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*ZAM3000*  
*Evaporative*  
*Light*  
*Scattering*  
*Detector*

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User's Manual

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## TABLE OF CONTENTS

<b>TABLE OF CONTENTS</b>	<b>2</b>
<b>CONTACT ADDRESS</b>	<b>4</b>
<b>PRECAUTION AND WARNINGS</b>	<b>5</b>
<b>ELECTRICAL WARNINGS</b>	<b>5</b>
<b>GENERAL WARNINGS</b>	<b>6</b>
<b>GUARANTEE CONDITIONS</b>	<b>8</b>
<b>GENERAL INTRODUCTION</b>	<b>9</b>
Principle of Operation	9
<b>THE ZAM3000 LIGHT SCATTERING DETECTOR</b>	<b>12</b>
<b>Control devices on the front side of the detector</b>	<b>12</b>
The display	12
The START button	12
The AutoZero button	12
The Error button	13
The arrow buttons	13
The Menu button	13
The Enter button	13
<b>Connectors on the front side of the detector</b>	<b>14</b>
Sample In	14
Waste Out	14
<b>Connectors on the back side of the detector</b>	<b>15</b>
Power supply	16
Exhaust	16
Gas supply	16
Serial port	17
Analogue Signal Connectors	17
<b>INSTALLING THE ZAM3000 LIGHT SCATTERING DETECTOR</b>	<b>19</b>
<b>Scope of delivery</b>	<b>19</b>
<b>Connecting to the gas supply</b>	<b>19</b>
<b>Power Supply</b>	<b>19</b>
<b>Connecting drain</b>	<b>19</b>
<b>Connecting to the HPLC system</b>	<b>20</b>
<b>USING THE ZAM3000 LIGHT SCATTERING DETECTOR</b>	<b>21</b>

<b>SYSTEM INITIALIZATION</b>	<b>23</b>
<b>DETECTOR SETTINGS IN NORMAL MODE</b>	<b>23</b>
Setting the temperature of the detector block	23
Adjusting the additive gas stream	24
Setting signal amplification	25
Signal compensation	25
Signal Smoothing	27
Adjusting the range for recorder output	28
Defining the recorder limit	29
Setting signal offset	29
The recorder marker	31
Configuring the serial data interface	32
Configuring the data rate	32
Content of data packages	33
<b>OPERATIONS IN SERVICE MODE</b>	<b>35</b>
Software and hardware information	36
The view fine mode	37
Adjusting the digital to analogue converters	38
<b>SERIAL DATA COMMUNICATION</b>	<b>40</b>
Configuration and hardware of the serial port	40
Settings in data communication	41
External instrument control	42
Data communication using the serial interface	43
Data packages	44
Status messages	44
Termination sequence	45
Changing the sample rate	45
Data format	45
Using Hyper-Terminal to check communication	46
Reporting Additional Information	49
Instrument information	49
Example of data communication	50

## CONTACT ADDRESS

In case of problems with your ZAM3000 evaporative light scattering detector please contact your local distributor or Schambeck SFD GmbH. The contact address is:

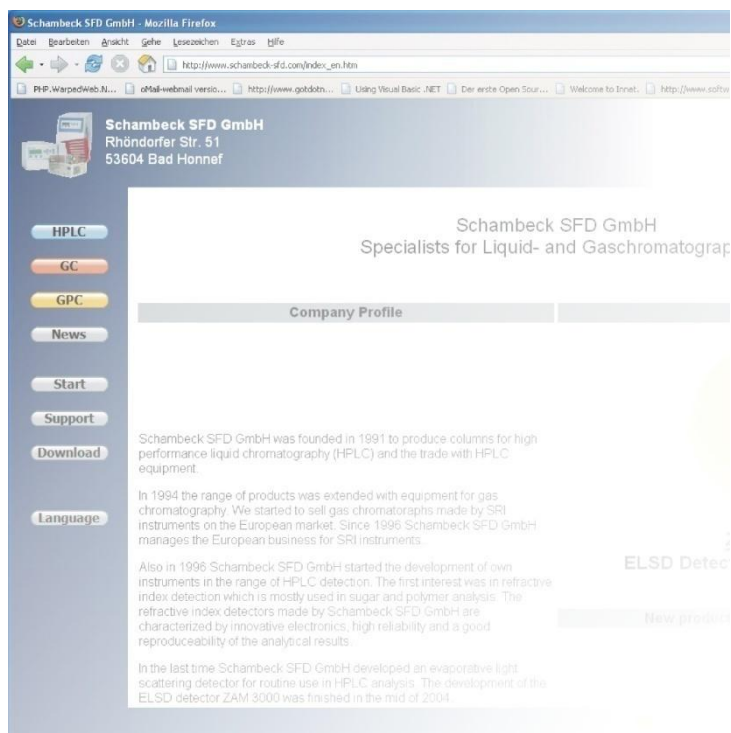
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## PRECAUTION AND WARNINGS

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The manufacturer is *not* reliable for any damage, harm or financial loss caused directly or indirectly by the use of this instrument if the instrument is handled without the observation of this manual or handling with carelessness.

 **NOTE**

Please read this manual carefully before working with the ZAM3000 evaporative light scattering detector. In case of any question please do not hesitate to contact your local distributor or Schambeck SFD GmbH directly.

## ELECTRICAL WARNINGS

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- Before opening the housing of the instrument, make sure the detector is switched off and disconnected from power supply.
- The voltage selected at the fuse on the backside of the instrument has to be set correctly to 110 V or 220 V according to your local power supply. Wrong voltage selection will result in damage of the instrument. Make sure, a 2A fuse is placed in the fuse holder. Internally a 3.15 A fuse is installed.
- Before changing the selected voltage the power supply has to be disconnected.
- The detector may only be connected to plugs with grounding.
- The ZAM3000 may only be operated in connection with other devices which fit to the safety requirements.

## **GENERAL WARNINGS**

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- To prevent damages of the ZAM3000 all capillaries and cables have to be checked for damages and leakages.
- For the disposal of inflammable and/or toxic solvents a plan for waste management has to be created. Such solvents may not get into the drain.
- If flammable or toxic solvents are used, ensure good air ventilation. In this case the ELSD detector needs to be placed in a fume hood.
- The ZAM3000 refractive index detector is built to operate in areas with temperatures between 10 °C and 35 °C.
- To reach a reliable operation of the detector it is recommended to use filtered samples and solvents only.
- The detector may be cleaned with appropriate cleaning agents only.
- Make sure that no liquid gets inside the detector. Liquid inside the housing may cause electrical short circuits which may result in the damage of the instrument.
- To prevent electrical shocks make sure that the detector is disconnected from power supply when the housing is opened to perform service work inside.
- To disconnect the instrument from power supply simply unplug the power cable.
- Electronic circuit boards and electronic components are sensitive to electrostatic charges.

- For some maintenance operation it is required to open the instrument's housing. Make sure that the instrument is disconnected from power supply before removing the housing. It is necessary to remove the housing during operation make sure not to touch electrical parts inside the detector.
- In case of the use of dangerous solvents pay attention to safety instructions regarding this solvent.
- During operation the housing of the detector should be closed.
- Do not use the detector in ambience of aggressive gases, very high humidity, strong vibrations and strong changes in the ambience's temperature.
- The gas used for nebulization and additional gas stream should be dry and free of oil and other contaminants.

## **GUARANTEE CONDITIONS**

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The term of guarantee depends on your local law. Beside this Schambeck SFD GmbH affords guarantee for at least 12 months beginning after purchase of the ZAM3000 evaporative light scattering detector.

All instruments are tested and certified by Schambeck SFD GmbH quality control. Only defects which result from faulty manufacture or material defects are covered by the guarantee. In case of a defect the original sales slip will be needed to make use of the guarantee. Repair works covered by the guarantee may only be performed by Schambeck SFD GmbH or licensed distributors.

