Environmental Dust Monitor #180

USER MANUAL

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I N D E X

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GRIMM values your comments and suggestions on this manual. Please use the comment sheet, on the last page of this manual, to send us your opinion on the manual's usability and any of your suggestions for specific improvements. Please report also any technical errors in this manual. In such a case send us your comment as email directly via the software link and we will reconfirm your valid contribution!

Copyright Notice

1 INTRODUCTION

Important Notes for the Customer

1.1.1 Safety Regulations

The manufacturer refuses every direct or indirect liability if the user opens the instrument or manipulates the instrument! This instrument is built and tested in accordance with EN-61010 (DIN VDE 0411 T1) to assure proper protection of the electronic material and measurement function of the instruments. All units have left the factory with regard to safeguarding in a perfect condition. In order to keep this state and to guarantee a safe operation, the customer must follow the references and warning notes which are contained in this manual.

If a safe operation is no more possible, the instrument has to be taken out of operation and to be protected against unintentional operation. A safe operation is not anymore possible,

- if the instrument shows visible harm,
- if the instrument does not work anymore,
- after longer storage under unfavourable circumstances,
- after hard stress during transport.

If the instrument was stored or transported at low temperatures and an acclimatisation period is not kept prior start up of min 1hour, the internal pump may not even start (due to possible inner condensation). In this case the electronic protection fuse will activate and disconnect the instruments power supply.

1.1.2 Laser Safety!

Caution! Optical laser class 3 B inside!
The instrument may only be opened by GRIMM trained service personnel.
During the opening of the laser unit, esp. the measuring chamber, a laser radiation of the class 3 B can be released.

You will find references in the EN 60825 (DIN VDE 0837 T1), but also in the corresponding VBG 93 "Laser radiation" prevention regulation for possible accidental exposure!

*All stickers shown are on the bottom of the instrument and **WARN** the operator for laser light radiation in case the covers of the instrument have been dismounted!*

LASER KLASSE 1

Vorsicht !
Unsichtbare Laserstrahlung,
wenn Abdeckung geöffnet
Nicht dem Strahl aussetzen !

1.1.3 Electric Safety

Before commissioning of the instrument, you need to check whether the main voltage is in the allowed range and specifications.

- The Lithium battery (SL-389; 3,6V; 1AH) on the digital circuit board that is necessary to the operation of the real-time clock. This battery must not be charged or changed in an emptied state by an unauthorised personal. The normal operation period is several years.
The recharge of the Lithium battery inside the memory card: (CR-2016 with 3V and 60mAh or CR-2325 with 3 and 200mAh) is not permitted.
- Fuses built into the instrument may only be changed by trained service personnel.

All fuses are to be replaced only by the same type!
Since the instrument has its internal electronic protection, the fuses will react only at a serious fault. Caution!

1.1.4 Transportation

The instrument may be transported only in the original packing and in the switched off mode. The aerosol inlet and output have to be closed with provided covers.

All transport clamps have to be installed.

We reserve the right to change or to improve the instruments described in this manual without previous announcement, simply in accordance to the technical progress. Therefore insignificant deviations between the descriptions in this instruction and your measuring instrument are possible.

Dust monitor #180, whole system

2 DUST MONITOR SYSTEM # 180

The ideal instrument should be able to measure ALL the environmental dust requirements at the same time. It should be easily installed and operate with minimal labour & maintenance, for as long as possible. It should automatically transmit daily, hourly, or updated results to networks or PC`s, store all obtained results on an internal data logger for later presentation, report the instrument conditions, especially if a failure occurs.

Some of the features of the Dust Monitor #180 System are:

19" rack mounted stationary construction, with built in optical unit, able to measure PM 10, PM 2.5 and PM 1 at the same time
Particle sizing from 0,23 µm to 20 µm
Particle mass from 1 to 1.500µg/m³
Attached climate sensor for temperature and humidity
Data storage of days, weeks or month of test results
Keyboards or remote (via RS-232C) operation
Existing hardware and software accommodates a wide variety of accessory inputs
Automatic volume control and registration
Automatic humidity compensation
The system can be operated independently and needs a protected environment or a shelter.

Introduction to the legal monitoring principals

Regular data of the environmental dust conditions are legally required and reported by different environmental agencies world wide to the public. These reports:
Follow US Clean Air Act requires PM 10 for EPA Part 50 for PM10 and now PM2.5

European Union Regulation 96/62 for monitoring in accordance to EN 12341 for PM-10 (and soon PM-2.5)
**Measure the particle size distribution in many different size channels, to obtain better knowledge for   sub-micron particle size distribution in addition to the dust mass distribution is more and more required**

Operating Principle

The particle size analyser /dust-monitor Model 180 described in this text is a stationary unit (19" rack mounted), used for the continuous measurement of particles in the air (aerosols). These particles can be reported in various modes. However, these measurements are determined as **Environmental mass as µg/m^3**. These measurements are reported for the various size distribution channels.

All units of the 180 series use light-scattering technology for single-particle counts, whereby a semiconductor-laser serves as the light-source. The scattered signal from the particle passing through the laser beam and is collected at approximately 90° by a mirror and transferred to a recipient-diode. The signal of the diode passes, after a corresponding reinforcement, a multi-channel size classifier. A pulse height analyser then classifies the signal transmitted in each channel. These counts can be displayed and are also stored in the data storage card and may be transferred via the RS 232 for further analysis. Without data storage card the instrument has an internal memory size of 80 Kbyte.

The ambient-air, to be analysed, is drawn into the unit via an internal volume-controlled pump at a rate of 1.2 litres /minute. The sample passes through the measuring cell, past the laser diode detector and is collected onto a filter. The pump also generates the necessary clean sheath air, which is filtered and passes through the sheath air regulator back in to optical chamber. This is to ensure that no dust contamination comes in contact with the laser-optic assembly. This particle free airflow is also used for the reference-zero tests during the auto-calibration.
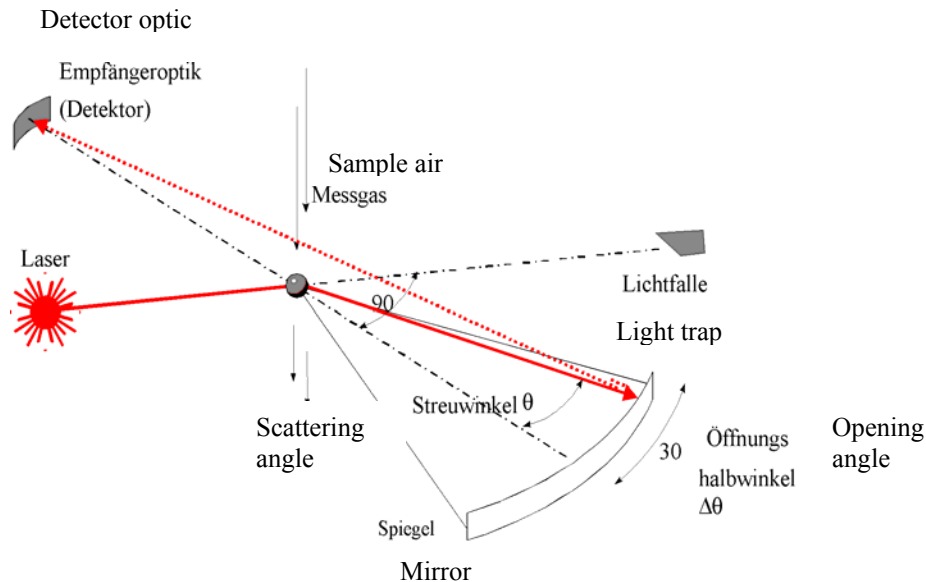
Picture 1: Measuring principle

Sampling Technology

2.1.1 Sampling Head

All particulate in the air passes the sampling inlet and enters vertically into the optical measurement cell. This stainless steel pipe is polished.

2.1.2 Measurement

During the measurement process all particles are categorised in their proper size and as being larger than the largest size channel can only be categorised as such (i.e. particles classified with diameter **>32µm** will be reported as such regardless of how much larger actually are). The #180 is using 31 channels. Practical experience has shown that very few particles above 10 µm are in the ambient air and rarely anything above 30 µm was found (as count) over a 24h collection time.

Thresholds of the different size channels in µm

0,25	0,28	0,30	0,35	0,40	0,45	0,50	0,58	0,65	0,70	0,80	1,0	1,3	1,6	2,0	2,5
3,0	3,5	4,0	5,0	6,5	7,5	8,0	10,0	12,5	15,0	17,5	20,0	25,0	30,0	32,0	

2.1.3 Sampleflow

The sample air flows through the sample inlet to the measuring chamber. Water droplets and coarse particles will be removed in the following glass bottle which serves as water trap. The sample flow is 1.2 l/min (72 l/hour). Then a fine dust filter removes all the particles from the sample air. A membrane pump sucks the clean air through a valve, a protection filter, an orifice and a three way valve to the sample outlet. The sample flow is controlled by a flow controller which monitors the pressure drop over the orifice. A part of the cleaned air is used to supply the measuring chamber with rinsing air to keep the optic and the measuring chamber clean. This clean air will be also used during the functional self test to calibrate the system for zero particles.

