. The dolomite dust covers the entire sizing range for all Grimm spectrometer from app. 0.2µm up to >30µm. Due to the fact that both the mother unit and the candidate are manufactured identically, the dolomite dust must lead to identically results in both spectrometers. The dolomite dust is injected by a 40msec pulse of particle free compressed air at the top of the cylindrical calibration tower and dispersed homogeneously over the whole round cross-section. At the bottom up to three candidates and one mother unit are attached at identical aerosol inlets. A reverse flow of particle free compressed air from the bottom to the top of the cylindrical tower guaranties a well defined and reproducible aerosol particle distribution during the whole calibration procedure.

During the calibration the counts in every single size channel, starting from the biggest, are compared between the mother unit and the candidate simultaneously. The calibration software is able to compare six size channels at the same time. The statistical comparison is based on a mean value calculated by a set of 15 single values. A single value is displayed every 6 seconds. Depending on the measured particle concentration, the calibration software can adjust the electronically thresholds of the candidate.

Threshold lower = more particles in the channel

Threshold higher = less particles in the channel



	>0,80 µm	>1,0 µm	>1,3 µm	>1,6 µm	>2,0 µm	>2,5 µm	>2,5 µm	>3,0 µm	>3,5 µm	>4,0 µm	>5,0 µm	>6,5 µm	>7,5 µm	>8,5 µm	>10,0 µm	>12,5 µm	>15
Mutter	1784466	1385846	1069580	902353	738986	575803	577479	448340	349123	270596	148172	68493	36846	24313	14268	6246	329
Schwellen	1202	1257	1335	1401	1498	1651	127	173	228	296	505	882	1084	1101	1126	1183	125
Kandidat2	1653303	1323306	1036360	889316	733700	589810	597256	461461	357852	276965	150413	70278	Kalibriert	Kalibriert	Kalibriert	Berechnet	Ber
Vergleich	-7,4 %	-4,5 %	-3,1 %	-1,4 %	-0,7 %	2,4 %	3,4 %	2,9 %	2,5 %	2,4 %	1,5 %	2,6 %	-1,2 %	-0,5 %	2,9 %		
Schwellen	1190	1244	1325	1389	1487	1626	130	179	238	310	536	933	1089	1106	1131	1191	126
Kandidat3	1720728	1281907	1139296	967564	754917	557010	551995	427982	329972	255356	143867	66397	36893	23495	Kalibriert	Berechnet	Ber
Vergleich	-3,6 %	-7,5 %	6,5 %	7,2 %	2,2 %	-3,3 %	-4,4 %	-4,5 %	-5,5 %	-5,6 %	-2,9 %	-3,1 %	0,1 %	-3,4 %	-1,9 %		
Schwellen	1183	1250	1284	1339	1445	1621	146	197	261	336	552	946	1086	1101	1127	1185	125
Kandidat4	1679283	1242106	1105863	942966	740983	547493	554145	431254	332192	257125	140015	66146	Kalibriert	Kalibriert	Kalibriert	Berechnet	Ber
Vergleich	-5,9 %	-10,4 %	3,4 %	4,5 %	0,3 %	-4,9 %	-4,0 %	-3,8 %	-4,8 %	-5,0 %	-5,5 %	-3,4 %	0,5 %	-1,9 %	-1,0 %		
Schwellen	1183	1250	1284	1339	1445	1621	146	197	261	336	567	953	1087	1105	1128		

Figure 3: Screen shot of the Grimm calibration software during a running calibration with one mother unit and three candidates (in this example: Grimm Environmental dust monitors with 31 channels).

The columns in the table in Figure 3 show the 31 size channels. The lines in the table Figure 3 show from top to bottom: the counts of the reference unit, and for each candidate the electronically settings of the threshold, the counts of the candidate and the calculated relative error. To indicate the meaning of the relative errors three different colours are used:

Red values indicate a running calibration of a size channel out of range. Green values mean a running calibration within the range. Black values means, that the relative error is saved for quality assurance, the channel threshold is fixed and the channel is labelled with "Kalibriert" in the software table.

The mean value comparison is repeated approximately 10 times for each size channel, till all readings of the candidate are repeatedly within a given range with a accuracy of ± 2%, compared to the mother unit. The certified accuracy for the mass mode is ± 5%, because of the fact that the particle diameter affects the particle mass by the third power. The calibration software controls all relevant parameters also the amount of calibration dust, to assure that the measured concentrations are above a fixed minimum. All results are stored electronically and are activated in a data bank for quality assurance.

After the tower calibration a further comparison at indoor conditions is done.

To illustrate the described procedure the following two screen shots so called "ramp" from the Grimm calibration software CalSoft show two examples of a measured particle number concentration of a candidate compared to a reference unit before and after a calibration.

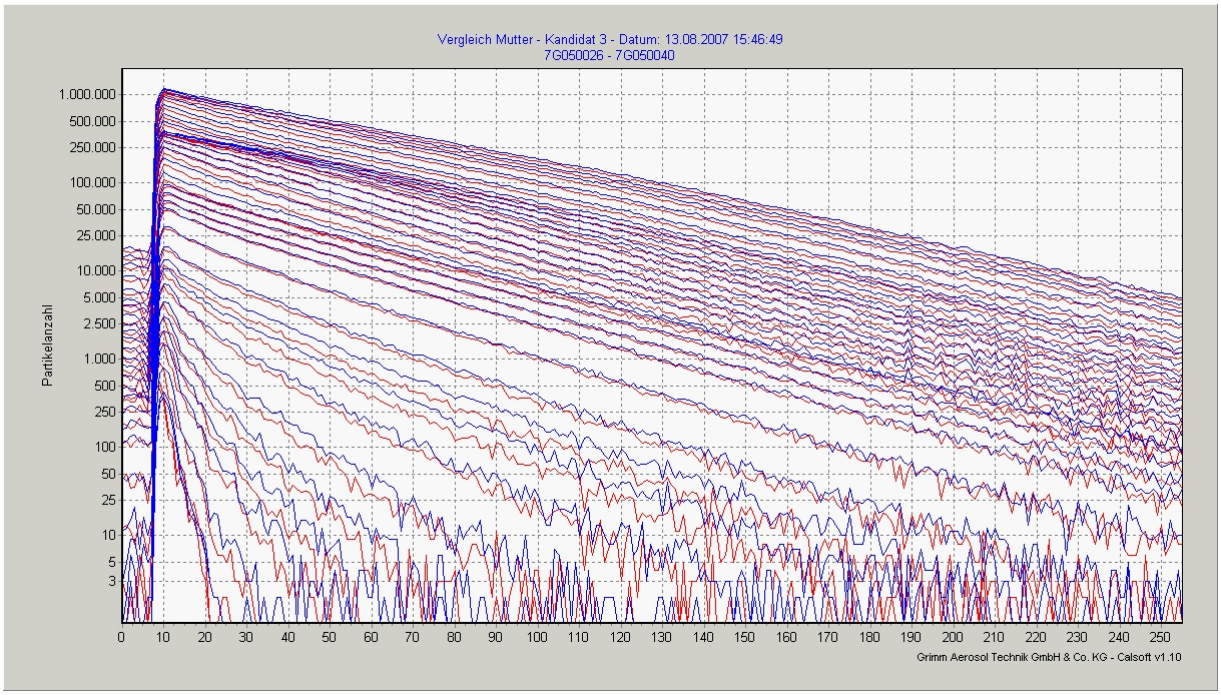


Figure 4: Before calibration: Simultaneously measured particle number concentration for all 31 size channels of the candidate (red) and the mother unit (blue) vs. time.

