Instruction Manual

Low Volume Sampler LVS 3.1
Medium Volume Sampler MVS 6.1

Sampler for PM_{10} and $PM_{2.5}$ (EN 14341),
TSP (VDI 2463 Page 7, TA Luft) and Soot (VDI 2465 Sheet 1 and 2)

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Important Information

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1. Introduction

This instruction manual is intended to provide a systematic and comprehensive introduction to the features, functions and operation of the sampling system. This manual also contains a number of important safety warnings. Please read this manual completely and carefully so that you will be able to make use of the system's many functions and do so both safely and efficiently. Please note that details in the description of the device and in the illustrations may deviate from the properties found in your own unit.

If not otherwise indicated, all the instructions and descriptions are applicable to both the LVS 3.1 and the MVS 6.1.

1.1. Symbols and Typography

In the interest of making the text clearer and more understandable, the following symbols and typographic conventions are used.

The following apply to sections that deal with the parameterization and control of the device by way of the control unit:

- Elements that can be clicked or selected (e.g. menu items) are highlighted in blue
- Other words appearing in software screens are **boldfaced**
- Instructions regarding elements to be selected in sequence sometimes use arrows in the interest of brevity (e.g. Settings → Language → English)

The following apply to safety information:

 **DANGER!**	This symbol indicates risk to life, serious injury and/or considerable property damage if the appropriate safety measures are not taken
 **WARNING!**	This symbol indicates risk of lesser injury and property damage if the appropriate safety measures are not taken
WARNING!	without a warning triangle indicates a risk to property if the appropriate safety measures are not taken
CAUTION!	indicates that undesirable results or states could occur if the appropriate notes are not observed
NOTE:	indicates important information or emphasizes a part of the documentation to which particular attention must be paid

1.2. Intended Use

The samplers LVS 3.1 and MVS 6.1 may be used only for the purposes specified in this manual and only in conjunction with devices and components recommended and approved by the Comde-Derenda GmbH.

1.3. Operating Environment

The device is designed for operation at temperatures of from -30 °C to +50 °C. In the case of extended exposure to strong sunlight in conjunction with very high air temperatures (upwards of about 35 °C), the system is to be set up beneath a self-supporting roof with an opening through which the air intake tube passes. The PNS is designed for outdoor use and may be operated without rain protection or the like.

1.4. Electromagnetic Compatibility

This is a Class A unit and may cause radio interference in residential areas. In this event the operator may be required to implement and pay for appropriate abatement measures. The device satisfies the requirements of the Electromagnetic Compatibility (EMC) Directive and harmonized European standards. Every modification to the system may have an effect on EMC characteristics.

1.5. Scope of Delivery

Included in the delivery are:

- 1 each Basic device LVS 3.1 resp. MVS 6.1
- 1 each Serial cable for connection to a PC
- 1 each Set of keys for the equipment
- 2 each SD memory card
- 1 each Memory card reader for connection to a PC (USB)
- 1 each Calibration protocol for LVS 3.1 resp. MVS 6.1
- 1 each Instruction Manual
- 1 each Air intake tube 12 mm
- 1 each Filter holder with filter cartridge

2. Safety Instructions

This unit was engineered and tested in accordance with DIN EN 61010-1:2002-08 (Safety requirements for electrical equipment for measurement, control and laboratory use). It left the factory in perfect working condition. In order to maintain this condition and to ensure hazard-free operation please be absolutely sure to observe the following safety notes. Disregarding these warnings or non-compliance with these notes could results in fatalities, severe bodily injury and/or significant property damage. Also observe local safety requirements that govern dealings with electrical and electronic equipment carrying line voltage. Although the device was manufactured in accordance with recognized safety regulations, hazards or adverse effects for the unit or other property could arise during use.

Only suitably qualified personnel may work on this unit. This personnel shall be thoroughly familiar with all the safety notes and with the installation, operation and maintenance procedures contained in this instruction manual. Safe and fault-free operation of the unit presumes proper handling and correct installation, operation and maintenance.

This device may be used only for the purpose intended by Comde-Derenda GmbH. Unauthorized modifications and the use of accessories and spare parts not supplied or recommended by Comde-Derenda GmbH can result in property damage and personal injury.

WARNING! If it is to be expected that hazard-free operation is no longer possible, then the device shall be taken out of service and secured against unintentional restarting.

It is to be presumed that non-hazardous operation is no long possible:

- if the electronics unit exhibits visible damage
- if the unit no longer operates or shows obvious deviations from normal operations
- if an electrical connector has been damaged

As long as the unit is connected to the line power supply components carrying electrical voltage may become accessible when covers are opened or other parts are removed.

WARNING!

- The unit must be disconnected from all sources of electrical power prior to starting maintenance or repairs or replacing parts.

- Whenever it is unavoidable to carry out maintenance or repair work on devices that are opened and connected to the power supply, then such work may be carried out only by a qualified employee who is familiar with all the associated hazards.

- Any interruption in the protective ground wire either inside or outside the unit or disconnection of the ground wire may result in the unit becoming dangerous. Any intentional interruption of the ground wire circuit is prohibited!

- The line plug may be connected only to a socket with a protective ground contact. This safety feature may not be counteracted by using an extension cord that does not incorporate a protective ground wire.

3. Overview of the System

The samplers LVS 3.1 and MVS 6.1 are used to collect suspended particulate matter either indoors or outdoors. The particulates are collected on special filters that are then evaluated through either gravimetric or analytical means.