DM180 Sampleflow schematic

Sample Out

1.2l/min

Sample Inlet

1.2l/min

rinsing air controller

Measurment Chamber

NC

NO

protection filter for pump (self test)

CQ

water trap

rinsing air filter

protection filter for value

flow controller

Switch -50mbar

BQ   Dust filter

0.3..0.5 l/min

valve 0..12V
Work-point is
8V at 1,2l/min

buffer

Membran Pump

buffer

rinsing air

sample flow

self test flow

dryer air
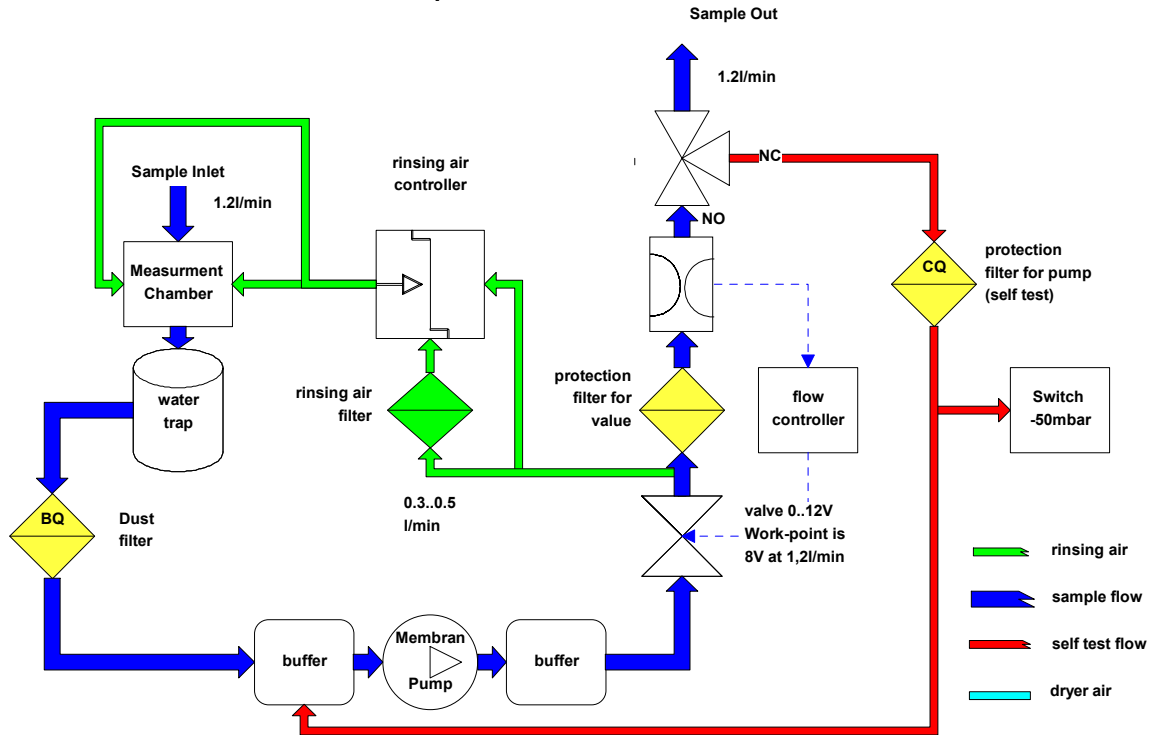
2.1.4   Dehumidification System (Dryer)

The sample air is not heated to avoid outgasing of vulnerable organic content before measurement, all particles in the sample air are measured. This means, below the condensation point of the humidity, probes are sampled as normal, however above 70% relative humidity comes a dehumidification system in function which removes humidity over a NAVION membrane-tube from the sample pipe and assures NO condensation during measurement. An extra humidity and temperature sensor (of type 1.153 FH 180) controls at all time the parameters.

Model 180 Vacuumflow schematic

from
Sample Out

sample pipe
holder

sample pipe

sample pipe
holder

under-pressure
regulator
-550mbar

1.2l/min

from
room

1.8l/min

Sample
Head

CQ   vacuum
filter

Linear
Pump   Silencer

permapure
dryer

Needle-valve

CQ   protection
filter for
vacuum pump

Outlet
back
side

1   3

Vakuum
meter   Switch
-400mbar

to meassurment chamber
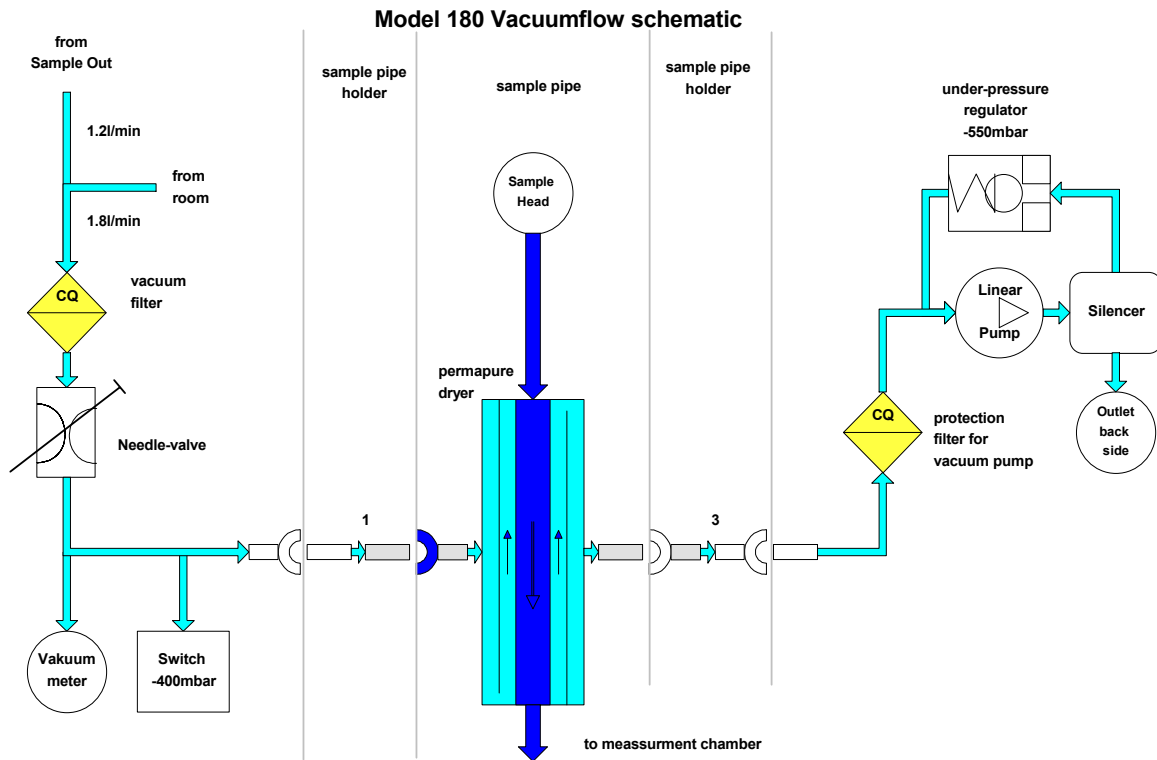
Mass Measurement Correlation

At the beginning of each measurement, the instrument initiates a self-test, which last approximately 30 seconds. The actual dust-measurement begins when the LCD displays the first result.

At that point the counts are stored and downloaded each 6 sec to the microprocessor in the monitor. These counts at each channel are converted to volume and multiplied by the density described in the next section. This new mass distribution is than the base for the individual cut points set by the EPA accepted sampling heads.

Subsequent results will be displayed every 6 seconds. The real-time dust-concentration measurement data are transferred each minute to the removable data storage-card, if used. The data is also available via the built-in RS-232 serial port. This data may be transmitted to an external computer. This data is available in intervals of every 6 seconds (fast-mode) or every 60 seconds (normal mode). Consequently is the total theoretical mass equation based on the

TM (*Total Mass*) = $\varnothing$P (*Particle size*) x PC (*Counts per 6*") as (V) volume

(in µg/m3)   x 14 (different size channel sections) x Da (Average density)

$\varnothing$P is calculated from the MIE theory
PC   is taken from the counts of the PAH (pulse height analyser)
V   is the volume equation
31   are the amount of size channels in the unit
Da   see section below N0. 4
PM-Values   = Size distribution curves as outlined in No1,
(PM-10 + PM-2.5)   implemented into the mass distribution curve
PSD   =   is the base of the data acquisition and can be expressed as well.
24h   value   =   average of the 1 min data collection of 1440 data sets.

Factory Calibration

The factory calibration of each particle size analyser/dust monitor employs a three-step process.

2.1.5   Verification Calibration of Laser Optics

The first step on the factor calibration is to verify the instrument's optics against a "mother-unit" for proper size classification and distribution.

2.1.6   Gravimetric Correlation Verification

Next a gravimetric correlation analysis is performed with stearin-acidity-aerosol. Using a gravimetric-factor of 1.0 for stearin aerosol is ideal, because of stearin's unique physical characteristics, a density of approximately 0.92 and a refractive index of approximately 1.45. A calibration certification is provided with each instrument. The acceptable control limit is +/- 5%.

2.1.7   Optical Calibration Cross Reference

After a successful stearin calibration, a 3rd test is employed with spherical glass-beads. The glass beads have a density of 2.8 and a refractive index of 1.36. The density-factor of 2.8 is coded into the instrument's hardware and used in the mathematical equation for the calculation and aerosol's mass.

Dust Mass Correlation

The particle size analyser/dust monitor determines the dust-concentration (counts/litre) through the optical-light-scattering method directly; however, the mass concentration is determined by extrapolation. The calculated mass concentration may be corrected to the specific aerosol measured with the gravimetric-correction factor (C-Factor). With a parallel low/high volume sampler a second sample is collected on a filter, weighted and than this value can be quickly determinate.

$$C - Factor \ = \ \frac{Filter \ \ weight \ (loaded \ \ filter \ - \ clean \ \ filter}{Theoretica \ l \ weight \ \ shown \ \ by \ \ the \ \ instrument}$$

The "C-Factor" results from the equation: Theoretical mass / real filter weight

The "C-Factor" is therefore mainly dependent on the aerosol density, refractive index and the form of the aerosol collected. Each instrument is factory calibrated for size and mass and leaves the factory with a C-Factor = 1.0

Notice:
All Dust Monitor #180 are factory calibrated to urban traffic conditions and any correlation check is ONLY recommended when a different aerosol is used.