The following cases are not covered by the guarantee:

- Improper use (e. g. capacity overload, use of not approved tools) of the ZAM3000 detector
- Parts which are liable to aging or abrasion like lamps, valves and heater cartridges
- Damages caused by use of force or not approved tools
- Damages which result from improper use due to non-observance of the operation manual, the use under abnormal conditions or improper maintenance
- Defects resulting from the use of third-party parts which are not approved by Schambeck SFD GmbH
- Instruments which are modified after purchasing by the customer
- Normal abrasion
- Fully or partial disassembled light scattering detectors



## **GENERAL INTRODUCTION**

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The ZAM3000 evaporative light scattering detector is suitable for the use in routine HPLC analysis. It can be used in those cases where the sample components do not absorb in the UV/Vis region of the spectrum. This makes the use of an UV/Vis detector impossible. Further more it can be used in cases where a gradient elution is needed to elute the components from the column. In these cases the use of a refractive index detector is impossible. As the evaporative light scattering detector ZAM3000 is more sensitive than an RI or UV/Vis detector, it can be used as an additional detector to lower the detection limit.

## ***Principle of Operation***

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The operation of the evaporative light scattering detector can be separated in three steps.

### **1. The Nebulization Step**

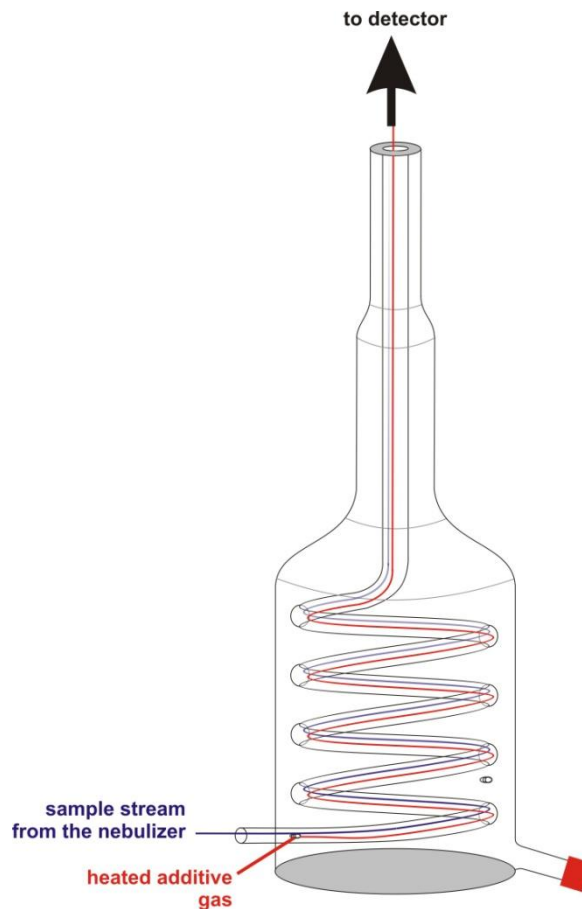
The sample containing eluent from the chromatography column enters the detector. It reaches the nebulizer. The nebulization takes place utilizing high pressure gas stream. The nebulization takes place in the nebulization chamber. The aerosol leaves the nebulization chamber and enters the evaporation chamber.

Drops which are too big to leave the nebulization chamber hit the wall and leave the detector finally through a siphon.

The nebulizer and the nebulization chamber are made from glass which makes them easy to clean and resistant to all common solvents used in chromatography.

### **2. The Evaporation Step**

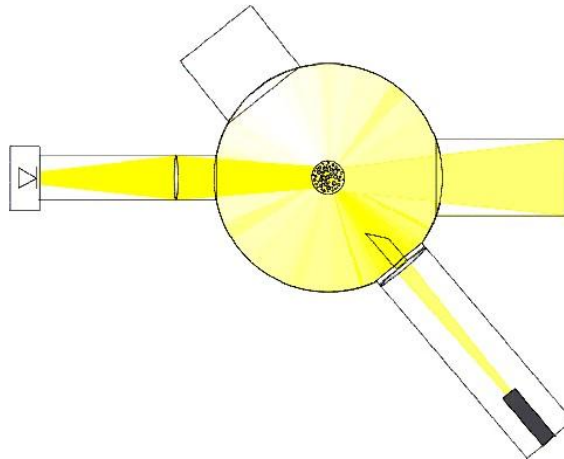
The aerosol enters the evaporation chamber. Here an additional heated gas stream is added. By this the aerosol is heated up, resulting in the evaporation of the solvent. Only small sample particles will remain and reach the detection chamber.



The evaporation chamber is also made of glass, resulting in an easy to clean part of the detector. The flow of the additional gas stream is controlled by a mass flow controller. Gas flow and gas temperature can be adjusted by the user. By adjusting these parameters the detection can be optimized depending on the analytical problem.

### 3. Detection Step

Small sample particles, leaving the evaporation chamber, enter the detection chamber. Here they pass an intense light beam which is guided perpendicular to the gas stream.



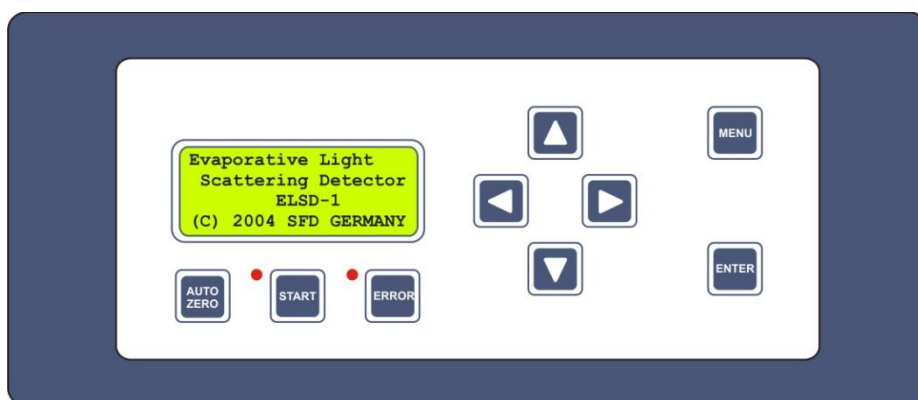
The small particles will cause scattered radiation which is detected using a photomultiplier. The angle between light source and photomultiplier is 120°.

The sensitivity of the detection depends how dry the sample particles are. Therefore the detection can be optimized changing the gas temperature and the gas flow of the additive gas stream.

All parts of the detector which come in touch with the sample are made of PTFE or glass. This fact results in high stability against all common solvents used in chromatography and easy maintenance. Contaminations can be located easily.

## THE ZAM3000 LIGHT SCATTERING DETECTOR

### *Control devices on the front side of the detector*



### **The display**

The current status of the ZAM3000 is shown in the display. Shown parameters are the temperature of the detector block, the current additive gas flow and the current detector signal. Furthermore the display is used to communicate with the user. This will be described later.

### **The START button**

This button is used to activate the detection mode. When the instrument is turned on, the additive gas flow and the photomultiplier high voltage are not activated yet. The instrument is in standby mode. When the START button is pressed, the gas flow and the high voltage are activated. If the instrument is in measuring mode, a red LED next to the START button will show up.

### **The AutoZero button**

If this button is pressed, the current detector signal is defined as zero. This signal will be subtracted from all reported data points. By this a signal offset can be eliminated. If the button is pressed and hold down for three seconds, the function will be deactivated. The unmodified detector signal will be displayed.

The AutoZero function also affects the detector signal reported to the serial port and the integrator output of the instrument.

The AutoZero function can be activated by an external analogue signal or by sending special commands using the serial data interface. This will be described later.

### **The Error button**

Currently only the red LED next to the Error button is used to alert the user, if an internal error occurred during operation.

### **The arrow buttons**

The different arrow buttons are used to navigate between different settings and menu items.

### **The Menu button**

The menu button is used to switch between different menu items. To select one item from the menu the Enter button is used.