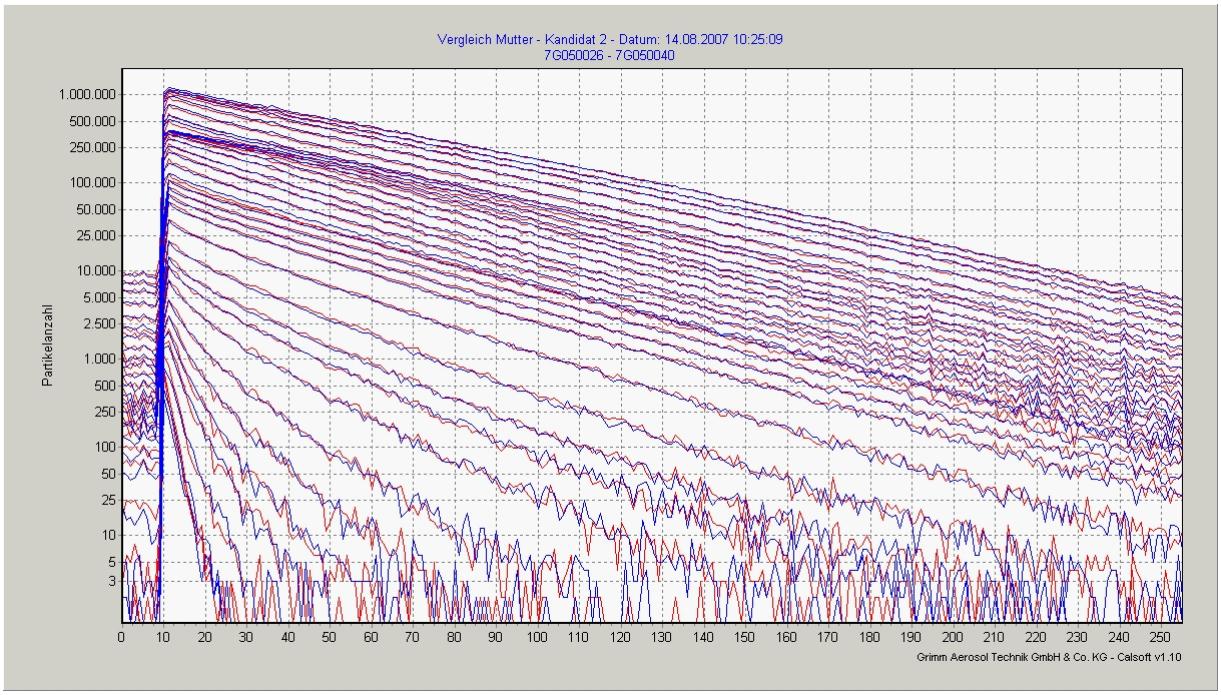


Figure 5: After calibration: Simultaneously measured particle number concentration for all 31 size channels of the candidate (red) and the mother unit (blue) vs. time.

3 GRIMM aerosol spectrometer series 1.129

3.1 Packing

After unpacking the device the shipment should be checked for totality with the enclosed packing list.
Included in delivery:

1 Sky-OPC with docking-station
1 Manual
1 Specific GRIMM communication cable

Further accessory according to chapter 3.2 is possible. Please contact your dealer or Grimm Aerosol Technk if you note damages or missing components.

3.2 List of accessory

Operationally necessary accessory

1.118-Sky	Manual Énglish (or German)
1.141	Special Grimm USB-data-cable for RS-232 or
1.143E	Special Grimm RS-232 connecting cable
N 86 KN.18	External vacuum pump, 230 V, 50 Hz, ca. 65 W, 6,0l/min, 100mbar abs.
????	External power supply
	**Attention!** An external vacuum pump and an external power supply are essential for operation. Those specifications comply with the demand of the application and conditions of the installation location(e.g. maximum flight height, voltage of board power supply, available space, etc.). If the by Grimm Aerosol Technik offered external vacuum pump or external power supply are not the mark **the customer has to care for an appropriate subsitute!**

Recommended accessory depending on application

1.142.A4	Data storage card with 4 MB storage capacity
1.177	Basic-software for all spectrometer of model series 1.100 (Version 3.30, state 2008)
1.148	Mini-filter for 0-test
1.153	Sensor for humidity (0 –100 %) and temperature (0,3 - +80 °C) with cable and plug
1.162	Plug for analogue socket
X5520-AP	Adjustable sampling probe for flow rates from 2,8m/s to 134m/s

Source of supply

Accessory and consumable is available at

Fa. GRIMM Aerosol Technik GmbH & Co. KG
Dorfstrasse 9
D-83404 Ainring
Germany
Tel.: +49 (0) 8654-578-0

Or at your local dealer

3.3 Technical data for model 1.129

Measurement principle:	90° scattering light detection
Laser:	Wave length: λ = 655 nm Capacity: P_{max} = 40mW P_{nom} = 0, 5/30 mW CW (Multiplex)
Size channels:	31 channels, the given channel thresholds [µm] apply to a count efficiency of 50% with mono-disperse latex-aerosols 0.25/ 0.28/ 0.3/ 0.35/ 0.4/ 0.45/ 0.5/ 0.58/ 0.65/ 0.7/ 0.8/ 1.0/ 1.3/ 1.6/ 2/ 2.5/ 3/ 3.5/ 4/ 5/ 6.5/ 7.5/ 8.5/ 10/ 12.5/ 15/ 17.5/ 20/ 25/ 30/ 32
Particle concentration :	1 to 2.000.000 particles/liter
Particle mass:	0.1 to 100.000 µg/m³ Displaying the mass distribution an additional channel up to 0.23 µm below the actual measurement range will be extrapolated throughout approximation of a lognormal distribution.
Reproducibility:	±3% over the whole measurement range
Sample volume flow:	1.2 l/min constantly through critical orifice, pump external!
Rinsing air volume flow:	0.4 l/min constantly through critical orifice, automatic subsequent cleaning in back-up mode (standby)
Self-diagnosis:	Automatically with every boot
Measurement time intervals:	Selectable: 6 sec normal (for 31 channels) or in a 1, 2, or 3 seconds interval for the lower or upper 16 size channels
Storage interval:	Selectable: 6 sec, 1 min, 5 min, 10 min, 15 min, 30 min, 60 min (for 31 channels) or 1, 2, or 3 seconds for the lower or upper 16 size channels
Communication:	Via PC and RS-232-interface, RS-232- to USB also possible
Data output:	Via PC and RS-232-interface, RS-232- to USB also possible
Analogue input	3 pieces (0-10V), resolution 10 Bit (ca. 10 mV)
Data interface:	ASCII: RS-232 (9600 Baud, 8 Bit, no parity, 1 Stop-Bit, protocol: Xon/Xoff)
Data storage card:	4 MByte, battery backed. Following data will be saved beside the measurement values: Date, time, measurement position number, temperature inside the device (*4) error code, pressure difference at critical orifice for volume flow (*255), pressure difference at critical orifice for rinsing air (*255), analogue voltage of the external senor (1 to 3) and ambient pressure
Power supply:	External 12V power supply, AC 95-250V, 47-63Hz
Operating temperature range:	0 to +40°C (32 to 104 °F) , r.H < 95% (not condensing)
Transport temperature range:	-20 to +50°C (32 to 104 °F), r.H < 95% (not condensing)
Sample air:	no corrosive or explosive gases
Pressure range of sample air:	>120 mbar

Continuance	**Technichal data for model 1.129**
Dimensions LxWxH	Docking-station 255 mm x 182 mm 72 mm Spectrometer 250 mm x 160 mm x 60 mm Total: 255 mm x 182 mm 72 mm
Weight:	Docking-station: 1.315 kg (2.90 lb) Spectrometer: 1.6 kg (3,54 lb) Total: 2.915 kg (6.44 lb)
Memory function:	The last in stand-by mode set display mode remains stored. During a power supply black out the averages of a measurement session with the associated sample volume will also be obtained so the measurement session can be continued automatically after voltage returned.