Delivery

19" rackmounted dust monitor 180

samplepipe holder 181

samplepipe 182 with attached temp./hum. sensor 1.153 FH 180
(delivered separately)

3 SYSTEM OPERATION

System Components

The Dust Monitor #180 system consists of the following items:

Necessary items:

180	19" rackmounted indoor dustmonitor
181	sample pipe holder
182	sample pipe
1.153 FH 180	temperature / humidity sensor
	user manual

Recommended items:

158	wind speed sensor
159	wind direction sensor
157	rain sensor
1.143C	RS232-connection cable to PC
1.142.A1–A6	PCMCIA memory data card, div. sizes
1.161A	battery for memory data card 1.142.A1-6
160	analog adapter 4..20mA for PM-10 + PM-2.5 and PM-1
177	32-bit monitoring-software for Windows NT / XP
1155A	memocard reader for PCMCIA memory data card (version F and later)

To understand the monitoring principle please read the following section first.

The Dust Monitor # 180

It is a 19" rack mounted unit, used for the continuous measurement of particles in the air (aerosols) and their proper size distribution. The measurements are expressed in mass concentrations (in units of µg/m^3). All 180 units use the light-scattering method of the single-particle counts, whereby a semiconductor-laser serves as light-source. The scattered signal from the particle passing the laser beam is collected at approximately 90° by a mirror and transferred to a recipient-diode. The signal of the diode passes, after a corresponding reinforcement, in 31 size-canal classifier.
Hereby, a pulse height analyser classifies the signal with leaves itself to a counter in each channel. These counts can be displayed and are also stored in the memo card and transferred to the RS 232 for computer analysis.

The ambient-air is sucked in with the help of an internal, volume-controlled pump through the sample cell and through a collecting filter. This filter collects all the particles. The pump also generates the necessary sheath air, which is filtered and passes through the sheath air regulator back in to optical chamber. In this way no dust contamination comes to the laser-optic. This particle free air flow is also used for the reference-zero tests.

At the beginning of each measurement, the instruments start a self-test for about 1/2 minute. The actual dust-measurement therefore begins after the LCD-display shows the first results (all 6 seconds). This real-time dust-concentration measurement data are transferred each minute to the removable storage-card, if used. These data are available in intervals of 6 seconds (fast-mode), or 60 seconds (normal mode) or only on request.

3.1.1 Measurement Range

Model   Mass-Concentrations (µg/m^3) and size channels

180 unit   0.1 – 1.500 µg/m3 of PM-10 and PM-2.5 and PM-1

3.1.2 Data presentation

Possibilities on the Model 180 LCD-Display

PM-10   EPA convention
PM-2.5   EPA convention
PM-1   Proposed EPA convention (all sub-micron dust)

Thresholds of the different size channels in µm

0,25	0,28	0,30	0,35	0,40	0,45	0,50	0,58	0,65	0,70	0,80	1,0	1,3	1,6	2,0	2,5
3,0	3,5	4,0	5,0	6,5	7,5	8,0	10,0	12,5	15,0	17,5	20,0	25,0	30,0	32,0	

3.1.3 Technical Data of 180

Measurement Principe:	90° light-scattering method.
Classification:	in 31 different channels.
Light source:	laserdiode, wavelength 685 nm
Laser power:	Pmax 60mW, Pnorm 0.5/32 mW (multiplex)
Smallest detectable particle size:	0.25 µm
Thresholds:	Set for an efficiency of 50% with monodisperse latex Aerosol.
Mass-calculation:	An additional channel becomes through extrapolation below the finest measured channel. Mass-calculation as arithmetic median value per minute
Accuracy:	±2% over the entire measurement range.
Self-diagnosis:	Automatically after each start/ timer set point
Measurement time:	From 1 min until continuous.
Ample volume-stream:	1.2 l/min ±5% steadily through regulation.
Sheath air volume:	0.3 l/min steadily through regulation.
Operation keys:	over foil-keyboard or RS-232 – Interface.
Dimensions:	180 : 483 x 177 x 400 mm, (4 HU)
	181 : 483 x 89 x 120 mm, (2 HU)
Weight :	180: 15 kg
	181: 2 kg

3.1.3.1 Data Presentation

LCD-Display:	2 rows x 16 signs.
Data-edition on LCD-Display:	Dust-measurements as gliding median value over a minute or mean values with total sampled air, Alarm-values, gravimetric-factor location No., date, time, measurement data of the optional accessories.
Analog input:	3 ports (0-10V), resolution 10 bits, 0 -10 V DC
RS-232 Data-interface:	9600 Bids, 8 bits, no parity,1 stop-bit, XON /XOFF protocol
RS-232 Socket :	Only useful with original cable 1.143E

3.1.3.2   Memory

Data-storage-card:	512KB to 64 MB on the card
Data collect:	measurement values each minute, date, time, Location, C-. Error codes collected, motor-current, 3x analog-inputs.

3.1.3.3   Power Supply

Specification:	230V / 50Hz, 110V / 60Hz (optional)

3.1.3.4   180 Monitor System Limits

Operational-temperature-range:	+4 to +40 °C, RH. <95% (not condensing).
Transportation-temperature-range:	-20 to +50 °C, RH. <95% (not condensing).
Sampling air temperature:	-20 to +60 °C, RH <95% non-corrosive.
Pressure differential limits:	5 to –50 mbar (short-term) (Maximum –100 mbar)
With overpressure:	max. +100 mbar with longer measurements used.

3.1.3.5   Memory-functions

The function used in the last Standby-mode will boot up again. The display mode remains as before; also the alarm-value, calculated filter-weight and sample flow remain stored. Even when a power fail during a measurement cycle occurs all mean values remain stored, so that with the power-return the measurement will automatically continue.

3.1.3.6   Laser Power of 180:

Laser type:	Semi conductor-Laser diode
Laser class:	3B

| 180	685 nm	60 mW	0,5/32 mW CW (Multiplex)

Operational Mode of Monitor 180

The following chapter is an overview over the different service-elements of your dust-measuring instrument.

> ***Please READ the manual first****, than start up the dust monitor!*

3.1.4   LCD-Display

The optical display on the unit consists of a LCD (Liquid-Crystal-Display) with 2 lines of 16 characters, therefore 32 characters. The display is back illuminated. On this display are shown the measurement results of two channels, or date, time, location (a two-digit number, that can be assigned to a certain area), values of the analog inputs or the C-factor. In addition, also all necessary system messages.
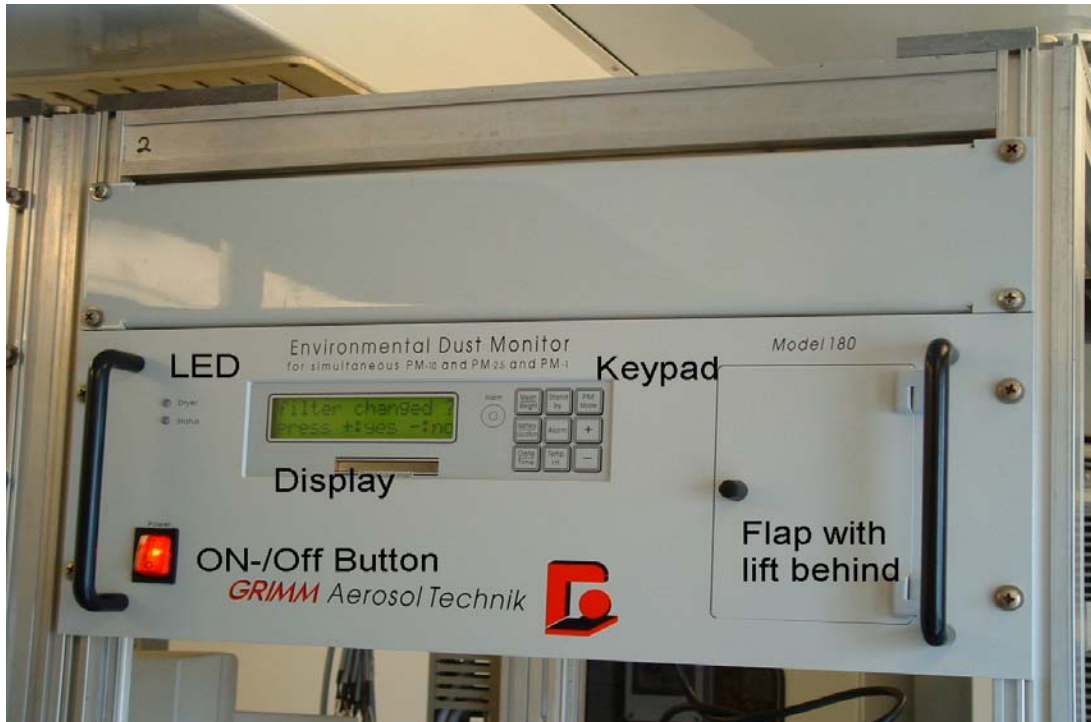
3.1.5 ON / OFF key

With the ON/OFF key (button *POWER* at the lower left side of the front panel), the instrument is started as well as turned off. Before turning off the instrument please go to Stand by. In order not to interrupt the measurement inadvertently, the turn off is delayed via software for approximately 1 second. Therefore the *Stand by* key must be pressed until the beep occurs. A renewed start should not be tried in less than 5 seconds.

Never TURN OFF the instrument in the run mode, but first go in standby (press key *Stand by*), than press the off key. Otherwise, it may lose data from the memory-card. The unit interpret switching off during measurement as loss of power and it will, after the restart boot up himself automatically. This means it will switch directly in the run mode without asking for filter exchange and will calculate the mean values including the previous measurement.

After start up the following messages are displayed:
Model 180,
Version 7.80 U or E (E for European time system: 24 hour and U for US time system 12 hour with AM/PM), and
date and time.
Then the question appears *filter changed?* With the two options *–(no)* and *+(yes).* After answering this question the start up process continues with the internal self test (display: *self test*). With the successful finish of the self test the measurement starts.