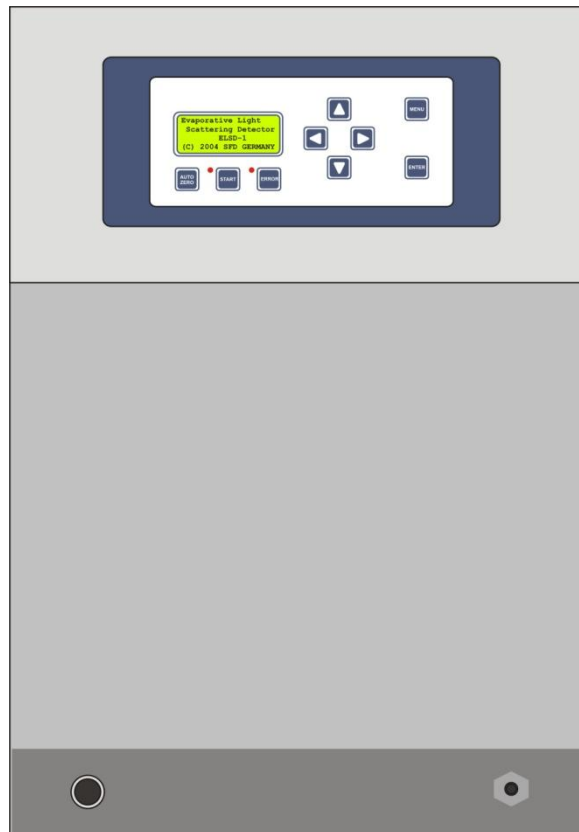
Pressing the Menu button will show the next available menu item in the status line of the display. The Menu button can be pressed several times until the desired item is shown.

In a configuration dialog the Menu button can be used to exit the current dialog without saving the altered settings.

### **The Enter button**

The Enter button is used to select a menu item from the list or to accept changes in a configuration dialog. If the changes should not be saved, press then Menu button to leave the configuration dialog.

### ***Connectors on the front side of the detector***



#### **Sample In**

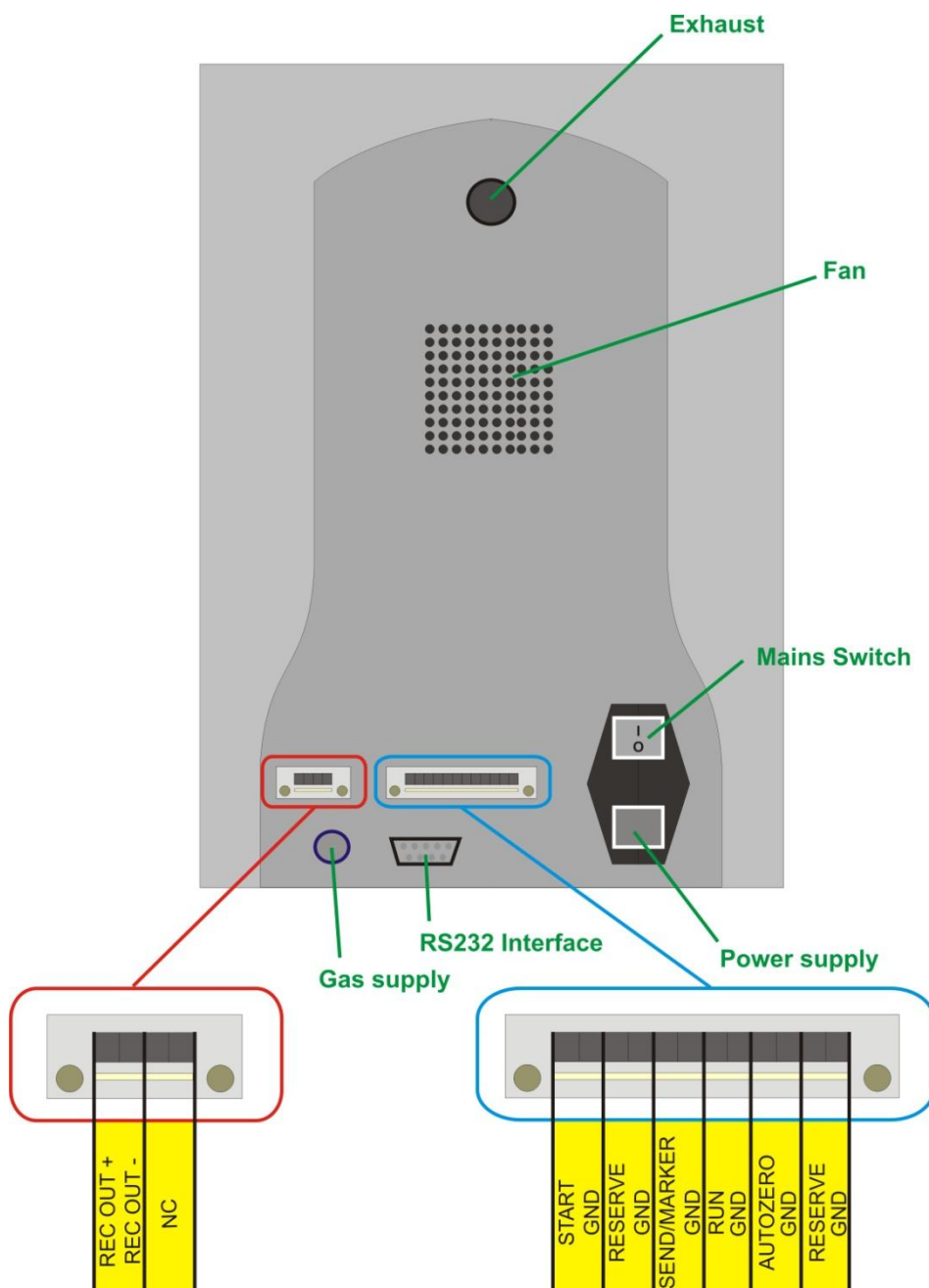
On the right side the SAMPLE IN connector is located. Connect the capillary coming from your chromatography column to this connector. Adequate finger tight fittings come with the instrument.

#### **Waste Out**

On the left side the WASTE OUT connector is located. Connect the Kevlar tube which comes with the instrument to this connector and place the other end of the pipe in a waste container. Make sure the waste container is placed beneath the instrument and the waste liquid can reach it unhindered.

In the case of flammable or toxic solvents make sure that solvent vapour is removed properly.

*Connectors on the back side of the detector*



## **Power supply**

The ZAM3000 evaporative light scattering detector can be with 120 V or 240 V (AC) current. The 120 V version of the instrument differs from the 240 V version of it in different heat cartridges only. This is done to get a better heating performance using the instrument with 120 V power supply.

Use the cable which comes with the instrument to connect it to your power supply.

The instrument is protected by a 1A fuse (slow) which is placed in the mains connector socket. It is not necessary to select the voltage the instrument has to operate with. This is automatically done by the power supply unit.

Make sure the instrument is connected to a grounded power source.

## **Exhaust**

During the analysis the solvent is evaporated. The solvent vapour needs to be guided out of the instrument and out of the lab. Connect the exhaust pipe which comes with your detector to this connector. Place the other end in a fume hood or use another ventilation system to remove the vapour. Using a ventilation system make sure that no negative pressure is applied to the instrument.

## **Gas supply**

For the nebulization and the evaporation process gas is needed. The most common gas for this application is nitrogen. Synthetic or compressed air might be used depending on your analytical problem. Make sure that the used gas is dry and free of oil.

To connect the instrument to your gas source a pipe with an outer diameter of 6 mm is needed. The gas pressure should be between 3.5 and 5.0 bar to get optimal operation conditions. The additional gas flow is constantly controlled using a mass flow controller. To ensure proper operation conditions the gas pressure should not drop under 3.5 bar during operation.



## **Serial port**

The ZAM3000 light scattering detector offers a serial (RS232) data interface which might be used for data acquisition and instrument control. The protocol used for serial communication is described more detailed later.

Using the serial interface and suitable software, data acquisition can be done without any data interface.

## **Analogue Signal Connectors**

The ZAM3000 has several analogue signal connectors on the back side of the instrument. Use the grey two pin connectors which come with the instrument to connect cables to the instrument. When a connection is established, make sure the polarity is correct.