3.4 Technical drawing of the docking-station inclusive installation dimensions

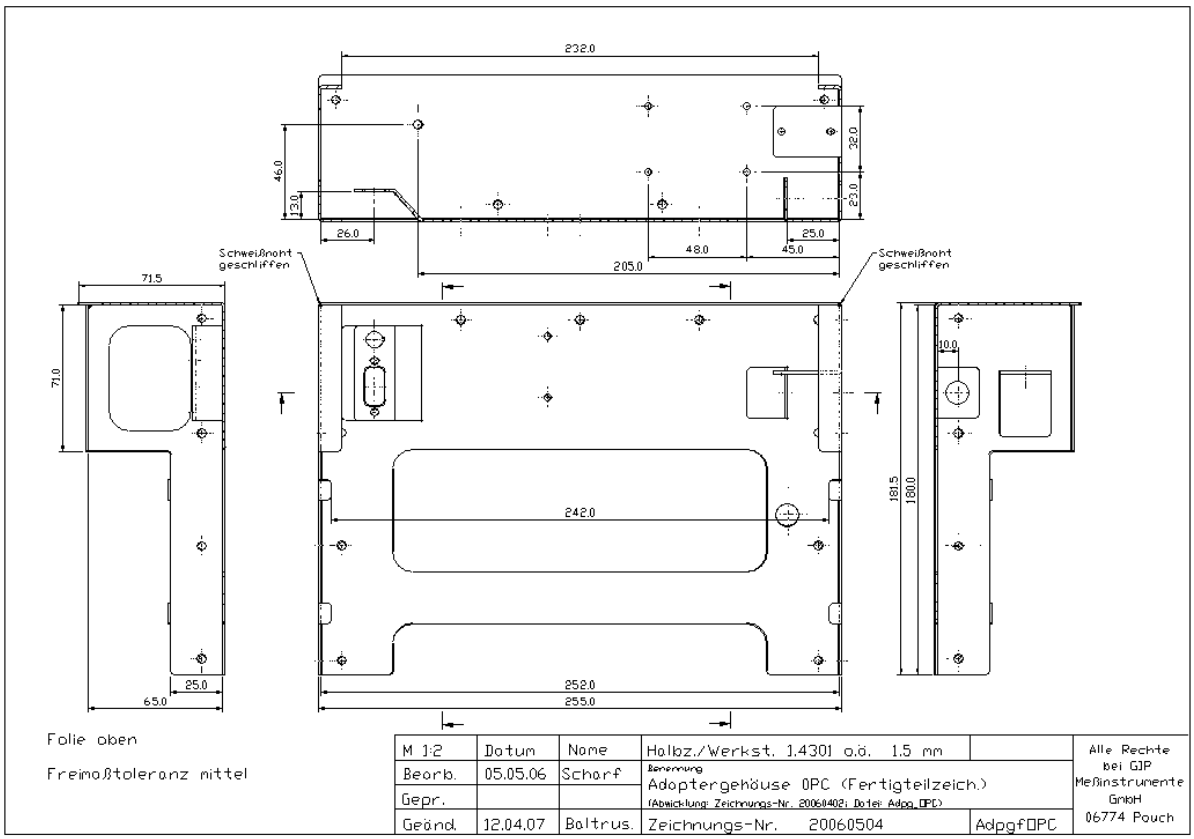


Figure 6: Installation dimensions docking-station and aerosol spectrometer

4 Control elements

Before taking the device into operation read this manual carefully!

Please inspect every single part of the measurement unit after unpacking. If you expect that the device cannot be run safely anymore put it out of operation and ensure it cannot be run accidentally anymore.

Expect a not safe operation, if

- The device shows apparent damages,
- The device does not work anymore,
- The device was being long-term stored under inappropriate conditions,
- The device suffered under heavy-duty transportation.

Each dust monitor accepts only formatted storage cards. Also format your storage card after purchasing a new one or switching from one dust monitor to a different one.

4.1 Control elements overview

The figure below shows the complete mounted device with all control elements and all connections. In the following you will find the explanation of the control elements and their function.

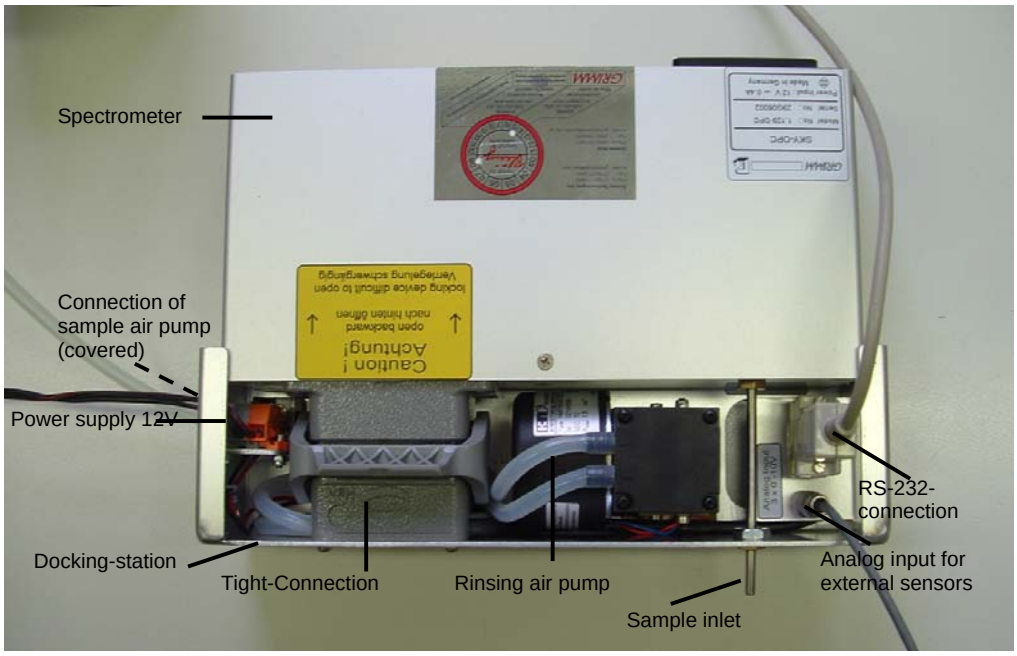


Figure 7: Sky-OPC with all control elements and connections

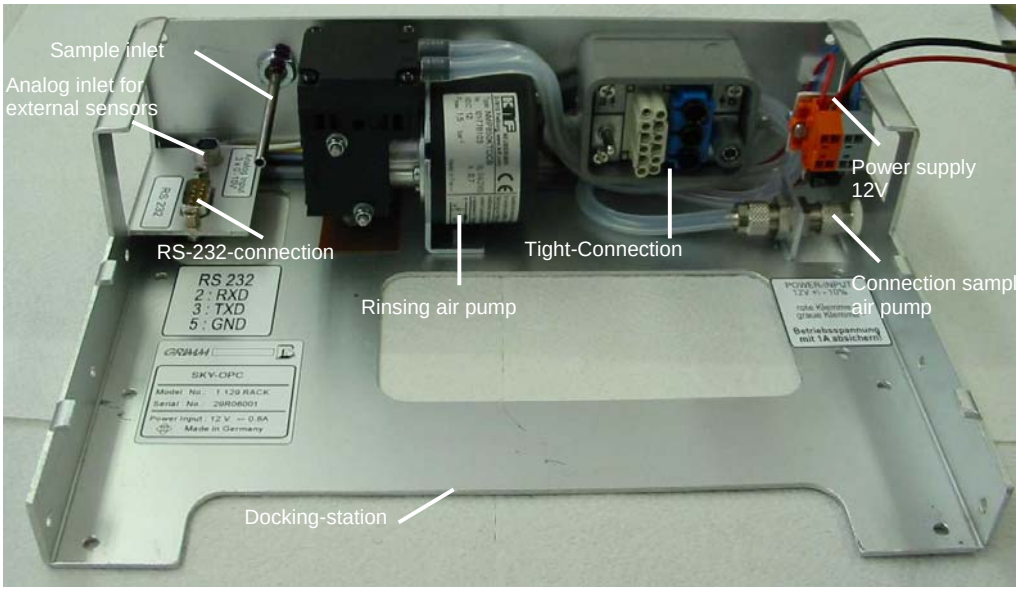


Figure 8: Docking-station with all control elements and connections

4.2 Power supply input 12V

In order to run the aerosol spectrometer connect it to an external power supply with an output voltage of 12V (±10%). Polarity:

Red terminal: + (plus)

Grey terminal: - (minus)

The operating voltage has to be fused with a 1A fuse.

The terminal for power supply is located at the corner of the docking-station. For a better accessibility and cable routing the upper side of the docking-station as well as the exterior is not closed.

As soon as the spectrometer is powered by the 12V operating voltage the internal rinsing air pump starts to work. The rinsing air circulation protects the laser optics just as the measurement cell from being soiled.

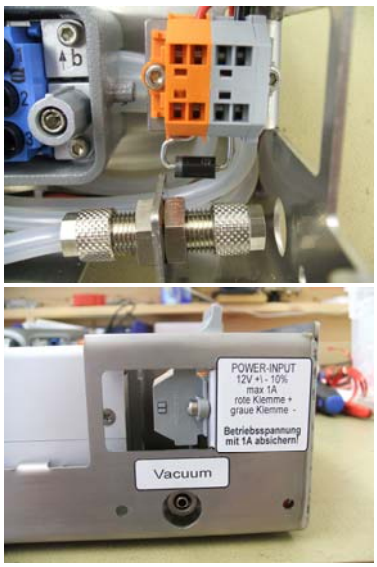


Figure 9: Connection of power supply

4.3 Connection sample air pump

In order to get the sample air the SKY-OPC is provided with a connection for an external vacuum pump. The tube connector for the external vacuum pump is located at the docking-station below the power supply inlet. The duct is labelled as “Vacuum” on the exterior of the docking-station.

The tube connector´s measures are: outside 6 mm and inside 4 mm diameter. A suitable external vacuum pump is listed as accessory for the SKY-OPC (product key nr. N 86 KN.18, 230 V, 50 Hz, ca. 65 W,

6,0l/min, 100mbar abs.). Choosing a different vacuum pump please make sure the necessary the demanded delivery volumes respectively pressures will be reached.

The sample air flow is controlled by a critical orifice. Thus the system is nearly independent from the ambient pressure. In this process the pressure behind and before the critical orifice is measured and a quotient is established. For a proper operation of the critical orifice and a correct rinsing air flow the quotient has to be < 0.5. See figure 10.

4.4 Tight-Connection for electrical and pneumatic connections

Installing the spectrometer inside the docking-station you have to make sure no cables or hoses will be squeezed. The straight sample tube at the docking-station has to fit into the notch of the spectrometer – do not force it in! Now secure the Tight-Connection. Therefore lock the retainer clip so you hear it locking. Each step is explained in the adjoining four figures.