3.1.6 Status LED

On the left side of the front panel there are two LED labelled as *Status* and *Dryer*. These LED's can have 4 conditions: off, red, yellow and green .

Status LED: Off: instrument is in stand by mode
                Red: instrument failure
                Yellow: self test running
                Green: normal working condition

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Dryer LED: Off: dryer not active
             Yellow: dryer self test
             Green: dryer active

3.1.7   Door/Flap with lift handler

On the left side of the front panel there is a door/flap which can be opened.

Key Functions

The key board on the Dust Monitor is shown below. Each operation is confirmed by a short bleep. The displayed mode is maintained as long as that key is pressed.

Between the standby and the run mode some keys have different functions, therefore read the following two sections carefully. Also notice that the instrument confirms each key pressing through a short beep.
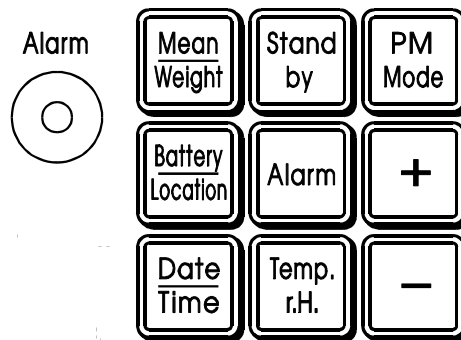
3.1.8   Key Functions in the Operation Mode

Mean/Weight	Displays the mean value of the particle concentration (PM10,PM2.5,PM1) of all measurements after start of the instrument (and/or after the last resetting) with the corresponding sample volume.
Standby	By pressing this key the current measurement stops and switches the instrument into the standby mode.
PM Mode	Measured value output is stopped as long as the key is pressed. The operating mode can be changed only during the standby mode!
Battery / Location	Pressing the key shows the measurement point no. This can be changed by pressing + or – button. Please note that the battery always shows a value of 130%, due to the fact that the instrument is connected to a fixed power supply.
Alarm	Press this key to call up the actual alarm value.
+	The cyclical display of the analog input values are switched on by pressing this key
-	The cyclical display of the analog input values are switched off by pressing this key
Date/Time	The actual date and time are displayed by pressing this key
Temp./r.H.	Displays the actual values of the temperature and humidity sensor

3.1.9   Key Functions in the Standby Mode

Mean/Weight	Display of the mean value of the particle concentration of all measurements after starting the instrument (or after reset) with

	corresponding sample volume
[Mean] & [-] key	Reset of the mean value and of the mean value of measurement by simultaneous pressing of the key
[Mean] & [Status]	Formatting, testing and clearing of the memory
Standby	By pressing this key the standby mode will be left and a new series of measurement will be started
PM Mode	Shows the display format of the PM- channels selected
PM Mode & [+] or [-] key	Setting of the desired display format, such PM-10 or PM-2.5 or PM-1
Battery/Location	Shows the actual battery capacity in %, and the set measuring point no
[Battery/Location] & [+] or [-] key	Changes measuring point no. Serves only to identify different measurements and may be set between 1 and 99.
Alarm	Call up of the actual alarm value
[Alarm] & [+] or [-] key	Changes alarm value. Zero deactivates alarm.
+	Display of mailbox and sheets upwards. After release of the key the display is visible for approx. 3 sec.
Date/Time short pressing	Display of date and time
Date/Time longer pressing	Setting of date and time. The number at which the flashing cursor is found can by activated by [+] or changed by the [-] key. By repeated pressing the date/time key the cursor keeps on being switched. If you don't press any key for a longer time there will be a return into the standby mode. By change of minutes the seconds are put on zero.
Temp./r.H.	W permits entering by pressing [+] key a higher and by pressing [-] key a lower value
-	Display of mailbox and sheets upwards. After release of the key the display is visible for approx. 3 sec.

3.1.10   Data erasing on the data logger card

If you press the [Mean/Weight] and [Temp./r.H.] keys simultaneously, then, after confirming of the security-retrieval through pressing the [+] key, all data on the data-storage-card will be erased. Thereafter each memory cell will be tested and the memory will be formatted This operation is only possible in the Standby mode. When there is a memory data card inserted in the data card slot, the internal memory wil not be erased. To erase also the internal memory first remove the data card.
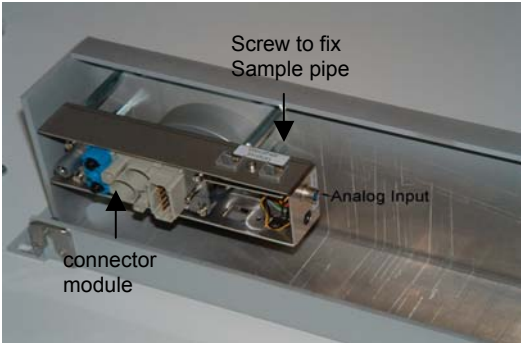
4 INSTALLATION

The dust monitor system #180/181 must be placed in the up most position of a 19" rack in a container or inside a shelter. The space needed is 6 HU (height units; 180: 4 HU and 181: 2 HU; for detailed dimensions see IEC 60297). When erecting the 19 inch rack, it has to be considered that the sample pipe #182 has to go straight upwards from the sample pipe holder #181 through the roof of the container. The hole, the conduit and the sealing has to be provided by the customer. A special tool can be ordered from the manufacturer which helps to mark the exact position of the hole to be drilled through the roof. It is also possible to use a perpendicular. The outer diameter of the sample pipe is 1.7 " (450 mm), the conduct must be of the appropriate size.

Installation and maintenance of the dust monitor #180 can be established without to remove the sample pipe or the sample pipe holder. The connections between the #180 and the #181 and the attached sensors are made via a special connector module consisting of two parts. One part is fixed mounted in the #181 and the counterpart is mounted on a lift in the #180. After installing the sample pipe holder #181and the sample pipe #182 the dust monitor #180 is mounted. Then the lift is moved upwards so that both parts of the connector modules are tightly plugged together. By doing this all electric and pneumatic connections of the whole system are closed. If for maintenance and service purpose the dust monitor has to be removed, simply unplug the connection module by lowering the lift with the connector. Then the dust monitor #180 can be pulled out without removing the sample pipe or the attached sensors. This easies up the maintenance work and prevents a leakage in the conduit of the sample pipe.

Installation

4.1.1   Installation Sample pipe #182 and Sample pipe holder #181

	The sample pipe holder #181 has to be mounted in the up most position of the 19" rack. The necessary nuts and screws have to be provided by the customer (depends of the type of 19" rack used). The space above the rack has to be open for the sample pipe to be installed. The center of the conduit for the sample pipe must be straight over the center of the opening at the top of the sample pipe holder.
	At the underside of the sample pipe holder #181 the fixed mounted connector module can be seen. At the side is the socket of the analog input. Here the connector from the sensor must be plugged in when installing the sample pipe. There are also placed additional sockets (RJ11) to connect further optional climate sensors (for wind speed, wind direction, etc.). Above the connector module is the holder for the lower end of the sample pipe. At the side of this holder is a small screw to fix the sample pipe when inserted in the holder.
	Here the sample pipe with attached sensor for temperature and relative humidity can is shown. The sensor holder will be delivered separately and must be fastened to the upper part of the sample pipe (pipe with smaller outer diameter). Then the sensor has to be slit into the protection sleeve. At the side of the sleeve is a small screw to fix the sensor in this position. Take care not to bend the cable of the sensor. Press the cover for the thicker part of the sample pipe tightly down, so that no rain can enter the pipe. Please take care not to squeeze the cable.

In case of a leakage of the conduit for the sample pipe, it could happen that rain water is running on the outer side of the sample pipe into the dust monitor. This could damage the dust monitor seriously. To prevent this to happen a small cup is provided to collect the drippling water and to lead it away with an attached tube. After passing the sample pipe through the conduit in the roof of the container, attach the rain cup over the sample pipe before inserting it in the sample pipe holder.

Please pass the sample pipe carefully through the conduit. Before inserting the sample pipe in the sample probe holder, fasten the rain cup on the pipe. Then fiddle the sensor cable with the attached plug through the opening in the sample probe holder. Connect the two tubes coming from the holder opening with the appropriate connectors at the bottom of the sample probe. These tubes provide a vacuum to the drying system included in the sample pipe. The tube with the metal connector has to be fitted in the inlet with the blue ring (before removing the tube press the blue ring down, to release an o-ring which is sealing the connection). Whereas the tube with the bare end has to be fitted over the inlet with the nibble. Carefully insert the sample probe into the holder. Take care that no tube is squeezed. Turn the screw at the inside of the holder to fix the sample pipe in the holder. At least plug the sensor cable in the appropriate socket.

Connector from Sensor
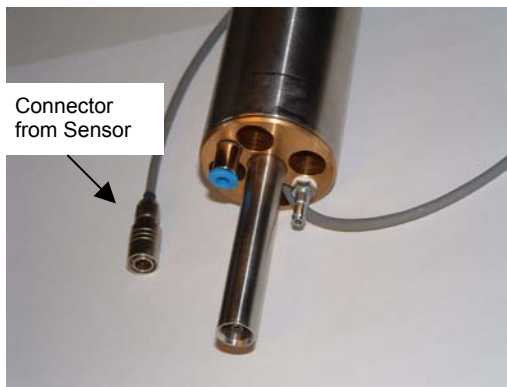
View of the lower end of the sample probe with the sample pipe, the connector cable from the sensors and the connectors for the two tubes of the dryer system.