The following connectors can be found on the back side of the instrument:

### **REC OUT**

The recorder output can be used to acquire the analogue detector signal using an external data interface. The signal is in the region between -1.2 and +1.2 V. If the recorder output is used, make sure the polarity is correct.

## **N.C.**

Not connected. This is a spare connector and currently not used yet.

## **START**

Use this connector to use an external signal to switch between standby and measuring mode of the instrument. To switch the operation mode it is necessary to connect the pin labelled START with the GND pin next to it for a short time.

An acoustic signal will occur when the command is executed,

## **RUN**

Use this connector to acquire an external start signal generated for example by an autosampler. The ZAM3000 accepts external start signals when it is in measuring mode only.

To start the data acquisition the pin labelled RUN needs to be connected for a short time to the pin GND next to it. An acoustic signal will occur when the data acquisition is started.

## **AutoZero**

The AutoZero connector can be used to react to an external AutoZero signal (e. g. generated by an autosampler). To activate the AutoZero function the pin labelled AutoZero needs to be connected to the GND pin next to it for a short time. An acoustic signal will occur when the AutoZero function is activated.

## INSTALLING THE ZAM3000 LIGHT SCATTERING DETECTOR

The following steps need to be done to install the ZAM3000 evaporative light scattering detector.

### *Scope of delivery*

N°.	Amount	Description
1	1 EA	Light Scattering Detector ZAM3000
2	1 EA	Power cord, 220 V
3	1 EA	Shielded signal cable
4	1 EA	Information / Manual CD-ROM
5	1 EA	Hex wrench, 3 mm
6	1 EA	Hex wrench, 4mm
7	1 EA	Waste tube (Kevlar)
8	1 EA	Exhaust tube
9	1 EA	Plastic clamp, blue
10	1 EA	Nebulizer, glass
11	1 EA	Nebulization chamber, glass
12	1 EA	Evaporation chamber, glass
13	1 EA	HWS clamp, metal

### *Connecting to the gas supply*

Use a PVC tube to connect the detector to your gas supply. The outer diameter of the tube should be 6 mm. The gas pressure should be in the range between 3.5 and 5.0 bar. Gas cylinders can be used as gas supply as well as gas generators. If compressed air is used, make sure it is dry and free of oil.

### *Power Supply*

Use the black power cord which comes with the detector to connect it to the power line. Before connecting make sure the correct voltage is selected on the back side of the instrument. Only grounded plugs may be used for power supply of the ZAM3000 light scattering detector.

### *Connecting drain*

Use the Kevlar tubing which comes with the instrument to guide not nebulized solvent into a waste container. Connect one end of the tube to the waste out connector on the front side of the detector.

Place the other end in your waste container. Make sure the waste container is placed under the instrument and the solvent can pass the tube without any hindrance.

### ***Connecting to the HPLC system***

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Connect the capillary guiding the eluent from your chromatography column to the sample in connector of the front side of the instrument. Use the black finger tight fittings which come with the detector to fix the connection.

When the connection is established, start your HPLC pump. When the instrument is used the first time it will take some time until the siphon of the nebulization chamber is filled with eluent. The siphon of the nebulization chamber needs to be filled with solvent to ensure the isolation of the detection system from the environment. When the first drops of eluent leave the waste outlet, the instrument is ready for use.

## **USING THE ZAM3000 LIGHT SCATTERING DETECTOR**

The ZAM3000 might be operated in normal measuring mode and in service mode. Usually the instrument is operated in the normal measuring mode. The service mode is used for maintenance and trouble shooting purposes.

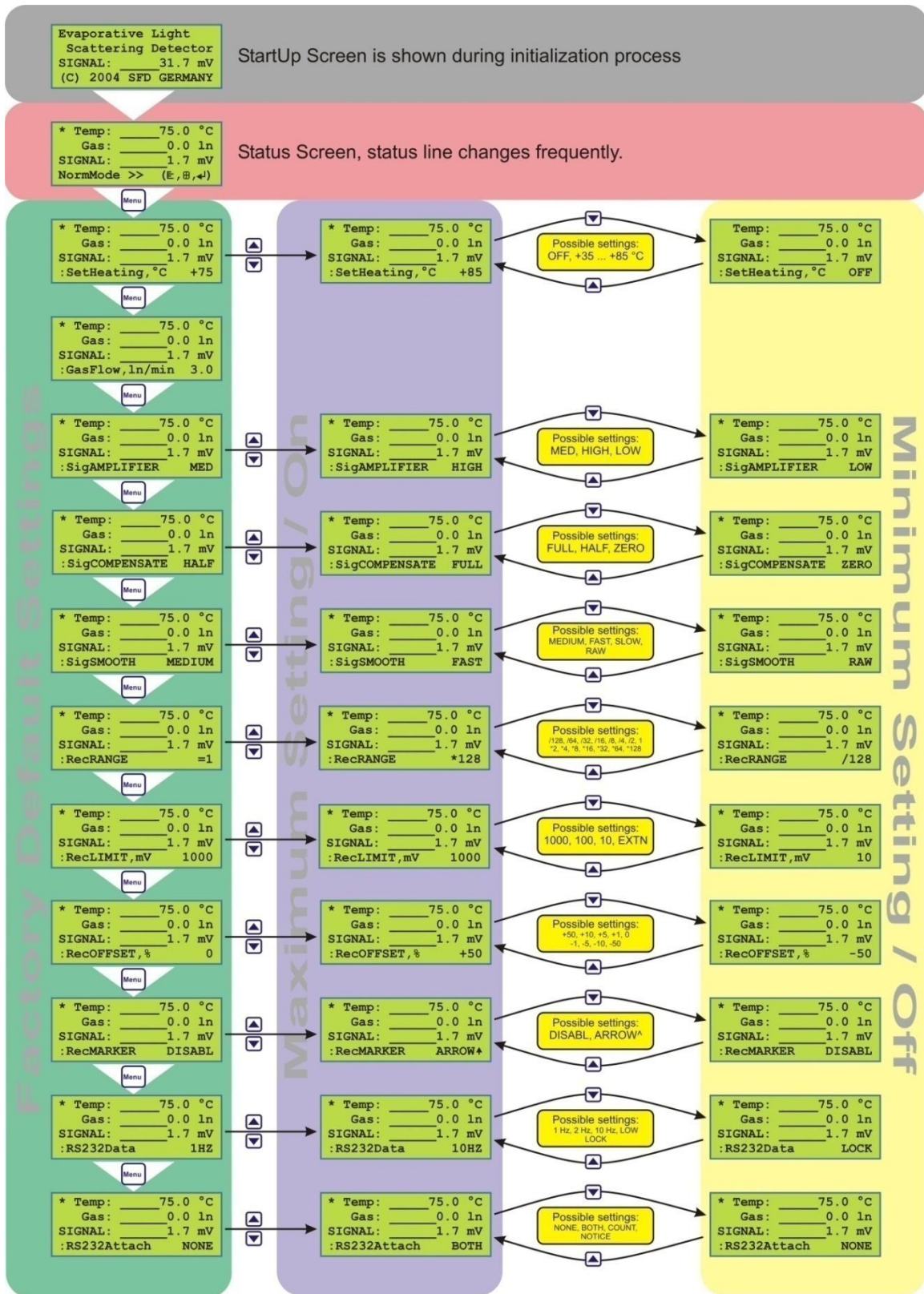
The display on the front side of the detector is used to show the current system status and to communicate with the operator.

The display contains four lines. The first three lines are used to display current detector parameters like detector block temperature, current additional gas flow and the current detector signal. The fourth line is used as status line, displaying other detector parameters and settings. The shown parameter changes every few seconds, if no button is pressed.

The fourth line is also used to communicate with the operator. By pressing the MENU button different items from the main menu can be selected. The currently selected item is also shown in the fourth line of the display.

If the detector is operated in normal measuring mode, all numerical values are shown with one decimal. In service mode all numerical values are shown with three decimals.

Press the button MENU to toggle through the main menu items. To select an item, press then ENTER button. The following figure illustrates the content of the main menu including all possible selections for several settings.