LVS and MVS are almost identical. They vary only in regard to the pumps installed (see 3.2.2). The differences are:

- The air throughput of the **LVS 3.1** ranges from 1.0 to 3.5 m³/h or scm/h and can be specified in steps of 0.01 m³/h or scm/h.
- In the **MVS 6.1** the potential volume flow is from 1.0 to 5.5 m³/h or scm/h. Its high throughput rate makes the MVS particularly suitable for the measurement of dioxins and other low-volatility organic compounds.

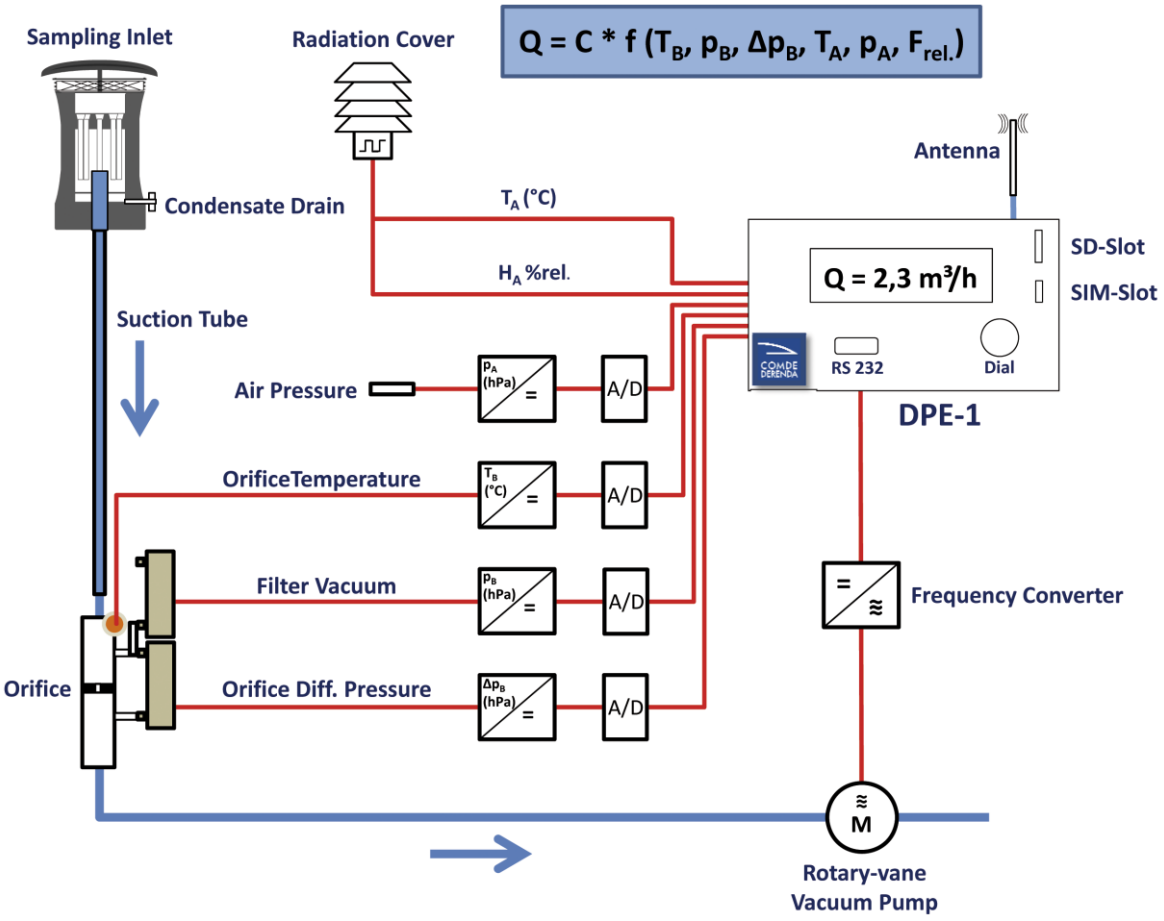


Fig. 1: Schematic Diagram of the LVS 3.1 / MVS 6.1

The LVS 3.1 and MVS 6.1 are the successors to world-renowned models GS050-3D, GS050–6D, LVS 3 (or MVS 6) and LVS 3D (or MVS 6D). The GS 050/3-N and its associated sampling system are described in the VDI (Association of German Engineers) Guideline 2463, Sheets 7 and 8. These are specified in the TA Luft (Air Quality Standards) as the references for monitoring suspended particulate matter, lead and cadmium. The LVS 3.1 is the reference unit for collecting suspended particulate matter as per DIN EN 12341 (PM10) and DIN EN 14907 (PM2.5). Since entry into force EN 12341:2014 for PM10 and PM2,5 the automatical sampling systems are reference devices.

Important properties of the new LVS / MVS generation:

- Can be used as an intelligent control unit for the PNS 15 and PNS 16 systems (automatic recognition of the sampling system connected to the unit)
- Separate serial interface for external sensors
- Simple calibration of volume flow regulation, without a PC
- Measured temperature values displayed at resolution of 0.1 K
- Great immunity to interference resulting from voltage fluctuations
- Extended configuration options for data transfer as per the Bayern-Hessen-Protokoll (Bavaria-Hesse protocol)

3.1. Functional Concept

The desired settings are entered at the control unit before sampling is started. Once started, sampling runs automatically in accordance with the specified parameters. Particulate-laden air is drawn in by a rotary-vane vacuum pump, through sampling inlet. The volume flow for the sampled air is measured at an orifice plate located between the filter and the pump. The selection of the type of sampling inlet will determine which particle fraction will be collected on the sampling filter. The air is then moved to the discharge point through a discharge filter provided to catch the debris resulting from wear at the rotary vanes.