4.1.2 Installation dust monitor #180

	dust monitor #180 before installation
	On the base of the dust monitor there are marked four screws. These screws secure the internal pumps from being damaged during the transport. They have to be removed before installation. Further more on the vacuum pump there is a transport clamp inside the housing. To remove this clamp please open the top cover. Remove the clamp which was initially fixed by two of the screws on the base of the housing. Then close the cover again.
	View on the vacuum pump inside the open housing. The marked clamp can be seen. This clamp has to be removed. When unfastening the screws on the base, the clamp will become loose and can be dragged away from the pump.
	Please store the screws and the clamp for future use. Whenever the dust monitor has to be transported (for maintenance, repair or other purpose), the screws and the clamp have to be reinstalled again. **Do not throw away.**

Mount the slide bars provided by the customer in a way, that the dust monitor #180 can be installed in the 19" rack directly under the sample probe holder #181. Then insert the dust monitor #180. Fasten the dust monitor with four screws (provided by the customer). Then attach the power cord (provided by the customer) to the socked at the back of the instrument. Do not apply power at this moment.

For a normal operation of the whole system, it is necessary that, when raising the lift of the #180 with the lower connector module, the two parts of the connector modules are fitting smoothly together. Please test this functionality before tightening the screws of the #180 and #181. Both front plates must fit tight together..

To raise the lift please open the flap on the right frontside of the dust monitor. Behind, one can see a glass bottle, which serves as watertrap and to hold back coarse particles. In the upper part there is the lever for the manual operation of the lift. To raise the lift, pull out the lever and move it to the up most position. Take care that both parts of the connector module are fitting smoothly together. Perhaps the #180 and #181 have to be slightly repositioned by releasing and tightening the screws again to provide smooth operation. Then push the lever gently inside. In the final position the tip of the lever must operate a small switch inside the housing. This switch will indicate the system, that the connector module is raised and all the connections are plugged in correctly. Otherwise the dust monitor will issue a warning in the self test during startup.

When removing any part of the system, this procedure has to be done in reverse order.

Start-up of the Dustmonitor #180

Before switching on the instrument, please make sure, that the whole system is set up as described in this manual and that the electrical connections have been installed according to the local regulations. Please verify that all local regulations regarding the use and operation of this kind of instruments have been followed accordingly.

When the measured data shall be stored on a memory card, make sure that the card is inserted in the slot on the front panel below the display, before the power is switched on.. Please read the chapter about handling and operation of the memory card first.

> **There is a possibility to loose data, when the memory card is not installed accordingly.**

To read out the measured data online, please connect the dust monitor #180 with the provided serial cable (#1.143E) with the serial COM port of a PC or Notebook. For installing and operating a serial data connection between the dust monitor and a PC/Notebook, please read the chapter about a RS232 data connection first. It is possible to operate the dust monitor with an inserted memory card and an online connection at the same time. The memory card then serves as a data buffer. The stored data can be read out later for further use. The dustmonitor #180 has a build in memory of 80 Kbyte. When no memory card is inserted, this small amount of memory serves as small buffer.

Switch on of the dust monitor

Verify if the LCD-display shows the model-name and the software-version-number for approximately 5 sec.. Later the display shows the date and the time.

> **Model 180**
> **Version 7.80**

By pushing the [Date-Time]-button the operating-hours of this instrument are displayed, when pressing the [Mean]-button the instrument specific serial number is shown. As operating-time the pump runtime and laser runtime is calculated.

Plugged-in data logger Card
In this case the unit will identify the card. The card size and the version of the storage card will be shown on the LCD-display, for example:

> **Card: 1024kByte**
> **Version: 1.20**

And following the storage interval is shown. The storage time interval can be changed with the [+] and [-] key. The corresponding vacant storage time (without overwriting already stored data) in the 2nd line is updated at the respective interval.

Display for example:

> **Interval: 6 sec**
> **free: 1d 15h 43min**

The filter exchange

will be the next question from the dust monitor to you . If you answer with yes [+], the calculated filter weight as well as the affiliated sample air-volume will be set to zero. The instrument will begin again calculating the filter-weight.

```
        Filter change
        [+] no  or [-]
```

In order to prevent an inadvertent erasure of the values, a delayed keyboard-retrieval follows, you must press this key at least for one second, until a beep sounds. By pressing the [-} key, the instrument continues adding the mass and volume data. Now, the instrument starts a self-test for approximately 30 seconds. If still you want to change some of the settings like alarm-value, time or to alter the displayed size, you need to press the [Standby] key, make your changes and than press the [Standby] key again for start and the text below will occur:

```
        Standby Mode
        Press 2nd Key
```

Measurements

Each measurement is started with a self-test, with which the measurement-cell is rinsed through by clean air. Several different internal measurements are enforced, from which conclusions of the status of the instrument are made. If all tests pass, the message appears on the display **"Calibration OK"** and measurements will be shown, such as:

```
PM-10:   46 µg/m3
PM-2.5:  27 µg/m3
```

Alternatively the message: "New Calibration" will occur. If this message should appear more than once, an appliance-disturbance is existing, which must be remedied. Then the message "**Fatal Error Please Check**" will be displayed. Possible causes for this is are:

+ a lint, that hangs at the air-nozzle and sticks out into the laser-ray,
+ a contaminated measurement cell
+ an instrument-temperature over 50°C
+ a laser or another hardware-defect (defect humidity sensor).

Try first to remedy the disturbance through a thorough cleaning of the air inlet. (See also chapters ...). Alternatively, the instrument must be send to your nearest representative for service.

Now the actual dust-measurement begins and after each 6 seconds, the measurement the results on the display are updated. After the first minute, the measurement values will have stabilized themselves, (since the gliding mean value of the last minute is established).

Factory calibration

As already outlined in section 1.5, each GRIMM dust-measurement instrument is calibrated in the factory and the results obtained are supplied as test certificate with each instrument.

5 ANALOG PORT

Construction of the Analog input port at the #181

The dustmonitor has a socket at the inner side of the sample pipe holder #181 for 3 analog connections (6 pin socket), where the matching analog sensor can be connected. The input signal is between 0 and 10 volts in each case. This connection-socket can also supply the external power for +10 VDC up to 40 mA .

Socket to connect climate sensors / one-wire bus

Analog Input

Analog input
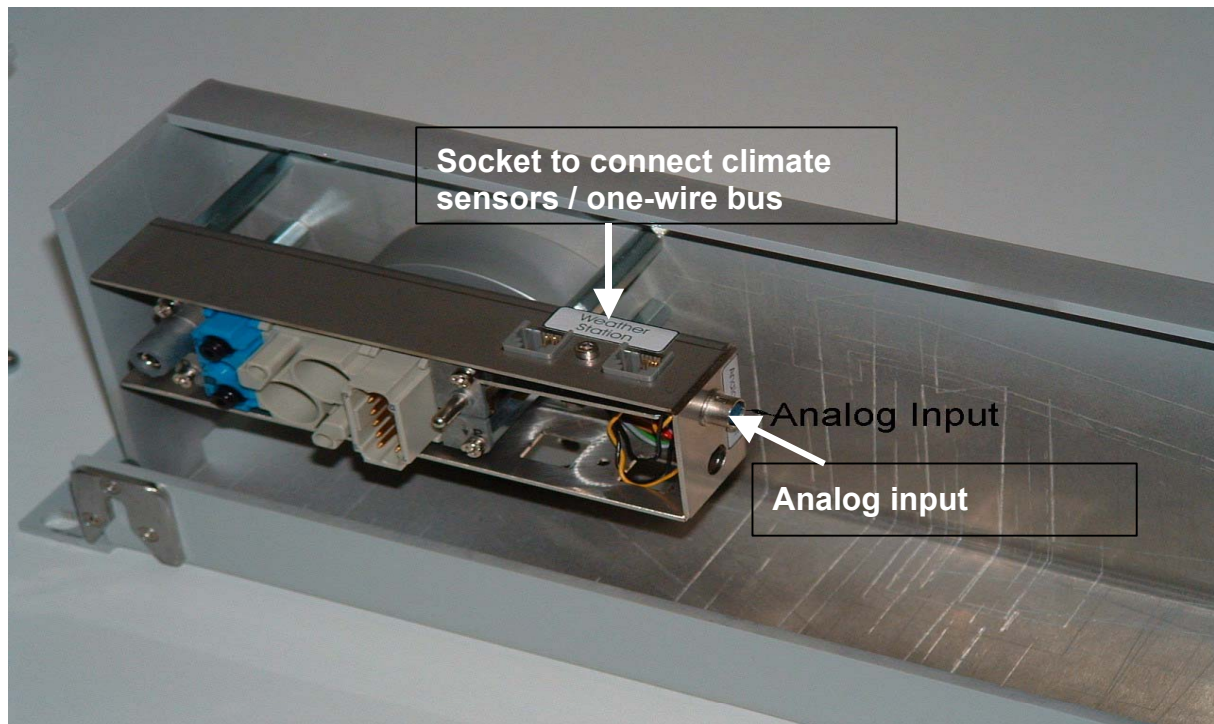
Picture: Sample pipe holder #181: view from behind

Possible sensors: temperature, air velocity , barometric air-pressure, humidity, CO_2, etc.... The measured analogue values are stored on the data-storage-card and can be shown on the CLC display. The resolution amounts to 10 bits (approximately 10mV). The texts and factors for the LCD-display can be changed.

Pins at the analog input socket:

1. Input 1
2. Input 2
3. Input 3
4. GND (mass)
5. +10V/40mA
6. free
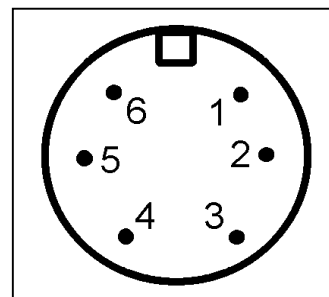
5.1.1 Technical Sensor Specifications:

One sensor which has to be attached is the 1.153H180 temperature and humidity sensor. Without this attached sensor the dustmonitor will not start up, and an error message is displayed.
It has the following specifications:

Dimension in mm:	$\varnothing$=15 mm, Length=200 mm, cable: ca.3m
Plug connection:	6 contacts
Power supply:	10V ±5%, < 5 mA
Temperature range:	0 to +80 °C
Resolution:	0.1 k
Precision:	type. 0.3 k
Humidity range:	0 - 100 % rH (relative humidity)
Resolution:	0,1 %
Precision:	type. 1 %
Air Velocity range:	0,3 to 20 m/s
Resolution:	0,1 m/s
Precision:	type. 1%

5.1.2 Internal barometric pressure sensor

In the #180 dust monitor is a barometric pressure sensor integrated. The signals are monitored, stored and can also be displayed on the display.