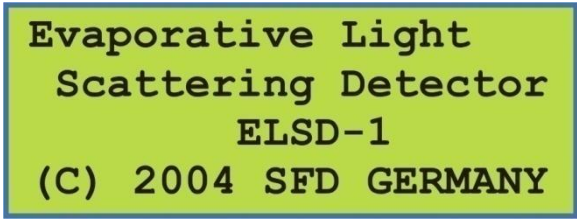


The different menu items are described more detailed on the following pages.

## SYSTEM INITIALIZATION

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When the instrument is switched on, the initialization of the system starts. Different functions and components of the detector are checked for proper functionality. If an error occurs during the initialization process, an error message will be displayed. During the initialization process the instrument's name is shown in the display.



Evaporative Light  
Scattering Detector  
ELSD-1  
(C) 2004 SFD GERMANY

When the initialization process has finished the detector automatically changes to the normal measuring mode. The additional gas stream and the high voltage of the photomultiplier are still deactivated. Now the instrument is in standby mode.

## DETECTOR SETTINGS IN NORMAL MODE

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### *Setting the temperature of the detector block*

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The additional gas stream is heated by guiding it through a heated detector block. At this point heat exchange between metal and gas takes place.

The temperature of the detector block can be set in the region between +35 °C and +85 °C. Furthermore it is possible to operate at ambient temperature. In this case the heating has to be set OFF.

To adjust the temperature of the detector block, press the MENU button until the status line in the display changes to:

:SetHeating, °C

Press then arrow buttons ▲ and ▼ until the desired temperature is shown in the status line. Press the ENTER button to accept the new settings.

**Please note:** The temperature takes some time until it is stable. During the stabilization process changes in the detector signal are normal. Make sure the detector signal is stable before starting a measurement. When changing the temperature of the detector block please keep in mind that changes in the detector temperature hardly affect the sensitivity of the detector depending on the solvent you use.

### ***Adjusting the additive gas stream***

---

The flow of the additive gas can be adjusted by pressing the MENU button until the status line in the display changes to

**:GasFlow,ln/min**

The gas flow will be altered by pressing the arrow-buttons ▲ and ▼. The new settings are accepted by pressing the ENTER button.

Beside the temperature of the detector block the sensitivity of the detector strongly depends on the flow of the heated additional gas.



### ***Setting signal amplification***

---

There are three different amplification modes available: LOW, MEDIUM and HIGH. The amplification factor in MEDIUM mode is 6 in comparison to the LOW mode. In HIGH mode the amplification factor is 10.

To adjust the amplification mode, press the MENU button until the status line changes to

**:SigAMPLIFIER**

Use the arrow buttons ▲ and ▼ to switch to lower or higher amplification modes. Press the ENTER button to accept the new settings. Changing the signal amplification will affect the signal which is reported to the serial port (RS232) as well as the signal which can be recorded using the recorder output.

It is strongly recommended to perform a test measurement using a standard sample of known concentration to make sure the detector signal is fully covered by the data acquisition system.

### ***Signal compensation***

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If the instrument is switched on, the additional gas stream and the high voltage of the photomultiplier is not activated yet. The instrument is in standby mode. In this stage the detector signal should be (nearly) zero.

Press the START button to activate high voltage and additional gas stream. Now the detector signal should rise up. The detector signal can be in the interval from -1.2 V to +1.2 V. Depending on the used data interface the signal difference which can be used for data recording might be shortened by the signal offset.

The ZAM3000 offers the option to compensate the signal offset. To activate the signal compensation function, press the MENU button until the status line in the display changes to

**:SigCOMPENSATE**

Press the arrow buttons ▲ and ▼ to select the grade of signal compensation. There are three different options: ZERO, HALF and FULL.

If the option ZERO is selected signal compensation is deactivated. If FULL is selected nearly the complete signal is compensated, after activation the detector signal should drop to zero. If HALF compensation is selected, half of the signal offset is compensated. To accept your selection, press the ENTER button.

The voltage used for signal compensation might be modified using the potentiometer R59. The voltage is already set after production of the instrument. Usually it is not necessary to adjust the voltage.

## ***Signal Smoothing***

The ZAM3000 evaporative light scattering detector offers the possibility of internal signal smoothing. If the smoothing function is activated, an average signal during a certain time period is calculated by the internal micro controller and reported to the signal outputs.

The use of the smoothing function is recommended if you need to examine small peaks in your chromatograms. In this case noise in the detector signal might generate problems during peak integration.

To activate the data smoothing function, press the MENU button until the status line in the display changes to

**:SigSMOOTH.**

Use the arrow-buttons ▲ and ▼ to select one of the available options. There are four different selections possible:

<b>Mode</b>	<b>Function</b>
RAW	No signal smoothing
FAST	Smoothing over a time period of 0.4 seconds
MEDIUM	Smoothing over a time period of 0.8 seconds
SLOW	Smoothing over a time period of 1.6 seconds

To accept the new selection for data smoothing, press the ENTER button.

### ***Adjusting the range for recorder output***

---

The ZAM3000 light scattering detector allows the user to adjust the data signal ranges used for the recorder output. By this it is possible to amplify or to attenuate the detector signal by a certain factor. Using this function allows the user to use nearly every data interface for data acquisition. The dynamic range of the used interface can be optimal used.

To modify the settings regarding the signal amplification or attenuation, press the menu button until the status line in the display changes to

**:ReCLIMIT,mV.**

Now use the arrow buttons ▲ and ▼ to select the desired signal amplification or signal attenuation.

For signal amplification the following factors are available:

\*2 - \*4 - \*8 - \*16 - \*32 - \*64 - \*128

For the detector signal attenuation the following factors are available. Use the arrow buttons ▲ and ▼ to select.

/2 - /4 - /8 - /16 - /32 - /64 - /128

If you select the option =1, the detector signal is reported without any change to the recorder output. Press the ENTER button to accept the modified settings.

The detector signal which is reported using the serial data interface is not influenced by the settings of the recorder signal range.

### ***Defining the recorder limit***

---

The internal software of the ZAM3000 allows the user to define the maximum voltage which is send to the recorder output. By this it is possible to adjust the detector signal to the needs of the used data interface.

The voltage which is defined for the maximum signal output corresponds to a detector signal of 500 mRIU.

To select the maximum detector signal, press the MENU button, until the status line changes to

**:RecLIMIT,mV.**

Now use the arrow buttons ▲ and ▼ to select between the different options which are available. The following options are available: 10 mV, 100 mV, 1000 mV. Further more the option "EXTN" is available. In this case the maximum detector signal is set to 1200 mV. Press the ENTER button to accept your new settings.

### ***Setting signal offset***

---

The internal software of the ZAM3000 light scattering detectors allows the addition of a defined offset voltage to the detector signal. Using this option it is possible to shift the signal to an optimal level for the used recorder or data acquisition system.

To define the signal offset the user needs to define a relative fraction of the maximal signal output defined for the recorder output. To define this fraction, press the MENU button until the status line in the display changes to

**:RecOFFSET,%.**

Use the arrow buttons ▲ and ▼ to select one of the available options. Following selections are possible:

-50 / -10 / -5 / -1 / 0 / +1 / +5 / +10 / +50

Press the ENTER button to accept your new settings. Selecting 0 will disable the signal offset option.

As the selection is a relative fraction of the maximum voltage which is defined for the recorder output the following signal offsets will occur:

RecOFFSET, %	RecLIMIT, mV=10	RecLIMIT, mV=100	RecLIMIT, mV=1000	RecLIMIT, mV=EXTN
	Spannungswert [mV]	Spannungswert [mV]	Spannungswert [mV]	Spannungswert [mV]
-50	-5.0	-50.0	-500.0	-600.0
-10	-1.0	-10.0	-100.0	-120.0
-5	-0.5	-5.0	-50.0	-60.0
-1	-0.1	-1.0	-10.0	-12.0
0	0.0	0.0	0.0	0.0
+1	+0.1	+1.0	+10.0	+12.0
+5	+0.5	+5.0	+50.0	+60.0
+10	+1.0	+10.0	+100.0	+120.0
+50	+5.0	+50.0	+500.0	+600.0

### ***The recorder marker***

To mark special events during an analytical run the ZAM3000 firmware offers the function 'recorder marker'. If this option is activated, every time the arrow-up ▲ button is pressed a signal spike is sent to the recorder output. The height of the spike is 1/8 of the maximum output voltage of the recorder output. The recorder marker can also be send using the analogue input 'Send/Marker' on the back side of the instrument. To send a marker spike to the recorder output the pin labelled 'Send/Marker' needs to be connected to the GND pin next to it for a short time.