Step 1: Installing the spectrometer inside the docking-station. Make sure the position of the retainer clip is towards the spectrometer, viz open.

Step 2: Insert the straight sampling tube into the notch at the spectrometer and close the retainer clip of the Tight-Connection.

Step 3: Lock the retainer clip of the Tight-Connection. Therefore lock the retainer clip so you hear it locking.

Ready mounted spectrometer within the docking-station.

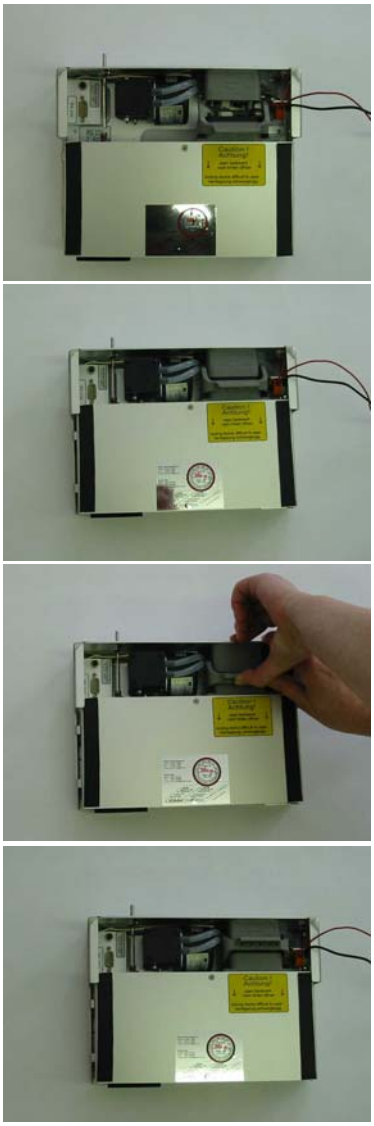


Figure 10: Assembly spectrometer and docking-station

4.5 Rinsing air pump

The laser optics and the measurement cell of the aerosol spectrometer are protected through a rinsing air circulation from pollution. The therefore necessary rinsing air is being delivered by a micro-membrane pump. The oil-free operation of the voltage-optimized membrane, special valves, and gasket systems eliminate a pollution of the rinsing air and enable a maintenance-free operation at the same time. The pump causes only a little loss of the flow rate and coevally possesses a high gas density. Specifications of the rinsing air pump: 12V brushless DC motor, 3.5 l/min delivery efficiency while atmospheric air pressure 1.5 bar maximum operating overpressure while continuous operation and 300 mbar absolute final vacuum.

The rinsing air flow is just as the sample air flow controlled by a critical orifice. In this process the pressure behind and before the critical orifice is measured and a quotient is established. For a proper operation of the critical orifice and a correct volume flow the quotient has to be < 0.5. See figure 10.

4.6 Sample inlet with straight connection pipe

The sample inlet with straight connection pipe ducts the aerosol flow directly into the spectrometer. For the straight sample air ducting losses of particles are being minimized. Moreover a simple cleaning of the sampling inlet is provided. Installing the aerosol spectrometer in- or outside an airplane the user has to make sure that the ambient aerosol flow will be lead appropriately into the aerosol spectrometer. The sampling has to be reproducible and isokinetic for different approach velocities.

4.7 RS-232 connection

The RS-232 connection enables controlling of the spectrometer or transmission of stored data onto a PC or printer. For more detailed information please see **chapter 6.1** following.

The original cables can be locked easily by dint of the sockets´ mechanism at the RS-232 connection. This way an accidental break of the RS-232 transmission is impossible.

Figure 11: RS-232 connection at the docking-station

4.8 Analogue connection for external sensors

The docking-station provides next to the RS-232 connection a 6-pin socket for three analogue inputs. It can be connected with a suitable analogue sensor having an output voltage between 0V and 10 V. This connection can also provide a voltage of +10V up to 40mA in order to supply the sensors.

Possible types of sensors can be temperature-, velocity-. pressure-, humidity-, or special gas-sensors. The measured analogue values will be stored on the storage card and displayed sequentially on the device. The resolution is 10 Bit (ca. 10mV). Text and factors for the LCD-display can be changed.

The pin configuration of the analogue socket is explained in Figure 12.

1 Input 1 (0-10V)
2 Input 2 (0-10V)
3 Input 3 (0-10V)
4 GND (Grounding)
5 +10V/40mA
6 1-Wire Bus

Figure 12: Pin configuration input socket and location at the docking-station

SKY-OPC´s contain serially an integrated barometric sensor. The measured values are stored as Ue4 in the data protocol and output as pressure-unit hPa. The registration of outside temperature and humidity can be utmost helpful for the proper operation of the aerosol spectrometer respectively for the interpretation of the measured particle data. For displaying the measured sensor values see RS-232 Transmission of measured values.

4.9 Pneumatic scheme of model 1.129

Figure 10 shows the pneumatic of the Sky-OPC´s schematically . The device provides a rinsing air flow (grey) and a sample air flow (black). Both volume flows are being kept constant independently of the ambient pressure by dint of critical orifices. Behind the measurement cell the total volume flow is lead though a filter which protects the critical orifices from pollution. The sample air flow rate is 1.2 l/min. The rinsing air flow rate is 0.4 l/min. Inside the rinsing air circulation is a BQ-filter which cares for particle-free rinsing air.

Four pressure sensor are located inside the device . The denomination and function of the pressure sensors is explained below, whereas the binary-coded address denominations of the pressure sensors (add. 1 through add. 8) is only relevant for the internal service.

pR	(add. 1)	Rinsing air pressure after critical orifice
pA	(add. 2)	Sample air pressure after critical orifice
p	(add. 4)	Pressure before critical orifice – both rinsing air and sample air
pM	(add. 8)	Pressure inside the measurement cell

The quotients pA/p and pR/p establish out of the measured pressures and are stored in the data protocol. Theoretical the quotient can have values among 0 and 1. The critical orifice works properly if the quotient value is <0.5. In order to be able to display within the used 8-Bit data protocol a better resolution the quotient is being multiplied by the factor 255. That means the critical orifice works correctly if the value is <120 (see also chapter 6.4).