5.1.3 Climate sensors

With the optional one-wire bus, it is possible to connect up to three additional climate sensors, like

- Wind speed
- Wind direction
- Rain

To store also the values from this sensors additional memory is required. Therefore the storage time of the memory card will decrease.
To install the additional sensors the dustmonitor must be shutoff. Then the sensors can be connected to appropriate socket on the back pf the sample pipe holder #181. When the instrument is switched on again, it will show a different version of the firmware (see start up). With one additional sensor it will show version 7.81 on the display instead of normal version 7.80. Before begin of the measurement the memory card also has to be formatted, to hold the new version.
To remove the additional climate sensors, shut down the instrument, remove the sensors and switch the power on again. Then format the memory card again.

Please backup all the data from the memory card before erasing or formatting the memory card.

6 RS232 INTERFACE

Concept of the RS-232-port

The serial interface consists of two 9-pin sockets at the instrument front behind the flap and at the back and is marked "RS-232 ". Over this interface, the dust-monitor can be operated and the results could be transmitted to a PC.
Only use the the original cable (No. 1.143E) to operate with the PC.

Pin-configuration **on the back**:
Pin #2: RD (Data reception)
Pin #3: TD (Data transmission)
Pin #5: GND (Signal-ground)

Pin-configuration of the service connector **at the front**:
Pin #2: RD (Data reception)
Pin #3: TD (Data transmission)
Pin #4: DTR (Data transmit ready)
Pin #5: GND (Signal-ground)
Pin #6: DSR (Switching for quick data transmission)
Pin #8: CTS (Switching for quick data transmission)

Transmission Protocol

The Baud rate is 9.6 kBd for the normal data transfer. Eight data bits without parity and one stop bit are used. The software protocol XON/XOFF is supported. During the quick data transfer mode the Baud rate can be up to 57.6 kBd.

During the Quick ASCII data transfer also the CTS line can be called up by pressing the keys [Mean/Weight] and [Alarm]. If there is no CTS line connected, the interface is considered to be vacant.

RS-232 Commands

Commands can be sent via the RS-232 interface to the Dust Monitor. The instrument will confirm the reception of valid commands through an echo. At the commands capital or small letters are not distinguished. Most of the commands (changes of settings) can only to be sent in the Standby mode.

The numeric values must be confirmed by pressing the enter key with a CR (carriage return). Any changes that may be occur during the running measurement (for example ESC tension), the data output is interrupted temporarily, but the data keep on being stored.

For test purposes you can use every terminal program which supports the XON/XOFF protocol. As example the "HYPERTERMINAL" programs can be used which is anyway a part of the accessories of Microsoft WINDOWS. The corresponding settings of the interface parameters however must select before starting (esp. the appropriate COM port for the serial connection).

A	Current alarm-value. Can be altered in the standby-mode.
B	Current battery-capacity. Is always 130% when connected to power supply.
D	ASCII-data-transfer of the data-storage-card (only in the standby)

```
 D
Memocard :  7.80    from: 87F03017       Sensor: FHE20603
Location : 13  :
P:   4    8    2   13   56   13    0   64  130    8   85    1    0    0    0    0
K:. 2395  4021  4460
P:   4    8    2   13   57   13  100    0  130   31  149    1    0    0    0    0
N:,  316   105    83
P:   4    8    2   13   58   13  100    0  130   31  149    1    0    0    0    0
N:,  212   103    82
OK
```

E	Sends present error-code :	
	128:	NEW SELFTEST
	64:	NO MEMOCARD (no memory card, wrong version, memory card with data from other instrument
	32:	CHECK NOZZLE Whirls> 5%
	16:	RUN TRAP , self start after voltage breakdown
	8:	PLEASE ,
	4:	PUMP CURRENT TOO HIGH Imot> 100%
	3:	FLOW-ERROR Pump-regulation outside of range
	2:	CHECK FILTERS Imot <20%
	1:	Imot> 60%
F	Fast-mode switched on. Results come all 6 seconds	
G	Send gravimetric factor. This value can only be altered in the standby mode. The range is between 0,1 to 9,9 with an incremental width of 0,05.	
H	Total amount of operating hours	
I	Time interval for the online output and the storage of the measured values. Can only be changed in Stand By mode. 0 = 1 minute 1 = 5 minutes 2 = 10 minutes 3 = 15 minutes 4 = 30 minutes 5 = 60 minutes	
J	Output of the measuring mode	

```
J
J:   PM10 PM2.5 PM1.0
```

L	Location number of unit, can only be altered in standby-mode	
M	Medium value and air-volumes	
O	Send capacity of data-storage-card (only in the standby-mode). If a + is . sent and the value, the data-storage-card will completely eliminated.	
R	Run. Start of the measurement from the "standby-mode ".	
S	Switches unit in "Standby-mode",	
T	Time-edition. In "standby" the clock can be changed.	
U	Look the keyboard	
	U=0	Unlocks the keyboard
	U=1	Can not shift to standby mode, mode is disabled.
	U=2	keyboard-access not possible
V	shows version-number the dust monitor's firmware	
	Version: 7.80 E	
!	Shows model – and version-number of monitor	

W	Shows filter-weight and sampled air-volume
Z	First shows the mean value, then sets the mean value and volume back to zero
@	Shows the serial number
	`Model 180    Version 7.80 E`
^A	Transmits calibration factor of the analog-sensors
^B	Set of baud rate for quick-data-transfer
^D	Interrupts the measurement-data transmission
^E	Starts up the measurement-transfer / turns off of the fast-mode
^L	Area/Country-date adjustment (E or U) (only in the standby-mode).
^T	Timer setting for automatic Start / Stop of the dustmonitor
_	Shows the "User"-Text and the analog input factors (only in standby-mode) In the first line, the three "User"-selectable phrases are presented. In the second line, the three multiplication-factors for the analog-signals and the offset values are shown.
	`$(1..3):Temp.:   .    _C|Input 2:.     V |Input 3:.     V |` `*(1..3): 1	10	1 |` `4.36 V	0.00 V	0.00 V |` The first line, the three "User"-selectable phrases are presented. In the second line, the three multiplication-factors for the analogous-signals and the offset values are shown.
$	Selection or change of the "User"-selectable phrases as well as factors for the analog signal to the LCD-display. (Only in the standby-mode). Symbols (over ASCII 127) cannot be entered. In the display the sign becomes ' °'(ASCII 248) as ' _' spent. Pre-determined texts can be selected with the TAB –Key, which can be confirmed through the enter key. They can be overwritten also with other texts. The numbers are always shown in five digits and begin from the 9th position. If signs are entered, besides a decimal-point, an acoustic warning in generated. The multiplication-factor, that is referential on 1V, can then be entered after the text . It can be changed through the command ` * `. **Example:** Temperature-sensor 0°C:=:3.0V and 50°C:=:8.0V User-Text: Temp.: . °C User-Factor: 10.0 [°C/V] Offset: - 3.00V
	In normal operation the sensor data from the temperature and humidity sensor 1.153FH180 will be read out automatically from the sensor. The data are stored in an internal memory, a EEPROM.
*	Change user-settings (factor and offset). (Only in the standby-mode)
?	Shows help test for the commands

```
     #################### Help for Dust Monitor #########################
| A' Alarm                     | ^L' Land (for Date)     [Standby]|
| ^B  Baudrate (Memocard)  [Standby]| L' Location Code             |
| B' Battery                   | M' Mean Value                |
| 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 / Intervall         | %' 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        |
|   ##################################################################### 
```

%   Shows the amount of free memory on the memory card

RS-232-Data transmission

In the RS232 data transmission (which can be seen over a terminal software) the mass values will be shown in µg/m³ with a multiplication factor of 10. At the end of each measuring interval a row of internal data will be displayed, followed by the mean of the mass values. "N" means mass value, "_" means mean value and "," stands for factor 10. To verify which data will be shown, enter the command "J".
The sequences of the data ("P" string) are as following:

Year Mon Day Hr Min Loc GF Err Qbatt Im UeL Ue4 Ue3 Ue2 Ue1 Iv

Explanation:
Year – month – day – hour – minute – Location (1 - 99) – gravimetric-factor –error-code – battery-voltage – valve current - zero-calibration - sensor 1 to 4 - interval .
The dryer operation is indicated with " after the P = P". Sensor 4 Ue4 is always the value for the internal barometric pressure sensor.

After the P values are the
"N" values for the mass concentrations PM-10, PM-2.5, PM-1.0 multiplied with the factor 10.