To activate the recorder marker function, press the MENU button until the status line in the display changes to

**:RecMARKER.**

Use the arrow buttons ▲ and ▼ to choose between the two available options NONE and ARROW. If the option NONE is selected the function is disabled, in case of the selection ARROW it is enabled.

### ***Configuring the serial data interface***

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The ZAM3000 light scattering detector offers a serial data interface (RS232) which might be used for direct communication with a computer. By this no external data interface is needed for data acquisition.

The user can define the sample rate which is used to send data packages to the computer as well as the content of these data packages.

### **Configuring the data rate**

To configure the data rate which is used for data communication with the computer, press the MENU button until the status line in the display changes to

**:RS232Data.**

Using this function ComRS232 you may adjust the parameters for the serial data interface. If the mode is set to LOCK no detector is sent to the RS232 port. Use this setting only in that case you want to record your data using an analogue data system. Use the buttons arrow-up ▲ and arrow-down ▼ to select the frequency for data output. You can choose between two modes:

<b>1 Hz</b>	One data point per second is sent to the RS232 port.
<b>2 Hz</b>	Two data points per second are sent to the RS232 port.
<b>10 Hz</b>	Ten data points per second are sent to the RS232 port.
<b>LOW</b>	(=0.4 Hz) One data point is sent to the RS232 port every 2.5 seconds.

To accept your settings press the ENTER button. Pressing the MENU button will discard any new input.



## Content of data packages

The contents of data packages sent by the ZAM3000 light scattering detector might be selected by the user. A data package sent by the detector contains at least the current detector signal (the unit for the detector signal is micro volt ( $\mu\text{V}$ )). Optional a counter and status messages can be added to the data package.

To configure the content of a data package press the MENU button until the option

### :RS232Attach

is shown in the status line of the display. Now press the arrow-up ▲ or arrow-down ▼ button to change the settings. The following options are available:

- **NONE** No additional information is transmitted. Only the detector signal is sent to the serial port
- **COUNT** A counter (incremented number) is added to the data package
- **NOTICE** Status messages are added to the data package before sending to the serial port
- **BOTH** The counter and status messages are added to the data package

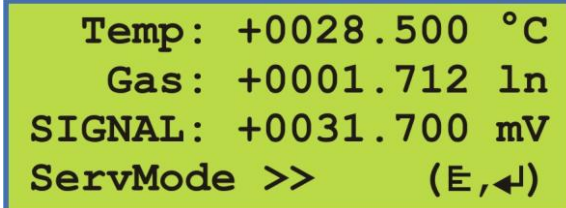
More details regarding the communication with the ZAM3000 light scattering detector using the serial (RS232) port can be found later in this manual.



## OPERATIONS IN SERVICE MODE

Since version 3.x the internal firmware of the ZAM3000 evaporative light scattering detector contains the service mode. This mode allows the user to check more detailed system parameters for example in case of a malfunction of the instrument to get more detailed information to call the technical support.

To activate the service mode press the buttons arrow-left ◀ and arrow-right ▶ at the same time for about three seconds. The display will change from normal measuring mode (NormMode) to service mode (ServMode).



```
Temp: +0028.500 °C
Gas: +0001.712 l/n
SIGNAL: +0031.700 mV
ServMode >> (E, ←, ↓)
```

The numerical values for temperature, optical balance and the current detector signal are now displayed with three decimals. In this mode the status line is used to navigate between several sub menus.

You might choose between:

- **NormMode** switch back to normal measuring mode
- **SwHwInfo** switch to Software/Hardware information
- **ViewFine** switch to view fine system analysis mode
- **AdjuDACs** switch to adjust mode for digital analog converter

To switch back to the normal measuring mode press the MENU button until the NormMode statement is shown in the status line.

```
Temp: +0028.500 °C
Gas: +0001.712 ln
SIGNAL: +0031.700 mV
ServMode >> NormMode
```

Now press the ENTER button to leave the service mode.

### ***Software and hardware information***

If you need detailed information about your instrument such as the firmware version number or the instrument's serial number press the MENU button in service mode until the option SwHwInfo is shown in the status line.

```
Temp: +0028.500 °C
Gas: +0001.712 ln
SIGNAL: +0031.700 mV
ServMode >> SwHwInfo
```

Then press the ENTER button. The display will show the currently running firmware version and the serial number of the instrument. The full information can be found in line two of the display.

```
Schambeck SFD GmbH
ELSD-1 V1.3 A0611030
SIGNAL: +0001.407 mV
ServMode SwHwInfo
```

To return to the former display press the MENU button.

### *The view fine mode*

To check internal settings of the light scattering detector the view fine mode can be activated. To access this mode press the MENU button until the sub menu ViewFine is shown in the status line.

```
Temp: +0028.500 °C
Gas: +0001.712 ln
SIGNAL: +0031.700 mV
ServMode >> ViewFine
```

Now press the ENTER button and the display will change to the following information:

```
Check Source Unit ←
0031 1683 0750 0220
SIGNAL: +0031.700 mV
ServMode ViewFine
```

The values in line two represent four different voltages measured by the instrument. To get an information which voltage is shown in which column press the ENTER button. The display will change to the following:

```
Check Source Unit ←
SIGN FLOW HVLT ILMP
SIGNAL: +0031.700 mV
ServMode >> ViewFine
```

To return to the former view press the ENTER button again.

The displayed shortcuts represent the following voltages:

- **SIGN**      The current detector signal
- **FLOW**     The current additional gas flow
- **HVLT**     The high voltage for the photomultiplier
- **ILMP**     Current for the light source (LED)

### ***Adjusting the digital to analogue converters***

Press the MENU button until the sub menu AdjuDACs is shown in the display.

```
Temp: +0028.500 °C
Gas: +0001.712 ln
SIGNAL: +0031.700 mV
ServMode >> (E, ←)
```

Press the ENTER button to access the mode to adjust a digital to analog converter. The display will change to the following view:

```
Set REC and GASx5 on
fixValue: _____ mV ←
SIGNAL: +0001.408 mV
ServMode AdjuDACs
```

This function allows the user to apply a defined signal to the recorder output and the integrator output.

 **NOTE**

Make sure that the signal amplification for the recorder output is set to 1/1 before using this function. Otherwise you have to remember the amplification factor.

This voltage can be checked using a voltmeter or may be used to test the used data system. By pressing the ENTER button you can go stepwise through a list of different voltages.

0 mV ← 1000 mV ← 1200 mV ← 0 mV ← -1000 mV ← -1200 mV

Pressing the ENTER button once will show the following information in the display:

```
Set REC and GASx5 on  
fixValue: 0000 mV ↵  
SIGNAL: +0031.700 mV  
ServMode AdjuDACs
```

Now the signal at the integrator output and the recorder output is exactly 0 mV. Press the ENTER button again to switch to the next voltage. The current voltage which is applied to the signal output is shown in the display.