The volume flow is regulated in m³ as desired. The current volume flow rate is shown at the display and control unit at resolution of 0.01 m³. The integrated controller operates at an accuracy better than 1% deviation from the set-point value.

Fig. 2: LVS 3.1

The sampling period, through to the time the unit is switched off, is recorded by the microcontroller and stored in the data memory. All sampling data are automatically stored in the unit's internal memory and – if mounted – on an SD memory card. The information stored in the data memory may also be accessed at any time via the display and control unit. Since flash memory is used, the data in the microcontroller and data memory will not be lost in case of a power failure. Expanded configuration options allow data transmission in accordance with the Bayern-Hessen-Protokoll (Bavaria-Hesse protocol), as well.

3.2. System Design and Components

The LVS 3.1 and MVS 6.1 both feature a rugged stainless steel housing with a lockable door. They consist of the main components described below.

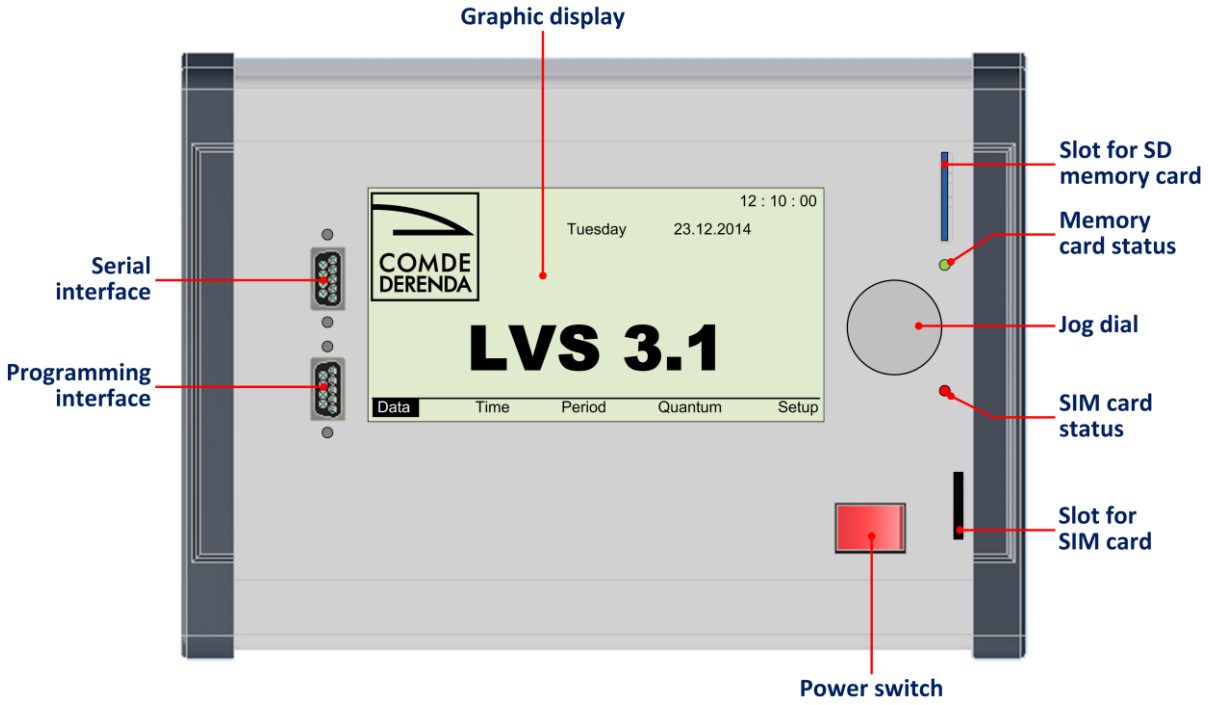


Fig. 3: Control Unit

3.2.1. Control Unit

All the system settings are entered at the control unit. The unit has the following elements and functions:

- Main switch used to switch the unit on and off
- Jog dial to select functions and to enter or change parameters
- An illuminated graphic display showing system functions, parameters, data and alarms

- SD memory card slot for automatic storage of sampling data and parameters and for updating the equipment firmware (also for the filter changer unit)
- Serial interface 1 (RS232) for external sensors
- Serial interface 2 (RS232) for data transfer (system configuration, data transfer as per the Bayern-Hessen-Protokoll / Bavaria-Hesse protocol)
- Serial interface 3 at the rear of the unit, for connection to a filter changer

Fig. 4: Rotary-vane Vacuum Pump

- Status indicator for the SD memory card:
  - Green = Memory card is on standby
  - Red = Reading from or writing to the memory card
  - Orange = Firmware update being transferred to internal flash memory
  - Dark = No memory card installed
- GSM/GPRS module with SIM card slot for online data transfer via mobile phone network (optional)
- Status indicator for the GSM/GPRS module (slow blink, rapid blink, steady light)

3.2.2. Rotary-vane Vacuum Pump

The oil-free rotary vane vacuum pump is located in a protected space in the lower part of the housing. It works with carbon vanes and is joined with an internal prefilter and an external discharge filter. Installed in the LVS 3.1 is a pump made by the Becker Company, achieving maximum volume flow of 4 m³/h. Used in the MVS 6.1 are pumps also built by the Becker Company, achieving a maximum flow rate of 8 m³/h. Both pumps will have to be serviced at certain intervals; see section 10.2.