Version : 7.80
```
  Year Mon Day  Hr Min Loc  GF  Err Qbatt Im  UeL Ue4 Ue3 Ue2 Ue1 Iv
P   4   8   2  13  56  13   0   64  130   8   85   1   0   0   0  0
K. 2395 4021 4460   5    0
P   4   8   2  13  57  13  100   0  130  31  149   1   0   0   0  0
N_, 316  105   83
P   4   8   2  13  58  13  100   0  130  31  149   1   0   0   0  0
N_, 212  103   82
```

In the Fast mode all 6 sec. The measured values will be transmitted
```
F
R
  Year Mon Day  Hr Min Loc  GF  Err Qbatt Im  UeL Ue4 Ue3 Ue2 Ue1 Iv
P   4   8   2  14   7  13   0   64  130   8  149   1   0   0   0  0
  Flow: 100 %
   DC/v  DC_d  DC_h  C0_h  C0_d
K  2559 4207 4640   0    0
N0, 159   91   74
N1, 114  110   87
N2,  95   95   78
N3, 111   93   76
N4, 230  106   82
N5, 173  104   82
N6,  99   96   78
N7, 199  105   79
N8, 109  102   80
N9, 138   96   77
P   4   8   2  14   8  13  100   0  130  31  149   1   0   0   0  0
N0, 184  103   81
S
```

Measurement values from optional climate sensors

When optional climate sensors are attached to the dustmonitor, the values will be shown in an additional line. This line will begin with S(A), then follow the values of the sensors which are connected over the one-wire bus.

7 GESYTEC INSTRUCTION FOR # 180

(This is special German data transmission protocol mode)

Change of mode from STANDARD TO Gesytec-mode

The change from the STANDARD to the Gesytec-mode is only possible via the key pad of the dust monitor. Simply switch on the instrument by pressing ON and „+"- key at the same time and keep both keys pressed until on the LCD-Display the model and firmware version is shown. The instrument will directly change over to the Gesytec-mode. This is shown on the display with an extra „S" at the end.
To return to the STANDARD mode start the instrument by pressing the „ON"- and the „-"- key at the same time. Now the instrument return to the reselected mode, in Europe as „E" or in America as „US" version.

Settings in the STANDARD operation mode

The only option is an additional command in the RS232-commands: „:" for the Gesytec - presetting. During the standby mode an extra signal as „:" (ASCII-Code 58) is issued, which will open a sub menu as following:

Settings for Gesytec

Instrument identification: 123
Serial -number :   987
Baudrate RS232:   9600
Auto-Cal. [h]:   off
Timer-Cal.:   10

 [K] [S] [B] [A] [T] [Esc] [ENTER] ?

After transmitting the „K" is it possible to change the Instrument identification. Possible are the ranges from 0 to 255.
The Gesytec- Serial number can be set after transmitting the   „S" from 0 to 999.
After sending the signal „B", the following help text will be shown. Now a number between 0 and 4 has to be entered:
            Baud input : 0=1200 : 1=2400 : 2=4800 : 3=9600 : 4=19200
            Baud rate RS232: 9600 ?

Auto-Cal. "A" is the time period, after which a new self test will started.
Timer-Cal. is the option to activate the self test at a full hour time.
Only Auto-Cal. or Timer-Cal. can be active at a time. The real start time could be delayed, because first the measuring cycle has to be finished and the values have to be stored. Then the self test will be activated. Entering 0 will deactivate both options.
By pressing the Escape key it is possible to exit from this submenu, without
changing the settings. By pressing the [ENTER] (ASCII-Code 13) the changes are stored.

GESYTEC- Operation

7.1.1   Use directly from the instrument keys
The instrument can be operated independently from the reselected mode with two exemptions:

1. The Gesytec- Instrument identification and the selected Baud rate can be diplayed by pressing the „PM-Mode"- key in the standby mode.
2. The question if the filter needs to be exchanged remains only for ca. 3 Sec. nn the LCD display, than it changes automatically in the standby mode.

7.1.2   Operating the unit via an external PC
This is the normal use of the protocol, since the instrument is installed in an environmental network and transmits the results only when requested. (GESYTEC- Protocol)

All STANDARD RS232 mode operations can NOT be used when this special mode is active.

The control is made by a so called „ST"- telegram.
The following „ST"- telegrams has been incorporated:
„R"   (Run)
„S"   (Standby) Stop of measurement
„N" (Null) (acts like in Run)
„K" (Calibration) the status bit 3 will be set

The „ST"- telegram can be transmitted as ASCII- or Hex- instruction and must use the following format:

Field-Nr.	Byte-Nr.	Data format	Field description
1	1	<STX>	Start of Text
2	2-3	ST	Telegram code
3	4-6	nnn	Instrument code
4	7-8	#A	Empty space key, (mostly a letter)
5	9	<ETX>	End of text
6	10	<BCC1>	Block sign lower nibble
7	11	<BCC2>	Block sign upper nibble

Hex-Format:

Field-Nr.	Byte-Nr.	Data format	Field description
1	1	<STX>	Start of text
2	2-3	ST	Telegram code
3	4-6	nnn	Instrument code
4	7-8	hh	upper nibble, lower nibble
5	9	<ETX>	End of text
6	10	<BCC1>	Block sign of the upper nibble
7	11	<BCC2>	Block sign of the lower nibble

Output over RS232 port

The data output, which is only generated when the data request „DA" was entered, is realized as „MD"- Telegram, in the following format:

Field-Nr.	Byte-Nr.	Data format	Field description
1	1	<STX>	Start of text
2	2-3	MD	Telegram code
3	4-6	03#	Amount of measuring places
4	7-10	nnn#	Instrument identification
5	11-19	±nnnn±ee#	Value of PM10
6	20-22	hh#	Operational status
7	23-25	hh#	Error status
8	26-29	nnn#	Serial number
9	30-36	hhhhh#	Temperature in 1/10°C (F= Minus)
10	37-40	nnn#	Instrument identification + 1
11	41-49	±nnnn±ee#	Value of PM2.5
12	50-52	hh#	Operational status
13	53-55	hh#	Error status
14	56-59	nnn#	Serial number
15	60-66	hhhhh#	relative Humidity in 1/10%

16	67-70	nnn#	Instrument identification + 2
17	71-79	±nnnn±ee#	Value of PM1
18	80-82	hh#	Operational status
19	83-85	hh#	Error status
20	86-89	nnn#	Serial number
21	90-96	hhhhhh#	Valve current in %
22	97	<ETX>	End of text
23	98	<BCC1>	Block symbol lower nibble
24	99	<BCC2>	Block symbol upper nibble

The „DA"- Telegram must be in the following format :

Field-Nr.	Byte-Nr.	Data format	Field description
1	1	<STX>	Start of text
2	2-3	DA	Telegram code
3	4	<ETX>	End of text
4	5	<BCC1>	Block sign of the lower nibble
5	6	<BCC2>	Block sign of the upper nibble

The sign „#" symbols the space key, „nnn" the numbers, „ee" s the exponent and „hh" is the hexadecimal presentation of one Byte.

To get the block checksum, the Exclusive-Or sum is calculated by adding the bytes of all transmitted symbols (incl. STX and EXT, starting from Zero) . The result is shown as two nibble hexadecimal signal and transmitted.

The **error status** is presented as Error-Code from the dust monitor.

The Bit 1 in the operational-status- is set as Byte, as long as the dust monitor is in the Standby- Mode. The Bit 2 is send during the self test phase only.

Error code 1: CHECK FILTER is only a system message, which indicates an increasing dust load on the filter. The filter should be replaced on the next maintenance interval. The measured data are not affected by this message.
Error code 64: System message, that the memory card is not inserted or not installed in a correct way. Does not affect the online data transmission.

8 SYSTEM MESSAGES

There is a continuous self check implemented in the dust monitor #180. Whenever a special condition occurs, the following messages can be displayed on the LCD-display of the dust monitor.

System and error messages

NO SENSOR ! **PLEASE CHECK**	No climate sensor (temperature and humidity) or connected or sensor defective, measurement will stop
Self Test **LIFT NOT OK!**	Lift is not in the upper position or the lever has not benn pushed in to its final position, measurement will not start
CARD ERROR ! **PLEASE CHECK**	The memory card has been inserted or removed during operation. Or the write protection is or has been activated
New Self Test	This error can be caused by several reasons during the start up self test. If this message remains on the display even after cleaning the sample air inlet (see maintenance), the dust monitor must be maintained by qualified service personal
Self Test not OK!	And the dryer LED on the front panel is red, than the vacuum of the dryer unit is not ok. Only during start up self test.
VACUUM NOT OK ! **PLEASE CHECK**	Vacuum for the dryer unit is not ok. Measurement stops. Please check for the pressure on the manometer behind the flap on the front panel
VACUUM SWITCH ! **PLEASE CHECK**	Vacuum pressure switch is closed without sufficient vacuum. Measurement stops. Please contact manufacturer or representative.
FILTER SWITCH ! **PLEASE CHECK**	Lowpressure after fine dust filter is too high without sample flow. Please contact manufacturer or representative.
PLEASE REPLACE **MEMORYCARD-** **BATT.**	Please replace battery of the memory card. Before backup all data from the memory card.
AIR FLOW NOT OK **CHECK AIR INLET**	Sample flow is not 1.2 l/min. The sample flow controller can not regulate the sample flow to the required level. Measurement stops.
PLEASE CHECK **MEMORYCARD**	Memory card is write protected
WRONG SerialNo. **Ser.No.xxxxxxxx**	The memory card contains data from an other instrument. First read out the data. Than format the card again.
WRONG VERSION ! **Clear Memorycard**	The memory card contains data from an other firmware version. First read out the data. Than format the card again.
Fatal Error Please **Check !**	Multiple self test was not performed successful. Please contact manufacturer or representative.
Clear Mailbox **& Intern Memory**	In the internal memory was a error detected. The internal memory has been deleted.

Messages shown on the LCD display

NO MEMOCARD	No memo card is inserted. If you want to use a memo card, please insert now.
CHECK DUSTFILTER AND AIR PASSAGE	The low pressure after the fine dust filter is too high. Please change the fine dust filter. Please contact manufacturer or representative.

9 MEMORY CARD

Data capacity

The storage capacity of the memory card depends on the settings (interval, amount of data) on the instrument and the amount of memory on the card. Only PCMCIA SRAM memory card can be used. The data will be stored in a FIFO (first in first out) process, that means when the memory is full, the data first entered will be overwritten.