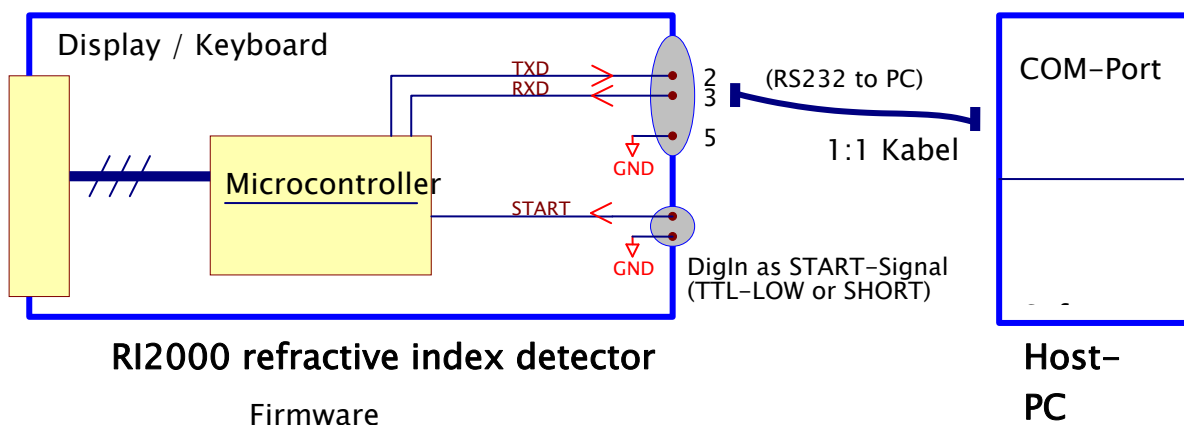
## SERIAL DATA COMMUNICATION

The serial port (RS232) is used for the direct control of the ZAM3000 light scattering detector and data acquisition. Using the serial port for data acquisition no data interface is needed. Only a direct cable connection and software, which is able to communicate with the ZAM3000, is needed. Possible communication software solutions are: Acquire2000, SFD.HPLC or HyperTerminal (which comes with Microsoft Windows). Custom made software solutions such as Excel macros or the implementation in existing software solutions are possible, too.

### *Configuration and hardware of the serial port*

The RS232 port of the ZAM3000 light scattering detector is configured as described below:

- Signal cable: TXD - pin 2 / RXD - pin 3 / GND – pin 5
- Data transfer: 9600 baud, 8 bit, no parity, 1 start bit, 1 stop bit
- No Handshake, no data flow control
- ASCII coded



All components participating on the data communication are shown in the figure above.



### ***Settings in data communication***

Using the key pad of the ZAM3000 the configuration of the data communication can be changed. The parameter RS232Data defines the data rate which is used for data communication. Possible settings are:

- **LOCK**            serial port blocked, no data communication            *no index*
- **1HZ**            1 Hz, 1 data point per second            *index !1x*
- **2HZ**            2 Hz, 2 data points per second            *index !2x*
- **10HZ**           10 Hz, 10 data points per second            *index !3x*
- **LOW**            0.4 Hz, 0.4 data points per second            *index !4x*

The parameter RS232attach defines the format of the data line, recorded to the host PC. Additional information beside the detector signal can be added. The following options are available:

- **NONE**           Only the detector signal reported            *index !x1*
- **NOTICE**        Detector signal and status message            *index !x2*
- **COUNT**        Detector signal and counter            *index !x3*
- **BOTH**           Detector signal, counter and status message            *index !x4*

#### **Remarks:**

- Initialization of data acquisition is only possible sending the command from host PC, starting using the internal key pad is not possible.
- Ending the data acquisition using the internal key pad is possible: Press ENTER key when RS232xxx is shown in the status line of the ZAM3000
- Running data acquisition is indicated by “...” in the RS232Data status line
- It is possible to read the index !xx, where xx represents a two digit number.

### ***External instrument control***

The digital input 'Send/Marker' on the backside of the ZAM3000 light scattering detector has two functions. It is used to record the start signal to initialize data acquisition and it is used to record the marker signal during data acquisition. The marker signal is used to mark special events during an analytical run such as valve switches or sample injections.

If 'Send/Marker' is activated the ZAM3000 light scattering detector reacts depending on the current data acquisition status.

<b>Data Acquisition</b>	<b>Parameter RS232 Attach</b>	<b>RI2000 Reaction</b>
Stopped	NOTICE or BOTH	Initialization of data acquisition, status message 'SE'.
Stopped	NONE or COUNT	Initialization of data acquisition
Running	NOTICE or BOTH	Status message 'MR'
Running	NONE or COUNT	No change

#### **Remarks:**

- If a command is processed successfully by the ZAM3000 light scattering detector, an acoustic signal will occur.
- If the serial port is deactivated (LOCK) the START/MARKER signal will be ignored.
- The digital input 'Send/Marker' can also be used to record a marker signal on the Recorder output.

### ***Data communication using the serial interface***

Generally the host PC sends commands in ASCII format to the ZAM3000 light scattering detector. Status messages and detector signals are reported in ASCII format, too.

The data acquisition status can be 'running' or 'stopped'. In the case 'stopped' no data packages are sent to the host PC. If the status is 'running', data packages are sent continuously to the host PC using the sample rate defined using the ZAM3000 firmware.

Following commands are accepted by the ZAM3000 evaporative light scattering detector:

ASCII	Hex		Executeable during stopped / running data acquisition
S, s	0x53, 0x73	Start data acquisition	Yes / No
H, h	0x48, 0x68	Stop data acquisition	No / Yes
Z, z	0x5A, 0x7A	Set flag AutoZero	Yes / Yes
P, p	0x50, 0x70	Set flag to switch purge valve	Yes / Yes
I, i	0x49, 0x69	Report instrument information	Yes / No
Space	0x20	Report single data point	Yes / No
other		No function, ignored	No / No

#### **Remarks:**

- If a command is executed successfully, an acoustic signal will occur.
- Setting a flag is not necessary the execution of a command.
- Letters which are not assigned to a command might be used as a command in later firmware versions.

## ***Data packages***

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A data package contains at least the detector signal and a termination sequence. Additional information such as status messages and a counter can be added.

The detector signal is reported in  $\mu\text{V}$  in form of a seven digit number with no decimals in the range from  $-8388607 \mu\text{V}$  up to  $+8388607\mu\text{V}$ . The format of the reported detector signal is:

1. Space (0x20) as separator
2. +/- (0x2D/0x2B) leading sign
- 3.-9 seven digits detector signal

The counter can be used to ensure that all data points are collected properly. Both – detector signal and counter – contain left hand zeros.

## ***Status messages***

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Certain events or states are reported using status messages. Depending on the settings status messages are reported to the host PC. The status messages consist of four ASCII symbols, as listed below.

1. Space (0x20) as separator
- 2.-4. three ASCII symbols (see table)

Message	
<b>ISE</b>	Start of data acquisition by external start signal
<b>ISA</b>	Start of data acquisition by host PC ('S'-command)
<b>!MR</b>	Marker signal
<b>!HL</b>	End of data acquisition by host PC ('H'-command)

### ***Termination sequence***

Each reported data line is terminated with a carriage return (CR, 0x0D) followed by a line feed (LF, 0x0A). The minimum length of a data line is therefore 11 characters, the maximum length is 28 characters.

#### **Remarks:**

- Data reporting initialized by an external start signal (DinIN) or the 'S'-command will not be terminated if the connection between detector and host PC is disconnected.
- Data acquisition can be terminated sending the 'H'-command or by pressing ENTER in the RS232xxx sub menu.
- Content of the data packages might be altered if future firmware versions.

### ***Changing the sample rate***

Press the MENU button until the display shows :RS232Data in the status line. Now use the arrow-up ▲ or arrow-down ▼ button to select the desired sample rate. You may select 1 Hz, 2 Hz and 10 Hz. By selecting the option LOCK the data transmission using the RS232 interface is disabled, no data will be sent. Press the ENTER button to confirm your selection.

### ***Data format***

The current detector signal is transmitted in ASCII using the serial interface. The signal voltage is displayed with 7 digits and one leading sign. The reported voltage is displayed in microvolts [ $\mu\text{V}$ ]. The current version of the ZAM3000 firmware allows data export in different data formats. (This is *not* supported in former versions.)