3.2.3. External Sensor

The unit's external sensor is used for continuous registration of temperature and relative humidity. The ambient temperature is measured at an accuracy of ±0.5 K in a range of from -40 to +80 °C, relative humidity at an accuracy of ±3 % in a range of from 0 to 100 %.

Fig. 5: External Sensor

The sensor is bolted to the unit by way of a mounting bracket. The knurled nuts on the side toward the unit can be easily removed, without the use of tools, to dismount the sensor for transportation purposes, for instance. A shield protects the sensor from direct sunlight and precipitation.

3.2.4. Air intake Tube and Sampling Inlet

Sampling inlets for the PM10, PM4, PM2.5 or PM1 particulate matter fractions may be used with the LVS/MVS. Depending on which sampling inlet is used, this will collect particulate with diameters of <10 µm, < 4 µm, <2.5 µm or < 1 µm. The air intake tube is fitted with a jacket tube for thermal insulation purposes. The sampling inlets (PM10 and PM2.5) are reference units as defined in EN 12341:2014.

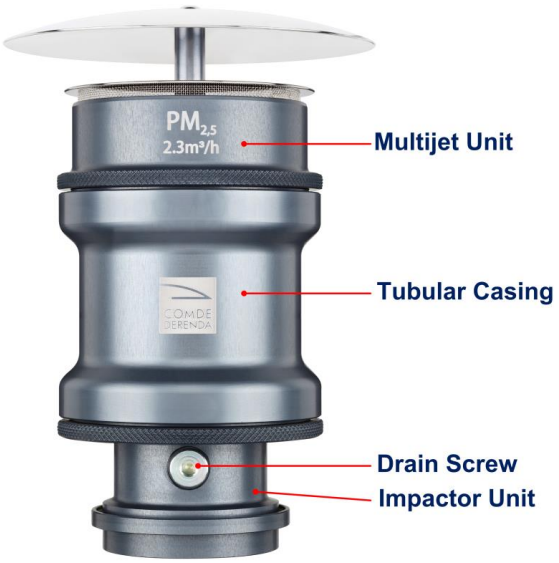


Fig. 6: Sampling Inlet

Interchangeable multijet units make it possible for the sampling inlet to collect a number of different fractions (PM10/PM4/PM2.5/PM1) at differing volume flows (4m³/h, 2.3m³/h and 1.0 m³/h).

The air intake assemblies comprise essentially three parts:

- Multijet unit with jet tubes, flow plate and cover, including insect screen
- Tubular casing
- Impactor unit with the intake tube, baffle plate and drain screw for rainwater that has entered the system

The stainless steel air intake tube is 500 mm long, the diameter is 12 mm. Other lengths are available on request.

4. Assembly and Getting Started

4.1. Transportation

The system and its components should be well packed and protected against shipping damage when moving the system to a new location. All the openings have to be closed during transportation in order to protect the device from dirt and grime.

4.2. Assembling the LVS / MVS

The sampling system has to be assembled on a flat and level surface. Assemble in the following sequence:

1. Remove the device and the associated parts from the shipping carton and check to ensure that all the parts are present (see 1.5).
2. Pass the air intake tube, from above, through the tube support and into the air intake opening.
3. Tighten the tube support's wing screw.
4. Slip the filter holder over the top of the air intake tube.
5. Insert a filter into a filter cartridge and load the cartridge into the filter holder (4.4).
6. Place the sampling inlet onto the filter holder and fix it in place with the two retainer clips at either side (before starting sampling, the baffle plate of the sampling inlet is to be greased, see 10.1).

WARNING! Use the system only with a filter loaded into the sampling position in order to prevent drawing in moisture and/or dirt as this could cause damage to the pump and/or the orifice plate.

4.3. Connecting and Powering Up the System

Connect the power plug of the LVS/MVS to a socket with protective ground contact. Next, connect the required external devices and/or sensors to the serial ports on the control unit (see 3.2.1). Activate the system with the power switch located on the control unit.

After the unit has been switched on, the display will show the initialization screen for a short period of time. It will be followed by the start screen (Fig. 8). Shown in addition to the date and time of day is the model designation.

NOTE: Whenever the system is moved to a new location observe an acclimatization period of one hour before sampling so that the external sensor can adjust to the ambient conditions.

4.4. Sampling Filters and Filter Cartridges

47 mm diameter filters are used for sampling. The filters are inserted in the device's filter magazine using special filter cartridges. That magazine is then inserted into the system's filter changer unit.

Insert the filter in a filter cartridge as described below:

- Remove the upper section of the cartridge.
- Lay the filter on the support screen which rests on the lower section of the cartridge.
- Join the upper and lower sections of the cartridge.