Before using the first time, the memory card must be initialized or formatted. Insert the memory card in the small slot under the display on the front panel of the instrument. The arrow on the card must show to the display. Then press the Mean/Weight and the Temp/rH. Button at the same time. You will be asked to acknowledge the erase of the data. Then the memory card will be formatted and all data will be erased. Before formatting a memory card which was already in use, please back up all data contained on the card.

If you want to use a memory card, the card must be inserted before switching on the dust monitor.

The dust monitor will only accept a memory card which has been formatted or which was already used in the instrument and there was no change in the firmware version.

If the memory card has been accepted by the dust monitor, the display will show for ca. 3 seconds the size of the memory and the version number. After that the configured interval for data storage and the free amount of storage time is shown. To change the storage interval press the buttons "+" or "-" to increase or decrease the interval. The free storage time will be updated accordingly.

A non accepted memory card shows no storage time.

When the memory card is not accepted, the measurement will not start. Please check, that the write protection is not activated.
All measured data will be stored automatically on the memory card, in the configured storage time interval.

Memo Card Battery

The stored data on the memory card are buffered by a battery, so they are not lost when the card is not inserted in a dust monitor. When the memo card is inserted in the dust monitor the buffer voltage is supplied by the dust monitor. When the internal battery looses the voltage, a message will be displayed on the LCD-display : " Please replace memorycard-batt." . Then the battery must be replaced. Please back up all the data contained on the memory card, before replace the battery.

Storage Time

There are memory cards in different sizes available, ranging from 256 Kbyte to 64 Mbyte. Depending of the size of the memo card and the configured storage time interval, the maximum starge time wil be as indicated in the spread sheet.

Y: year; d: day; h: hour

INTERVALL	1min	5min	10min	15min	30min	60min
INTERN	2d 17h	13d 13h	27d 2h	40d 15h	81d 6h	162d 12h
256Kbyte	8d 16h	43d 8h	86d 16h	130d	260d	1Y 155d
512Kbyte	17d 6h	86d 6h	172d 12h	258d 18h	1Y 152d	2Y 305d
1Mbyte	34d 12h	172d 12h	345d	1Y 152d	2Y 305d	5 Y 2 4 5 d
2Mbyte	69d	345d	1Y 325d	2Y 305d	5Y 245d	11Y 125d
4Mbyte	138d	1Y 325d	3Y 285d	5Y 245d	11Y 125d	22Y 250d
6Mbyte	207d	2Y 305d	5Y 245d	8Y 185d	17Y 5d	34Y 10d
8Mbyte	276d	3Y 285d	7Y 205d	11Y 125d	22Y 250d	45Y 135d

In normal operation the storage interval will be set to 5 or 10 min. If you are using a longer time interval, you have to wait till the time interval is finished, before stopping the measurement other wise you will loose data (if you had set the interval to 60 min and you stop the measurement short before the end of the interval, you will loose 59 min of measured data).
When the time indicated in the spread sheet is exceeded, the oldest data on the memory card will be overwritten.
When there are additional sensors attached to the dust monitor, the indicate storage time will decrease accordingly.

Write Protection

The memory card has a build in write protection, to prevent a undesired overwriting of measured data. The lever for the write protection is on the side of the memory card. If you want to store new data, you must remove the write protection by sliding. If you want to secure stored data you activate the write protection.

10 MAINTENANCE

General

It is recommended to work through the following points once a year. All service and maintenance work should only be done by trained and qualified service staff.

10.1.1   Cleaning the sample flow path inside the dust monitor #180

To clean the sample flow path inside the dust monitor #180, please switch off the instrument and disconnect it from the power supply. Remove the dust monitor from the rack (see chapter installation). Open the flap on the front panel and unscrew the class bottle. Blow clean, oil free pressured air (max pressure 3 bar) through the sample flow inlet in the flow direction. **Never** blow in the adverse direction. **Never** clean without the glass bottle unscrewed.

10.1.2   Cleaning the fly screen at the sample probe inlet

To prevent very coarse particles or even small insects to enter or block the sample flow inlet, the inlet on the sample probe #181 is protected by a fly screen. Please check whether there is dirt on the fly screen and remove it.

10.1.3   Cleaning the sample pipe

Remove the dust monitor #180 as describe before. Let the sample probe holder and the sample probe installed. Blow from below clean, dry air through the sample pipe. **Never** dismantle the sample probe or draw anything through the sample pipe.

10.1.4   Change main dust filter

Once a year, the main dust filter (BQ filter), on which all the sampled dust is collect must be exchanged. This will be done during the yearly maintenance, which will be made by the manufacturer or an authorized dealer.

10.1.5   Cleaning the casing

The dust monitor #180 has a casing made of stainless steel which is a protection against mechanical forces and against influence from EMV. The keypad and the display must also be protected from mechanical stress. To clean the casing only use a dry, clean cloth. Never spill liquid over the instrument.

10.1.6   Internal rinsing air filter

To protect the measuring chamber and the laser optics from contamination, clean, dry air is feed into the measuring cell. Also to provide clean air for the self test during start up. This clean air is produced by a special rinsing air fine dust filter. This filter has a operating time of several years and should only be changed by trained service personnel. If the system message " CHECK NOZZLE AND AIR INLET" is displayed several times, even after cleaning the sample flow path, than an internal failure of the rinsing air supply has occurred. In such a case please contact the manufacturer or the responsible dealer.

11 DELIVERIES, WARRANTY AND TRANSPORTATION

1. Your complete Dust Monitor system #180 is delivered in a carton. Please ensure that the shipment is complete and without visible damages. The unit will arrive in either a carrying case or in a singled well-packed carton. Please make certain that all items have been received by you and there is no apparent damage to any part(s).

2. If you discover damages due to shipping, contact your shipping agent and GRIMM. If you suspect the instrument as damaged during shipment, do not start it up for risk of further damages.

3. If the instrument was transported and stored during a time of low temperature, please allow it and the battery sufficient time to warm up. Otherwise, there is a risk of damage to the instrument.

4. If you detect damages due to the transportation, you must fail a complain these immediately. In this case the instrument must not be put into operation from safety reasons. In order to protect the instrument against future damages incurred during transportation, we recommend taking the original packing into self-keeping. Particularly after the transportation at low temperatures a sufficient acclimatisation phase must be kept before the start-up of the instruments. Otherwise instrument damages can occur.

Instrument Warranty

The company GRIMM Aerosol Technik guarantees the customer that the enclosed instrument is constructed for the described application field and is free from material and assembly mistakes. No further reaching guarantees or claims for specific fields of application are taken over. Should the measuring instrument fail during the 1 year warranty period or not meet the warranty requests, the company GRIMM Aerosol Technik reserves the right either to exchange the defective parts or to supply a replacement unit. Excluded from that are damages that arose from wrong handling. The company GRIMM Aerosol Technik will carry out the repair of the instrument in the factory free of charge, but the costs for freight, dispatch as well as other additional costs are chargeable to the customer. On-site repairs can only be carried out against reimbursement of the travel and service costs. For further reaching claims under guarantee, damages through failure or other expenses the company does not accept any liability, even if the instrument has been at the customer's disposal as warranty or rental instrument (or in some other way)

GRIMM warrants the goods sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for (12) months, or the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty.

This limited warranty is subject to the following exclusions:

a. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment

b. Seller does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies.

c. Unless specifically authorised in a separate writing by GRIMM, here makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

d. The foregoing is IN LIEU OF all other warranties and is subject to the Limitations stated herein. No other express or implied warranty of fitness for particular purpose or merchantability is made.

e. GRIMM warrants the goods sold hereunder, under normal use and service as described in the operator's manual, shall be free from defects in workmanship and material for (12) months, or the length of time specified in the operator's manual, from the date of shipment to the customer. This warranty period is inclusive of any statutory warranty. This limited warranty is subject to the following exclusions:

f. Parts repaired or replaced as a result of repair services are warranted to be free from defects in workmanship and material, under normal use, for 90 days from the date of shipment.

g. GRIMM does not provide any warranty on finished goods manufactured by others or on any fuses, batteries or other consumable materials. Only the original manufacturer's warranty applies.

h. Unless specifically authorised in a separate writing by Grimm, he makes no warranty with respect to, and shall have no liability in connection with, goods which are incorporated into other products or equipment, or which are modified by any person other than Seller.

i. RESPONSIBLE for the extent permitted in some areas by low is the user or buyer and the limit of the sellers liability for any or all losses, injuries or damages of the goods, liability or otherwise) shall the return of goods to the seller and refund of purchase price, or at the option of the seller, the repair or replacement of the goods. In no event is the seller liable for any consequential or incidental damages. Furthermore Grimm will not cover any dismantling or reinstallation costs or charges.

j. No Action, regardless of form, may be brought against Grimm more than 12 months after a cause of action has accrued. The goods returned under warranty to Seller's factory shall be at Buyer's risk of loss, and will be returned, if at all, at Seller's risk of loss.

k. Buyer and all users are deemed to have accepted this LIMITATION OF WARRANTY AND LIABILITY, which contains the complete and exclusive limited warranty of Seller. This LIMITATION OF WARRANTY AND LIABILITY may not be amended, modified or its terms waived, except by writing signed by an Officer o f Seller.

Service Policy

Knowing that inoperative or defective instruments are as detrimental to GRIMM as they are to our customers, our service policy is designed to give prompt attention to any problems. If any malfunction is discovered, please contact your nearest sales office or representative, or call any GRIMM sales office as outlined at the end of this section in this manual.

When Returning the complete System for Service.
Contact GRIMM Instrument (see "section 11 Buying Source) for specific return instructions. Customer Service will need this information when you call:
- The instrument model number
- The instrument serial number
- A purchase order number (unless under   warranty)
- A billing address
- A shipping address

12 BUYING SOURCE

EUROPE: **GRIMM Aerosol Technik GmbH & Co. KG**
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