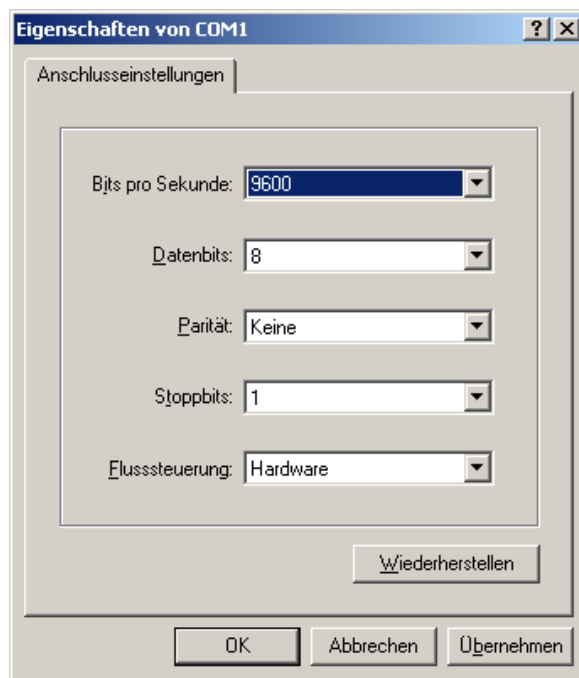
To change the data format press the MENU button until **:RS232Attach** is shown in the bottom line of the display. Now use the arrow-up ▲ and arrow-down ▼ button to select one of the following options:

Option	Result
<b>None</b>	Only the current detector signal [ $\mu\text{V}$ ] is transmitted.
<b>Count</b>	Two columns are reported: The first column contains the detector's signal, the second column contains the current number of the data point (counter)
<b>Notice</b>	Two columns are reported: The first column contains the detector's signal, the second column contains a marker, if a certain event took place:  <b>!SE:</b> External start signal (dig. Input) Start of data block <b>!SA:</b> External start signal (Computer) Start of data block <b>!HL:</b> External hold signal (Computer) End of data block <b>!MR:</b> Marker
<b>Both</b>	All information are transmitted in up to three columns.

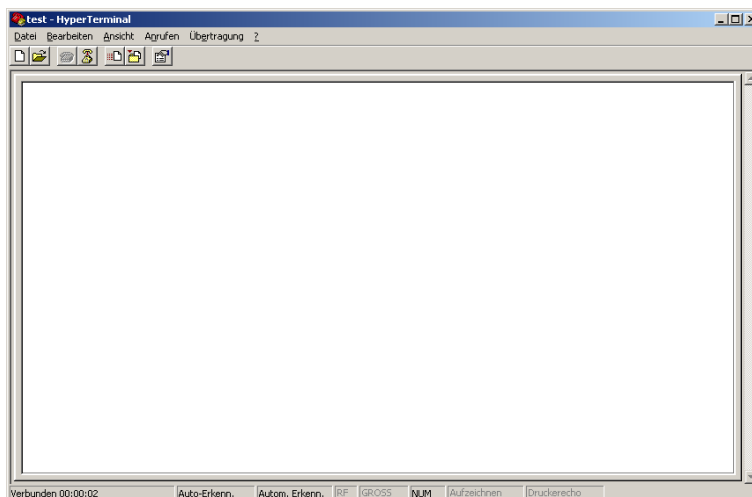
### ***Using Hyper-Terminal to check communication***

To find out how the communication works simply use HyperTerminal, installed with Microsoft Windows. Using this terminal emulation you can directly send commands to the detector and see the result or 'answer' on the screen. HyperTerminal can be found in the program group <All Programs> – <Accessories> – <Communication> (WinXP Professional).

When the program is started a name for the communication setup has to be defined. In the next step the communication port needs to be defined. Select the appropriate port from the displayed list. In the next dialog box the communication parameters need to be set, as described previously.

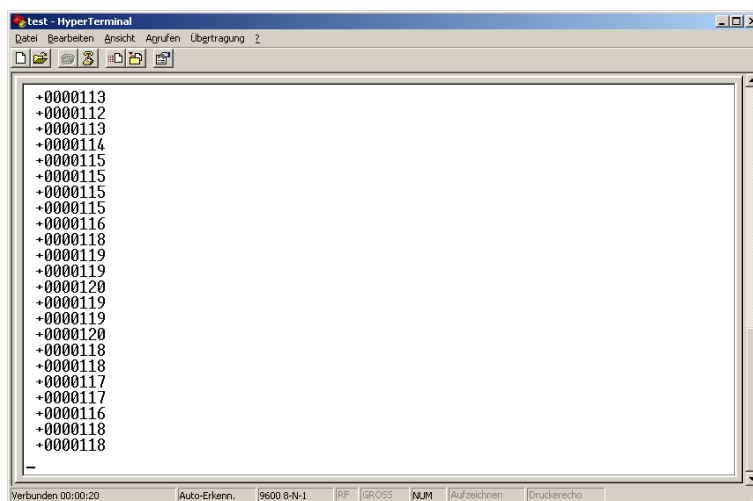


Click the <OK> button to establish the communication with the ZAM3000 detector. The terminal window will be show on your screen like the following example.



Press the <S> key to start data transmission or the <H> button to stop transmission. Pressing the <P> button will switch the purge valve, pressing <Z> will set the detector signal to zero.

When data are reported without any attached information the following screen appears:



The format of the data packages depend on your format settings.



### ***Reporting Additional Information***

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Beside the detector signal and status information other information can be received from the instrument, sending appropriate commands. Receiving further information is only possible in the case data acquisition is stopped.

### ***Instrument information***

---

Sending the command 'I' while data acquisition is stopped will result in receiving the following answer from the instrument:

ZAM3000 V1.3 C0507438

From this line the user can get the information which instrument is answering (ZAM3000) and which firmware version is used (V1.3). The last number (C0507438) represents the serial number of the instrument.

### ***Example of data communication***

The following listing shows an example of data communication between ZAM3000 light scattering detector and PC. Comments are added and printed in green colour. The termination sequence containing special characters CR and LF is represented by the symbol ¶.

```
+0436795¶          running data acquisition without additional
                    information

+0436795¶

+0436803¶

+0436803¶

+0000000¶          Execution AutoZero Command

+0000000¶

-0000001¶

-0000001¶

+0000001¶          Stop of data acquisition

+0000217¶          Start of data acquisition

+0000218¶

+0000217¶          Stop of data acquisition

RI2000 V4.0 C0507438¶ System Info using ,I'-Command

-0015171 +8388607 !14¶ System-Info using ,Space'-command: 1Hz,
                    Maximum information

-0015176 +0000001 !SA¶ Start of data acquisition, block A

-0015174 +0000002¶

-0015171 +0000003¶

-0015170 +0000004¶

-0015171 +0000005¶

-0015171 +0000006 !HL¶ Stop of data acquisition, block A

-0015171 +8388607 !34¶ System-Info using ,Space'-command: 10Hz,
```

Maximum information

-0015172 +0000001 !SA¶	Start of data acquisition, block B
-0015173 +0000002¶	
-0015174 +0000003¶	
[...]	
-0015173 +0035998¶	
-0015172 +0035999¶	
-0015173 +0036000 !HL¶	Stop of data acquisition, block B
-0015175 +0000001 !SE¶	Start using external start signal (RS232), block C
-0015172 +0000002¶	
-0015180 +0000003¶	
+0000000 +0000004¶	Executing AutoZero command
+0000001 +0000005¶	
-0000001 +0000006¶	
-0000003 +0000007 !MR¶	External marker signal (RS232)
-0000003 +0000008¶	
[...]	
-0000021 +0004427¶	
-0000021 +0004428 !HL¶	Stop of data acquisition, block C
-0000031 !12¶	System-Info using ,Space'-command: 1Hz, Status messages
-0000030 !SA¶	Start of data acquisition using ,S'-cmd, block D
-0000031¶	
-0000031 !MR¶	External marker signal (RS232)
-0000033¶	
-0000032 !HL¶	Stop of data acquisition, block D
-0015187 +8388607¶	System-Info using ,Space'-command: incl. counter
-0015189 +0000001¶	Start of data acquisition, block E

-0015189 +0000002¶

-0015190 +0000003¶

running data acquisition

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