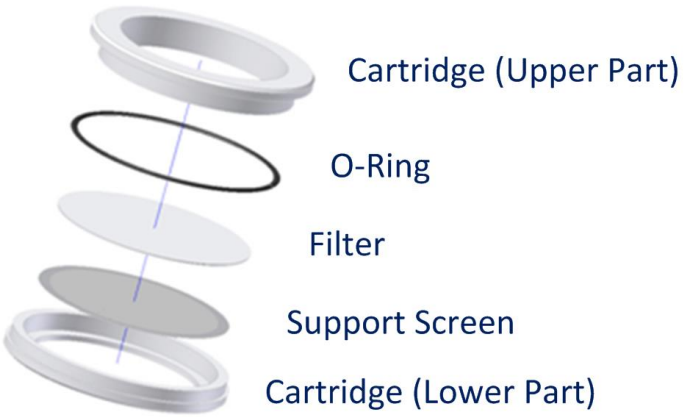


Fig. 7: Assembly of a Filter Cartridge

Restrictions in the weighing technology make it necessary to use glass or quartz fiber filters when determining the concentration of the suspended particulates. Electrostatic charges can influence weighing if other types of filters (e.g. PTFE or diaphragm filters) are used.

When using sintered filters for asbestos analysis, first insert a diaphragm filter with larger pore size (e.g. 8 µ) and then the sintered filter.

Due to the elevated flow resistance when compared with fiber-type filters, one must expect a reduction of air throughput when using a diaphragm and sintered filters at maximum air throughput.

4.5. Storage

The following instructions should be followed if the unit is moved or taken out of service for an extended period of time:

- The storage temperature should be in a range of from -10 °C to +60 °C
- The pump intake port has to be covered
- Protect the device's inlets and outlets against grime

- It is necessary to avoid both high relative humidity (which could cause condensation in case of a temperature change) and any severe vibration of the unit

It is advisable to thoroughly clean and maintain the unit before any extended period out of service.

5. Operation and Settings

5.1. Operation

The main menu that appears once the unit has been powered up enables access to all the system settings and functions. The jog dial at the control unit is used for navigation within the individual menus. Turn the jog dial to change from one menu item to the next and to change the parameter selected. The menu item active at any given moment is shown inverted or outlined. Press the jog dial to confirm the selection of the menu item or to confirm the modified value.

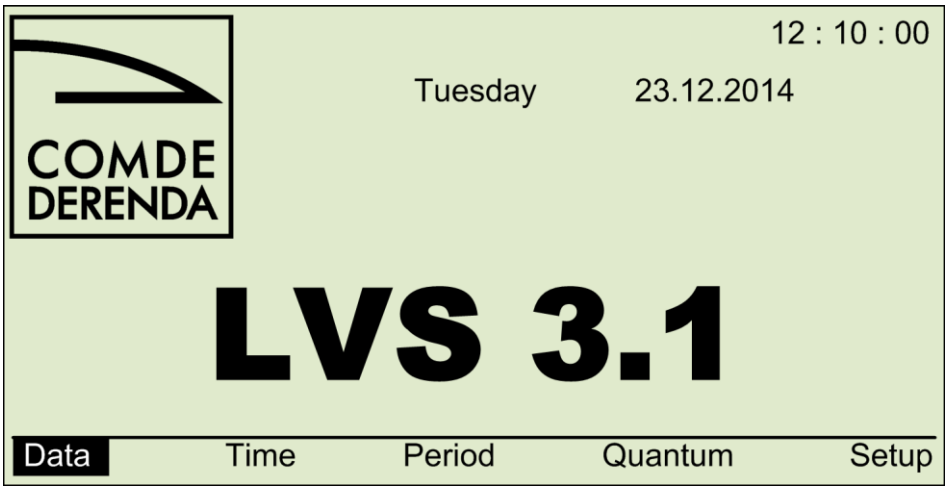


Fig. 8: Start Screen and Main Menu

5.2. Software Design

The software makes possible convenient adaptation of all system settings and exact parameterization for the sampling tasks being planned. See **Appendix A: Menu Structure of LVS/MVS** for a survey of the menu structure implemented in the software (functions with blue background are only available when using a filter changer). The main menu, which is always shown whenever the unit is switched on, provides access to the submenus described below.

5.2.1. *Setup* Menu

The **Setup** menu (Fig. 9) is used to specify numerous settings at the unit. It contains the following menu items and functions:

- Language: Selecting the language for the equipment software
- Jobparameters: Selecting parameters to be used during sampling
- Date/Time: Setting the date and time of day
- Transfer: Selection and configuration for data transfer
- Contrast: Setting the contrast level for the display screen

- Service: Current measured values and manual control of the pump
- Kalib. Daten: Calibration of the volume flow sensor
- System Info: Information on the equipment data
- Administrator: Changing the password
- Device Adjustment: Special settings made by the manufacturer
- Leak Test: Execute a leak test

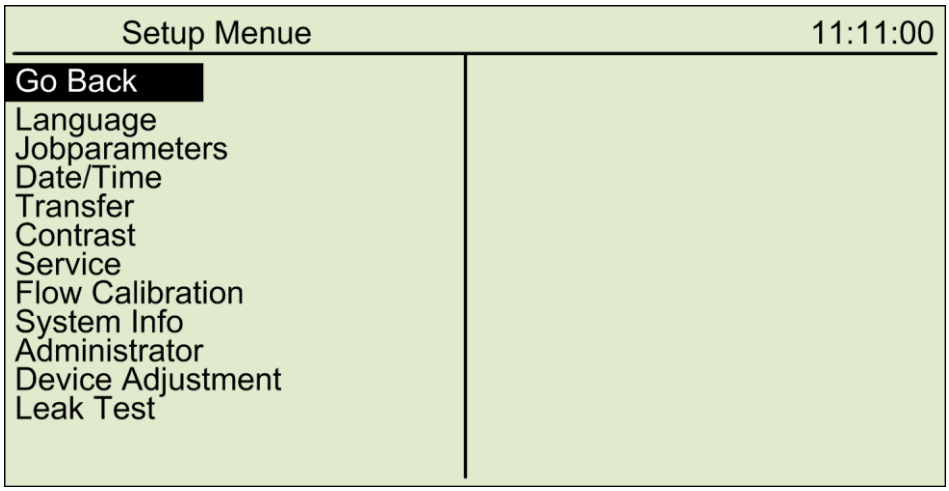


Fig. 9: Setup Menu

5.2.2. Menus for Individual Operating Modes (*Time*, *Period* and *Quantum*)

These menus are used to enter parameters for the three operating modes **Time**, **Period** and **Quantum**. Once the values for the desired mode have been entered, sampling is started right from the menu. The display then changes to show operating information (see Fig. 26).