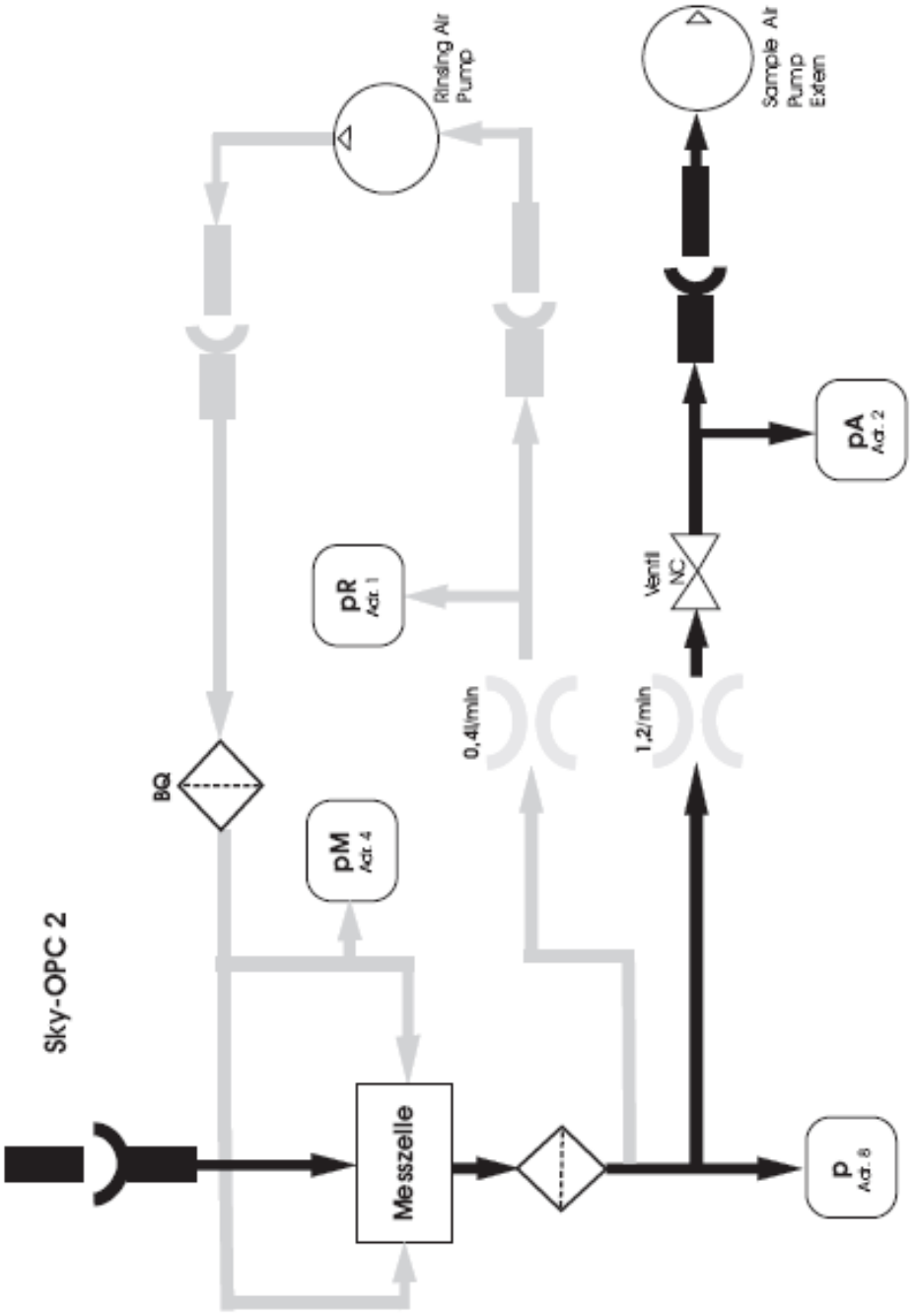


Figure 13: Pneumatic scheme model 1.129

5 Measurement procedure

5.1 Initiation

Previous to initiation assemble the device consisting out of spectrometer and docking-station and make sure all external connections are fixed (power supply, vacuum pump, RS-232 communication, and as the case may be external sensors). Information regarding function, location, and advices of the external connections and how to connect them properly see chapter 4 Control elements.

If a data storage card is being used insert it into the docking-station before you assembly the spectrometer. For further advices see chapter 7 Data storage card**.**

After connecting external power supply, vacuum pump, RS-232 cable and proper fixing of the spectrometer into the docking-station through Tight-Connection the measurement can be started via terminal-program or Windows-software.

Does the measurement not start the sample air duct is closed by an magnetic valve. (NC = normally closed).

5.2 Measurement

Every measurement is initiated by a self-test which rinses the measurement chamber with pure air. During the self-test the pneumatic and optical functions just as the reference voltage are being inspected and gives feedback about the condition of the device. After the self-test the actual dust measurement begins. The indicated value will be refreshed every six seconds.

Possible reasons for errors during the self-test:

- A very polluted measurement chamber
- The device´s temperature is above 50°C
- A failed laser or a different hardware error.

5.3 Display of measured values

Via the accordant control commands of the terminal program or via the menu of the Windows-software the display of measured values can be selected.

The terminal program reflects the particle concentration as unit particle/liter or particle/100ml. The unit particle/100ml appears only if the storage interval is smaller than 1 minute means not displaying averages. Other displays of measured values (dust concentration as unit µg/m^3) are possible – therefore see examples in 6.4 Important hints for the customer.

The Windows-software offers further conversions into other units.

Please note that data which is sent via the RS-232-interface and is stored on the storage card are the same as the as the set operation mode; i.e. you can either measure **and** store particle concentration or particle mass!

5.4 Gravimetric control of dust-mass-occurrence

Due to the fact that the measurement device does not detect the dust concentration as mass directly but indirectly via optical scattering light measurement, the results have to be corrected by the so-called gravimetric-factor at the respective location. Since the SKY-OPC model 1.129 does not have a built-in gravimetric-filter just like aerosol spectrometer of the series 1.100 the gravimetric factor cannot be determined and is factory-specified as value 1.00.

A gravimetric control of the dust-mass occurrences is not possible with the SKY-OPC. Thus the device should basically be run in order to determine the particle concentration and size in the respective measurement mode particle count distribution (via Windows-software) also called Count Mode (control command C via terminal program). The mode mass distribution (via Windows-software) also called Normal Dust Mode (control command N via the terminal program) is due to named reasons only very restricted applicable and useful; only use it in exceptional cases.

6 RS-232 Interface

6.1 Assembling of the RS-232-interface

The serial interface is performed as a 9-pin socket at the docking-station. Via this interface the dust monitor can be controlled the values can be sent to an external printer or a PC. Always use the original accessory cable (catalogue-nr. 1.143E RS-232 or catalogue-nr. 1.141 USB-data cable for RS-232).

Pin-configuration of the dust monitor “RS-232 to PC“:

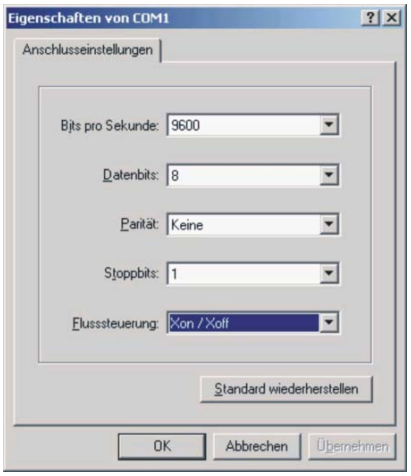
Pin2: RxD	(receiving data)
Pin3: TxD	(sending data)
Pin5: GND	(signal-/ operation grounding)
Pin7: Alarm 12V/0.5A	(voltage for optional alarm sensor)
Pin8: CTS	(Clear To Send)

6.2 Transmission protocol

Following settings form the basis of the transmission protocol:

The Baud rate is for normal data transmission **9.6 kBd**. **Eight data bits without parity** and **one stop bit** are being used. Software protocol **Xon/Xoff** is being supported. In addition to the Quick-data transmission there is a query of data of the **CTS-line**. Here the Baud rate can be up to **57.6 kBd**. The same with the ASCII data transmission to a printer. The Clear To Send - signal (CTS) shows if a modem or a printer is ready to receive data from the interface.

6.3 RS-232 commands



Following commands can be sent via RS-232 interface to the dust monitor. The device will confirm the reception by an echo. You can use either small or capital letters for the commands. Numeric values which can only be changed within the stand-by mode have to be concluded by pressing CR (Carriage Return, ASCII 13).

For testing you can use every terminal program which supports the **Xon/Xoff- protocol**. Just to give an example it´s possible to use the "HYPER-TERMINAL" program which belongs to the standard accessory of Microsoft Windows. The respective settings of the interface parameters have to be done before (see figure aside). The function keys can be set with orders for the dust monitor.

Annotation: The commands listed in the following contain all commands which can be used for Grimm aerosol spectrometers. For reasons of compatibility each model and version contains a complete kit of all available commands. Certain models do consequently not have an assigned function to some commands or as the case may be the commands will not be performed.

These commands will are indicated in red colour.

Commands

A Output of the current alarm value. It can be changed within the stand-by mode.

A
Alarm : 0 /l :

^A Calibration factors for the analogue input voltage

B Output of the battery capacity (having power supply connected always 130%)

B
Battery Power : 130 %

^B Setting the data transmission Baud rate:

0 = 9.600 Baud
1 = 19.200 Baud
2 = 57.600 Baud

C Switching on count mode / Switching of mass display (for device 1.129: multiplex operation will be switched on).

D ASCII-data transmission from the data storage card (only in stand-by mode) Example for count mode:

D
Memocard : 12.30 from: 29G07003
Location : 2 :
P 7 4 18 16 34 1 0 66 255 85 80 248 0 0 0 0

K . 704 1082 2162 0 0 29 57 0 0 0 0
P 7 4 18 16 34 1 0 66 255 85 80 248 0 0 0 0

C_: 420648 312631 253253 138895 73489 33731 13396 6428
C_; 3061 2279 1395 647 493 365 274 197
c_: 197 146 110 77 36 18 10 7
c_; 4 2 0 0 0 0 0 0

P 7 4 18 16 34 1 0 66 255 85 80 248 0 0 0 0

K: 546 825 1631 0 0 35 91 0 0 0 0

^D Cuts off transmission of measurement values

E Output error code (ERROR)

Error Code:	LCD-Display	Meaning
"128"	NEW SELFTEST	Self-test erroneous
"64"	NO MEMOCARD	No storage card or wrong version or storage card with data of a different device
"32"	CHECK NOZZLE	Whirl >5%
"16"	NO OPERATION	Battery capacity = 0%, Reset after power blackout
"8"	PLEASE RECHARGE	Power supply less than 10.5 V
"2"	CHECK FILTER	Vaccum aerosol insufficient
"1"	CHECK FILTER	Vacuum rinsing air insufficient

^E Request for transmission of measured values / switching of fast-mode

F Switching on fast-mode. The measurement data will be output every six seconds.

G Output gravimetric factor. In stand-by mode the gravimetric factor can be changed within the range from 0.05 up to 9.9 with a resolution of 0.5.