5.2.3. *Data* Menu

The **Data** menu contains all the functions related to the data memory (overview, transfer and deletion of stored data). This menu also provides access to the update functions for the equipment firmware and for the filter changer unit.

5.3. Basic Settings

Certain basic settings will have to be made at the unit before starting the configuration work proper.

5.3.1. Choosing a Language

Follow these instructions to select the language for the operator prompts:

1. Select the Setup item in the main screen and confirm by pressing the jog dial.
2. When in the **Setup** menu select the Language item and confirm this.

3. Turn the jog dial until the desired language appears in the right half of the display (English, German, Spanish, Italian and Polish are available at present) and confirm your choice.
4. Confirm the Back menu item to return to the main menu.

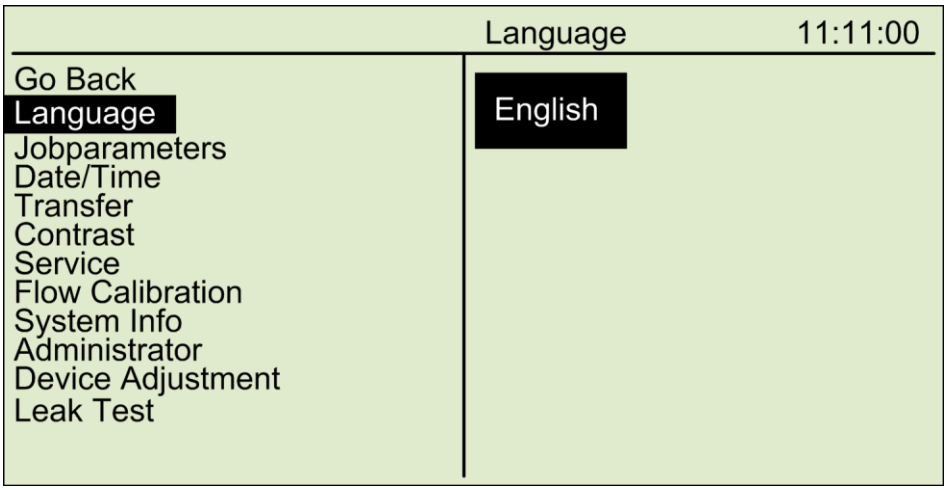


Fig. 10: Selecting a Language

5.3.2. Setting Time of Day and Date

To set the current date and time of day:

1. Select the Setup item in the main screen and confirm by pressing the jog dial.
2. Select Date/Time in the **Setup** menu and confirm.
3. Turn the jog dial in order to select the desired value (day, month, year, hour, minute, second) in the **Date/Time** screen (Fig. 11); the selected value will be outlined in each case.
4. To change the selected value press the jog dial – the value is now shown inverse – and turn the dial in the appropriate direction until the desired value is reached.
5. Press the jog dial to confirm the entry.

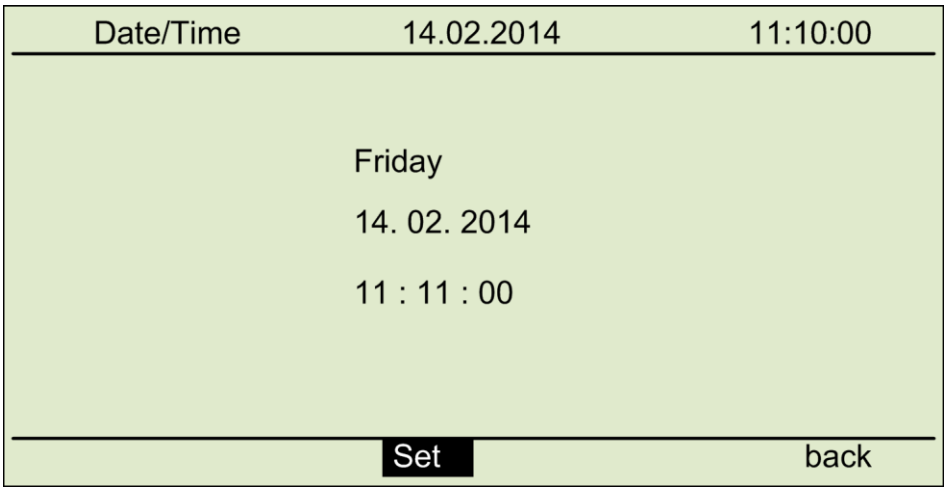


Fig. 11: Setting Time of Day and Date

6. Repeat steps 3 to 5 for all the values to be changed.
7. Select and confirm Set to store the values shown.
8. Select and then confirm Back twice in a row to return to the main menu.

5.3.3. Adjusting the Display's Contrast

In order to adjust the contrast in the display:

1. In the main screen select the Setup item and confirm this by pressing the jog dial.
2. In the **Setup** menu select Contrast and confirm your choice.
3. The current contrast value is shown in the right half of the display; turn the jog dial to adjust the contrast as desired, on a scale of from 0 (bright) to 63 (dark), and confirm your selection.
4. Confirm at the Back button to return to the main menu.

5.3.4. Dew Limit Function

If the air temperature falls below the dew point at constant air pressure, it leads to condensation water on cool surfaces. At dew point the relative air humidity is exactly 100 %. The temperature of dew point depends on temperature and humidity of the environment and is calculated by the device (see Fig. 12: Tdew). If loaded filters are stored in the optional cooling chamber, in case of extreme ambient conditions water may condensate inside the cooling chamber and infect measurement data. This could happen if the temperature inside the cooling chamber falls below dew point level.

To prevent situations that may cause interferences, there is a dew limit function that adjusts the control range of the cooling in case of critical ambient conditions. Usually the cooling starts at a chamber temperature of 22 °C and stops at 19 °C. If the dew point value is higher than 18 °C, the control range of the cooling is adjusted automatically.

NOTE: The dew limit function is activated in the default settings.

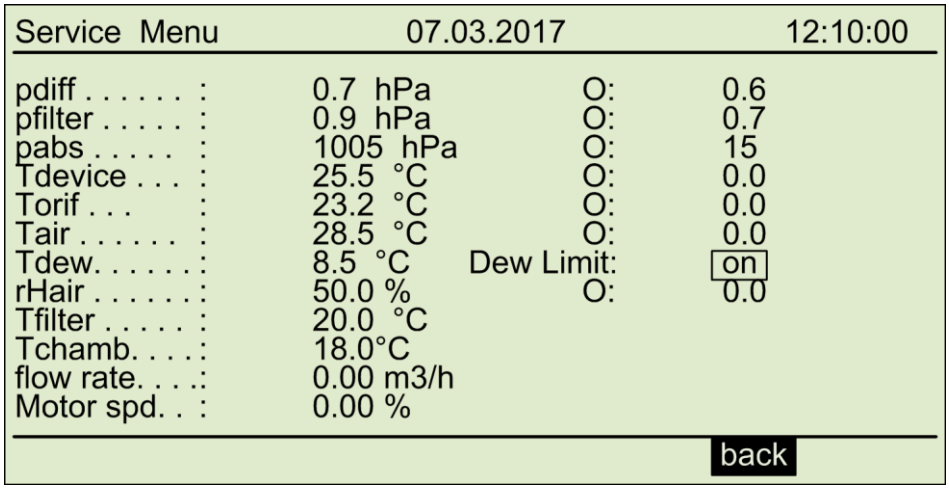


Fig. 12: Service Menu with marked Dew Limit

In order to deactivate dew limit or re-activate it:

1. Choose Setup in the main menu and confirm by pressing the Jog Dial.
2. Choose Service in the **Setup** menu and confirm by pressing the Jog Dial.
3. Choose the line **Dew Limit** and press the Jog Dial. The value is now shown inverted.
4. Turn the Jog Dial to change the value and press the Jog Dial to confirm the setting.
5. To get back to the main menu, choose and confirm the Button Back.

5.4. Setting Standard Conditions and Volume Flow Correction

Defined in the **Job parameters** menu (Fig. 13) are the standard conditions for air pressure and temperature for sampling and the type of the volume flow correction.

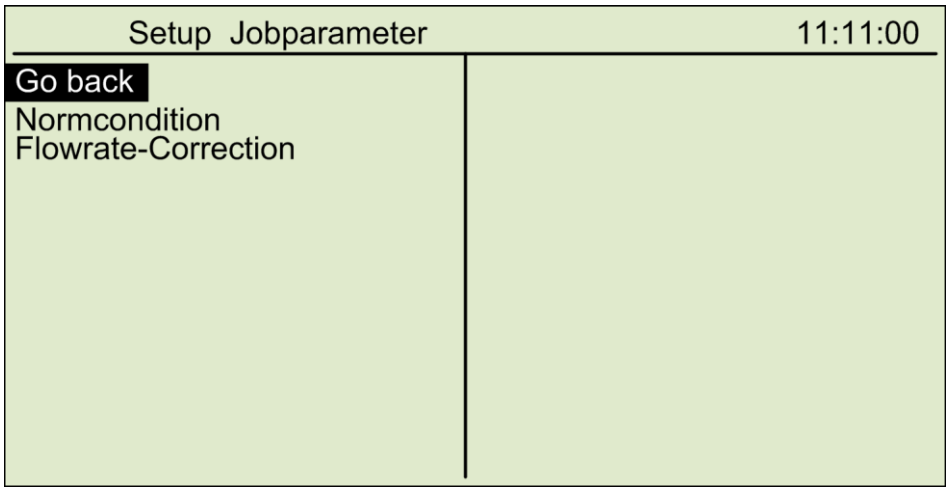


Fig. 13: Setting the Job Parameters

5.4.1. Defining Standard Conditions

Proceed as described below to define the standard conditions used when calculating the standard volume flow and the standard volume:

1. In the main screen select the Setup item and confirm this by pressing the jog dial.
2. Select Job parameters in the **Setup** menu and confirm.
3. When in the **Job parameters** menu select Normcondition and confirm your choice.
4. The current value is shown in the right half of the display (Fig. 14); turn the jog dial to select one of two possible combinations of atmospheric pressure and reference temperature:
    a. 20 °C / 1013 hPa
    b. 0 °C / 1013 hPa
5. Press the jog dial to confirm the entry.