^G Byte / interval: storage size of interval

H Output operation hours (Hour)

I Interval for the normal output and storing will be output onto the storage card. It can be changed within the stand-by mode.

Interval settings for storing:

0 = 1 Minute
1 = 5 Minutes
2 = 10 Minutes
3 = 15 Minutes
4 = 30 Minutes
5 = 60 Minutes
6 = 6 Seconds (fast mode)
7 = 3 Seconds (only 16 channels either >0.25µm - >2.5µm or >2.5µm - >32µm)
8 = 2 Seconds (only 16 channels either >0.25µm - >2.5µm or >2.5µm - >32µm)
9 = 1 Second (only 16 channels eitherr >0.25µm - >2.5µm or >2.5µm - >32µm)

In order to choose the intervals 7, 8, and 9 the **multiplex mode** has to be **switched off before** with the command "**<**" or "**>**"! Then either the lower 16 channels from >0.25µm up to >2.5µm or the upper 16 channels from >2.5µm up to >32µm will be measured .

J Output channel threshold in µm (example count mode)

J *Channel threshold*

Jc:	*0.25*	*0.28*	*0.30*	*0.35*	*0.40*	*0.45*	*0.50*	*0.58*
Jc;	*0.65*	*0.70*	*0.80*	*1.00*	*1.30*	*1.60*	*2.00*	*2.50*
jc:	*2.5*	*3.0*	*3.5*	*4.0*	*5.0*	*6.5*	*7.5*	*8.5*
jc;	*10.0*	*12.5*	*15.0*	*17.5*	*20.0*	*25.0*	*30.0*	*32.0*

Particle count

C8:	*43167*	*31404*	*25011*	*13215*	*6935*	*3095*	*1290*	*665*
C8;	*370*	*300*	*180*	*55*	*45*	*40*	*35*	*27*
c8:	*27*	*11*	*8*	*3*	*2*	*2*	*0*	*0*
c8;	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*

L Output pre-dial measurement location (location number) and changing it within the stand-by mode

^L Country settings (E for Europe or U for US) for date output at the dust monitor (only within stand-by mode), changes the format of displaying the date

M Output averages and sample volume

M

Mc:	*447430*	*324824*	*258999*	*136537*	*70110*	*31757*	*12825*	*6485*
Mc;	*3357*	*2574*	*1640*	*847*	*648*	*493*	*366*	*269*
mc:	*269*	*201*	*154*	*114*	*58*	*32*	*22*	*16*
mc;	*8*	*3*	*1*	*0*	*0*	*0*	*0*	*0*

V: 0.0288 m3

N Switching on normal mode (displaying mass) / switching off count mode

O Output data storage capacity (only within the stand-by mode). If after the capacity output a + is sent the data storage will be completely deleted alternatively initialized for this aerosol spectrometer.

P Preferences modem submenu

Q Quick-data transmission from the data storage card (only within stand-by mode). The data transmission occurs binary-coded with up to 57.6 kBaud.

R Run. Starting the measurement out of the stand-by mode.

S Stop. Switching to stand-by mode

T Time output (Time). Within the stand-by mode the clock can be set. Changing the minutes will zero the seconds.

^T Timer mode for switching the dust monitor on and off automatically. (version x.40 of higher)

U **Unlock Keys (No meaning, because 1.129 has no keys)**

V Output the devices´ version number
V
Version : 12.30 E

W Output filter weight and corresponding sample volume (Weight)
W
Weight : 2.4 ug Volume : 0.038 m3

^Y Power OFF, switching off the dust monitor

Z Output with subsequent resetting of the averages and volume (Zero).

! Output version and model number of the device
!
Model 1.109 Version 12.30 E

@ Output serial number
@
Ser.No. 9G040001

< Constantly high laser capacity; multiplex mode off (“small particles”, 16 channels 0.25µm up to 2.5µm)
Attention: This command is possible, but depending on firmware version, it is not included in the command help list, after pressing "?". Multiplex mode off is necessary to enable sampling intervals with 3, 2 or 1 second after pressing the command "I" for intervall

> Constantly low laser capacity; multiplex mode off ("big particles", 16 channels 2.5µm up to 32µm)
Attention: This command is possible, but depending on firmware version, it is not included in the command help list, after pressing "?". Multiplex mode off is necessary to enable sampling intervals with 3, 2 or 1 second after pressing the command "I" for intervall.

Long Break Switching on the dust monitor (if switched off by ^Y)

_ (Underline) Output of "User"- texts and analogue input- factors (only within stand-by mode).
Example:

_
$(1..4):Input 1: . V |Input 2: . V |Input 3: . V |Pressure hPa|
**(1..4): 1 | 1 | 1 | 179.3722 |` 0.000 V | 0.000 V | 0.000 V | 1.880 V |*

The first line shows the three "User"- texts. The seconds line shows first the three multiplication factors for the analogue voltages and then the offset values.

$ Selection or modification of the "User"-texts just like the factors for the analogue voltage output on the LCD-display (only within stand-by mode). Special characters (via ASCII 127) cannot be input. The output shows the character '°'(ASCII 248) as '_' (underline). Given texts can be chosen be pressing the key TAB and have to be confirmed by pressing the return key. They also can be transcribed by any texts. The number output is always five-digit and begins with the ninth position. If characters except of a decimal point are input on this position an acoustical warning appears. The multiplication factor which is based on 1 Volt can then be input after the text. It also can be changed by the commando `*´.

Example:

Temperature sensor:	*0°C = 3.0 Volts and 50°C = 8.0 Volts*
User-text:	*Temp. : . °C*
User-factor:	*10.0 [°C/Volt]*
Offset:	*3.00 Volts*

Here is the user-factor the gradient (m) and the offset the Y-axis intercept (c) of the calibration straight line with the general form y = mx+c.

The model 1.129 offers that you can even read out the sensor data directly from the sensor (sensors with known value “E” or higher – 3 character of the serial number – are being equipped with an EEPROM for the sensor data) Taking over the data out of the EEPROM including the “user-text” will only take place if the “user-factors” inside the device are set on 1.0 and the offset values are 0.0. An afterward calibration by the user is thus still possible (positive offset values are not possible).

***** Changing user-factors (only within stand-by mode). The user-factor based on 1 Volt equates to the gradient (m) of the calibration straight line with the general form y = mx+c, which forms the basis of the conversion of voltage signal to sensor value.

? Help for commands

```
#################### Help for Dust Monitor ##############################
|  A' Alarm                          | ^L' Land (for Date)     [Standby]|
| ^B Baudrate (Memocard)     [Standby]|  L' Location Code                |
|  B' Battery                        |  M' Mean Value                   |
|  C' Count Mode             [Standby]|  N' Normal Dust Mode    [Standby]|
|  D' Data Memocard          [Standby] |  O' Clear Memocard      [Standby]|
| ^D' Disable Output                 |  P' Preferences Modem   [Standby]|
|  E' Error                          |  R' Run Measurement              |
| ^E' Enable Output                  |  S' Standby Modus                |
|  F' fast                           | ^T Timer Set            [Standby]|
|  G' Gravimetry C-Factor            |  T' Time Set            [Standby]|
| ^G' Byte / Interval                |  %' Memo free           [Standby]|
|  H' Runtime hours                  |  U' Unlock Keys         [Standby]|
|  I' Interval                       |  V' Version                      |
|  J' Output Channels                |  W' Weight                       |
|  @' Serial-No.                     | ^Y' Power OFF                    |
|  $' User Strings (Analog Inputs)   |  Long Break: Power ON            |
|  *' User Factors (Analog Inputs)   |  Z' Zero Clear Mean              |
|  _' Output User Strings + Factors  |  !' Output Model + Version       |
#########################################################################
```

additional help commands in service mode 0.

To change to service code 0 one has to send the vertical line "|" and then press tabulator. The vertical line can be send as ASCII code 124 via the num block (press and hold "Alt" and press on num block "124") or with the corresponding key depending on keyboard design or national settings press and hold "Alt Gr" > <.

```
|  &' Mixer Humidity Threshold       |  ;  Autocal             [Standby]|
|  ]' Analog Sensor Value            |                                  |
|  ~' last Service                   |  X' X-tal                        |
| ^F  Flow Adjust    [Standby]       | ^V' Version change               |
#########################################################################
```

& Mixer Humidity Threshold. No meaning. Only for Model 1.109 in combination with a outdoor wheather protection housing model 1.165FG.

; Autocal. No meaning. Instrument will stopp during a continuous measurement at a full hour. Measurement will continue automatically after a self test.

] Analog Sensor Value No meaning, only for Model 1.109 in combination with a outdoor wheather protection housing model 1.165FG.

~ last Service. Who did the last service and when was it done. Identification by individual service key and date.

X X-tal. No meaning. Only for trained service technician. Output of the frequency of the quarz from the internal clock on the digital board.

^F Flow Adjust [standby]. No meaning. Only for model with internal pump (1.108 or 1.109). With the + and - key the flow rate can be increased and decreased in steps to a maximum of 0.05 litre/min.

^V Version change. No meaning. Only for model 1.105, changes the data displaying.

Setting the service mode 0

By sending the ASCII-rows [124] and [9] or sending the vertical line "|" and press tabulator the dust monitor will change into the service mode 0. During the data output via the RS-232 interface additional data and explaining texts will be output.

Example 1:

Pressing key V in the user mode shows the version number of the software:

```
V
Version : 12.30 E
```

Pressing key V in the service mode shows additionally to the version number of the software following details: Creation date of the assembler part, processor type, creation date of the basic part.

(date: dd.mm.yyyy)

```
V
Version : 12.30 E     DM109G 17.12.2007      87C552:011   DM109G 14.12.2007
```

Example 2:

Normal data representation in the user mode:

```
P   56    2    5   22   51    1  114    0   81   97   67  237    0  132   81   0
C_:  132940    77350    48435    22270    9325    4610    3210    1795
C_;   1305    1050     765     575     385     280     195     131
c_:    131      82      68      49      33      20      13      10
c_;      7       4       2       1       1       0       0       0
```

Data representation in the service mode:

```
Year   Mon   Day   Hr   Min   Loc   4Tmp   Err   pA/p   pR/p   UeL   Ue4   Ue3   Ue2   Ue1   Iv
P   08   7   16   10   51   1   114   0   81   97   67  237    0  132   81   0
C_:  132940    77350    48435    22270    9325    4610    3210    1795
C_;   1305    1050     765     575     385     280     195     131
c_:    131      82      68      49      33      20      13      10
c_;      7       4       2       1       1       0       0       0
```

Besides the alarm voltage output works within the service mode inverted. Within the service mode also all storage card version can be read out.

6.4 RS-232 Transmission of measured values

The data in the with "P" characterized line (so called "P-line") relate to the Bytes which will be stored onto the storage card. The resolution of the external voltage is 10 Bits, so the Bytes characterized as Ue1 .. Ue3 represent only the more significant part. The two low-order Bits are together located in UeL. Bits 1 and 0 belong to Ue1. For the maximum value of this voltage is 10 Volts the 10 Bit- value has to be multiplied by the factor 9.776E-3 in order to get the correct voltage value in Volts. Because of the unavoidable tolerances within the hardware those values will be furthermore multiplied by an individual correction factor. These factors can be requested from the device. Since different user-texts and user-factors can be set at the device they always should be queried and considered by the analysis software. The user-factors always relate to the voltage value in Volts.

The data order during the transmission of measurement values is as follows:

Year Mon Day Hr Min Loc 4Tmp Err pA/p pR/p UeL Ue4 Ue3 Ue2 Ue1 Iv

Explanation:

Loc = Location (selectable from 1 through 99)

4Tmp = Quadruple temperature in °C inside the device (e.g. 1: 100 = 25°C or e.g. 2: 88 = 22°C)

Err = Error codes (Annotation: The pressure ratios pA/p and pR/p will be included into the error bits during a later revision)

pA/p = Pressure after critical orifice aerosol / pressure in front of critical orifice *255 (Annotation: For a proper operation the values have to be smaller than 120 for then the quotient is <0.5)

pR/p = Pressure after critical orifice rinsing air / pressure in front of critical orifice *255 (Annotation: For a proper operation the values have to be smaller than 120 for then the quotient is <0.5)

UeL = Low-order Bits (sensor 1 through 3)

Ue4 = Ambient pressure in hPa

Ue3 = Sensor analogue input 3

Ue2 = Sensor analogue input 2

Ue1 = Sensor analogue input 1

Iv = Interval

After the P-line the measurement values follow. The measurement values are characterized as “C” for counts or “N_” for mass.

The „C“ characterizes the counts of the lower 16 size channels from >0.25µm up to >2.5µm, measured with the high laser efficiency and the “C” stands for the counts in the upper 16 size channels from >2.5µm up to >32µm which are measured with the lower laser efficiency. The last value of the second „C“ line C_; and the first value of the first “C” line C_: are identic because both mean the particle concentration >2.5µm. All in all the multiplex operation shows the particle concentration in 31 size channels.

The multiplex mode unit for particle concentration is usually **particle/liter**. If the data is stored with a higher time resolution than 1 minute (means 6 seconds or 3,2, or 1second) during deactivated multiplex mode the displayed concentration values appear as the unit **particle/100ml**.

Here are some examples:

Version : 12.30

Example 1:
Measurement mode Counts, measurement interval 1 minute (**Multiplex on**) , data output in the unit **particle/liter**, beginning of line contains "_" (underline).

C_: 132940 77350 48435 22270 9325 4610 3210 1795
C_; 1305 1050 765 575 385 280 195 131
c_: 131 82 68 49 33 20 13 10
c_; 7 4 2 1 1 0 0 0

Example 2:
Measurement mode Counts, measurement interval 6 seconds (**Multiplex on**), data output in the unit **particle/100ml**, beginning of line does NOT contain "_" (underline) but "0" for lower size channels.

C0: 18885 11655 7455 3695 1705 700 425 245
C0; 130 60 30 15 15 10 5 1
c0: 1 1 0 0 0 0 0 0
c0; 0 0 0 0 0 0 0 0

Example 3:
Measurement mode Counts, measurement interval 1 second (**Multiplex off,** channels >0.25µm up to >2.5µm), data output in the unit **particle/100ml**, beginning of line does NOT contain "_" (underline) but "00" for lower size channels.

C00: 16005 9530 6095 2945 1405 650 480 295
C00; 170 110 70 40 25 20 15 5

In the measurement mode mass the calculated particle masses for 32 size channels will be displayed in the unit µg/m³. Basis for calculating the particle mass are the measured count data of the 31 size channels just like an additional only mathematical determined size channel at the lower end of the measurement range. The measurement mode mass is only possible within multiplex mode. Please note the in chapter 5.4 mentioned restrictions again.

7 Data storage card

7.1 Storage capacity

Depending on the settings of the device, i.e. the set interval and the capacity of the data storage card (standard 4MB) various maximum storage times will be reached. Only PCMCIA SRAM data storage cards can be used. The data will be stored as a FiFo-process (First in First out), i.e. stored in a circular buffer. In case of a full card the oldest values will be transcribed.

Insert the data storage card into the small black slot at the front of the dust monitor (below the Tight-Connection) until you hear a gentle click.

A properly inserted card pokes out or the body for about 1cm. Insert the card with the **arrow facing up**.

Insert the data storage card previous to the measurement and initialize it. A storage card will only be accepted by the device if it is formatted or having been used within the same device and version and number of the connected sensors did not change.

The data storage card can be deleted respectively initialized via the terminal program by the command O or via the Windows-software opening the menu Tools. If the storage card is not being accepted the measurement will not start. Please check if the write protection of the storage card is activated. If so please deactivate it (see 7.4 Write protection) !

All measured values will now be automatically filed on the data storage card.

Additionally to the beginning of a measurement an alarm signal (peep) resounds

It is not possible to use cards with stored data in a device having a different serial number.

7.2 Data preservation / storage card battery

The data on the storage card are preserved tough a buffer battery. When the card is inside the device the power supply occurs through the device. Always read out the data before you change the battery, otherwise data can be lost.

7.3 Storage times of the storage cards

There are data storage cards with various storage capacity, beginning at 256 KB up to 6 MB. For model 1.129 usually only 4MB storage cards are being used. Within “Normal“ mode set the interval to 1 minute. **Using the interval 60 minutes there might be a loss of data of the last 59 minutes!** Transcending the stated time leads to transcription of the oldest values. The card remains ready-to-operate.

Chart 1: Storage times of the storage cards for version *12.30*

INTERVAL	1min	5min	10min	15min	30min	60min	6sec	3sec	2sec	1sec
INTERN	12h	2d 13h	5d 2h	7d 15h	15d 7h	30d 15h	1h 12min	36min	24min	12min
4 Mbyte	26d 3h	130d 16h	261d	1Y 27d	2Y 54d	4Y 108d	2d 14h	1d 12h	1d 15min	12h 7min

Connecting next to the sensors 1.. 4 further additional sensors the storage times will decrease.

Some more hints:

If the storage card has been used before in a different device-version which does not have the same version number the data storage card will automatically be formatted, i.e. all hitherto existing data will be completely deleted.

The data storage card should only be changed within the stand-by mode, otherwise loss of data might occur.

Insert the storage card precious to a measurement!

The average durability of a battery inside the 4MB data storage card is more than a year. Take out the battery if not using the card for a longer period.

7.4 Write protection

The storage card possesses a write protection which secures the measured data from accidental transcription. The write protection can be activated by a slider next to the battery compartment. Deactivate the write protection if you want to file new measurement data onto the storage card. In case first read out and save the data and format it afterwards.

8 Maintenance and cleaning

It is recommended to regularly discharge following issues

8.1 Straight sample probe

The air inlet located at the front of the device has to be cleaned in direction of the actual air flow with clean and oil-free compressed air with a pressure of ca. **3** bar. Take the spectrometer out of the docking-station before! Possible pollution at the inlet can be recognized just by seeing through it.

Never drag any implements (e.g. cloths etc..) through the inlet-orifice or dismount it!

8.2 Cleaning of the measurement chamber

Cleaning the measurement chamber should only be performed by trained service staff or by users who successfully attended a service training course. Previous to cleaning the measurement chamber the measurement chamber itself has to be opened by removing the filter cover plate on the back of the spectrometer. Reassembling the device can lead to leakages or faulty positioned O-rings! Thus we strongly advice against opening the device arbitrary!

8.3 Housing

The dust monitor is inside a metal housing which protects it against mechanical impacts or electro-magnetic exposure. For cleaning the device please use a dry cloth or in case of stains wet special cloths which are also being used for computers.

Protect the device against contact with fluids!

8.4 Internal rinsing air filter

In order to protect the laser optics against pollution and for the self-test of the device particle-free air is being produced via a micro-filter which works several years even for continuous operation. Changing the filter has to be done by trained service staff.

9 Accessory

9.1 Zero-test filter (model 1.148)

By dint of the zero-test filter the measurement device can be checked for noise within the signal electronics and leakages within the intake system. If the filter is connected to the air intake the concentration values have to decrease to zero at once. A rising of the pump´s motor current to more than 60% and its related error message is here normal.

9.2 Sensor for temperature and humidity (model 1.153)

This sensor has a low current consumption.

Technical data:

Dimensions:	∅ = 15 mm, length = 130 mm, cable: ca. 2m
Connecter:	6- pin
Power supply:	10V ±5%, < 5 mA
Temperarute measurement range:	0.3 up to +80 °C
Resolution:	0.1 k
Accuracy:	typ. 0.3 k
Humidity measurement range:	0 up to 100% rF
Resolution:	0,1%
Accuracy:	typ. 1%

9.3 Sky-Probe, quasi isokinetic probe (model X5520-AP)

This probe was developed for quasi isokinetic sampling within higher flow speed. It is designed for a sample volume rate of 1.2 liters/minute. It exists out of a straight sampling pipe with a hollow-cone-shaped inlet head which can be fitted to the desired flow speed between 2.8 m/s and 134 m/s by adjusting.

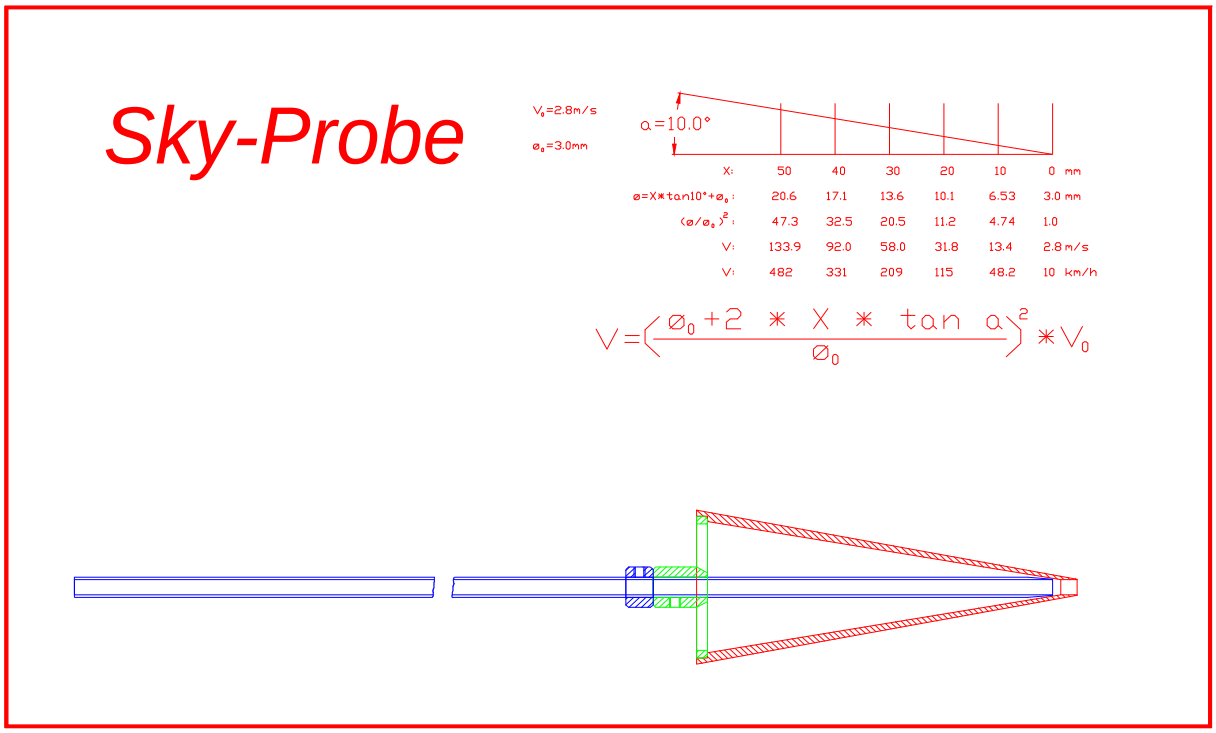


Figure 14: Sky-probe sampling inlet

10 Warranty

GRIMM Aerosol Technik guarantees every customer that the in this document described device is developed, constructed, and manufactured according to the best technical requirements for the described application. Furthermore is guaranteed that this device has no material defect and was delivered free of assembly errors after passing a severe quality check. However neither further warranty is given for an application-specific function nor for damages emerged from material or assembly faults. Every device is seized by the production and journalized most accurately especially the calibration and validation data.

Should the device fail during the 1-year warranty or being not up the standard GRIMM Aerosol Technik has the right to replace the faulty parts or the device apart from operating errors. GRIMM Aerosol Technik will fix the device at the factory exempt from charges; only the transport fees just as the accordant additional charges are for the customers account. On-site repair will only be done for refunding the travel and service costs. The company GRIMM is not in charge for further claims which can be educed from the warranty.

GRIMM takes over the warranty of the sold goods only if those are being used under normal conditions and according to the instructions of this manual. The warranty expires after 12 months, beginning with the day of delivery. Return consignment charges for repair under warranty are to the customers account.

This warranty has following exceptions:

a) For spare parts which will be replaced or repaired under warranty in order to make operation possible again we take over warranty for 90 days, normal use preconditioned.
b) The supplier is not liable for third´s party products or batteries of consumables; only the original warranty is held up.
c) Without written confirmation GRIMM does not give warranty on third´s party products which have been modified or built in or out by untrained service staff.
d) Everything mentioned above substitutes other warranty agreements respectively restrictions. No further liability claims will be given especially beyond normal usage.
e) Usage and operation is within the customers RESPONSIBILITY. He has to obey the legal restraints and claims and has to operate the device according to the lawful and operational purpose. Deviations lead to warranty exclusion.
f) Legal measures against the company GRIMM no matter from which side after a time-period of 12 months are baseless without exception.
g) The buyer just as the seller both agree that this WARRANTY RESTRICTION which form the claims and restrictions shall not being questioned. Both parties are registered traders under German Commercial Code.
h) In case of a legal action the place of jurisdiction is Traunstein, FRG.

11 Transport

The in here described product is delivered in cartboard box. Please assure yourself that the shipment is complete and without visible damages. If you spot damages due to the transport you have to reclaim them immediately. In this case you **MUST N O T** take the device into operation for safety reasons. In order to protect the device from future transport damages we recommend to keep the original packaging.

If the device is equipped with a transit support they have to be reinstalled previous to the transport.

Particularly after transport under low temperatures a sufficient acclimatization phase has tp be maintained otherwise damages can result.

12 Repair

Having knowledge that defect or inactive devices cause disprofit it is GRIMM´s politics to care as fast as possible about those customer issues. If an idleness/ breakdown is ascertained we kindly ask you to immediate contact the next GRIMM selling agency or you local dealer.

Please contact the service department of the company GRIMM via Email before you send one of our devices back for service:

Service@grimm-aerosol.com

Please specify with following details:

- Model number and Version of Firmware
- Serial number with year of manufacture (see name plate on the top of the device)
- Date of purchase order and your order number (except of it is a case of warranty)
- Your invoice address
- Your shipping address

Please make sure that the device or devices or free of any dangerous to health contamination before you ship the device or devices!

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