These parameters are used internally to calculate the standard values (volume flow, air quantity).

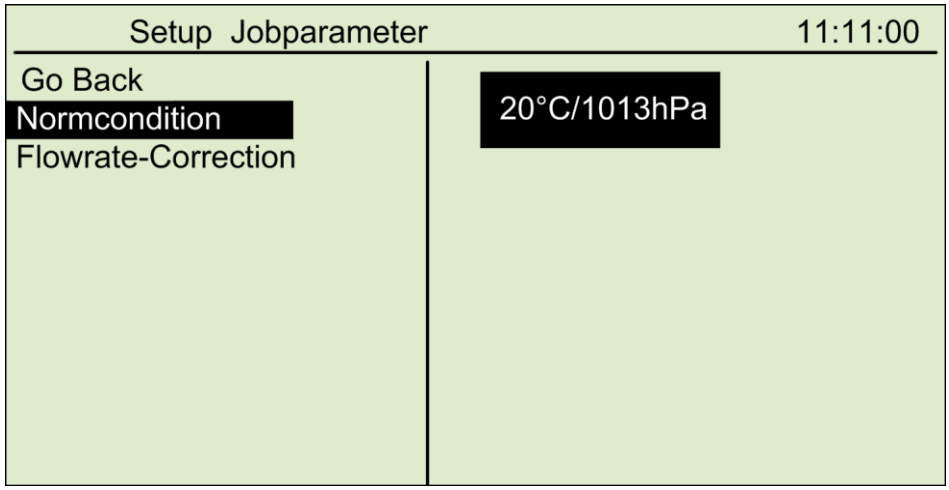


Fig. 14: Setting the Norm Conditions

5.4.2. Volume Flow Correction Method

When selecting the method for correcting the volume flow it is possible to choose between the form specified in the EN 12341 standard and the expanded method (IDEAL), which takes account of the relative humidity. Select the correction method as follows:

1. Select the Setup item in the main screen and confirm by pressing the jog dial.
2. Select Job parameters in the **Setup** menu and confirm.
3. When in the **job parameters** menu select Flowrate-Correction and confirm your choice.
4. The current value is shown in the right half of the display; turn the jog dial to select one of two possible methods: EN 12341 or IDEAL.
5. Press the jog dial to confirm the entry.

5.5. Data Transfer Settings

All the settings affecting data transmission are made in the **Transfer** (Fig. 15) menu.

5.5.1. Selecting Parameters for Transfer

You can select four of the following twelve measurement parameters for transfer by the system:

1. Flowrate in m^3/h (volume flow in m^3/h)
2. Flowrate in Nm^3/h (volume flow in scm/h)
3. Quantity in m^3 (air quantity in m^3)
4. Quantity in Nm^3 (air quantity in scm)
5. Temperature orifice (temperature at the orifice plate)
6. Ambient temperature (temperature of the outside air)
7. Relative humidity (humidity of the outside air)
8. Ambient pressure (pressure in the outside air)

9. Pressure filter (pressure differential at the filter relative to the ambient air)
10. Filter temperature (temperature in the sampling chamber; only relevant when using a filter changer)
11. Temperature chamber (temperature in the storage chamber or cooling chamber; only relevant when using a filter changer)
12. Error number (code number identifying an error or event as it occurs)

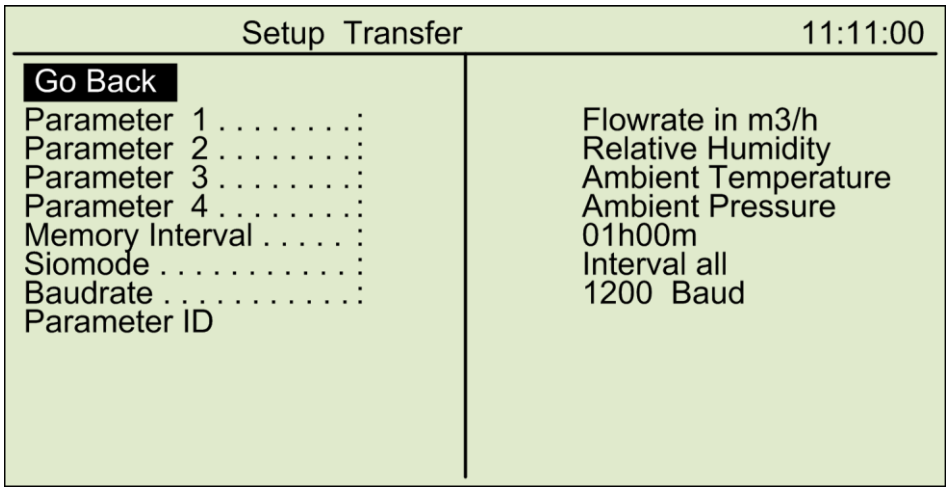


Fig. 15: Configuration Settings for the Data Transfer

Select the desired parameters as follows:

1. Select the Setup item in the main screen and confirm by pressing the jog dial.
2. When in the **Setup** menu select the Transfer item and confirm this.
3. Select Parameter 1 in the **Setup Transfer** menu and confirm.
4. The current parameter is shown adjacent to that, in the right half of the display; turn the jog dial to select one of the twelve possible parameters (see list above).
5. Press the jog dial to confirm the entry.
6. Repeat steps 3 to 5 for the remaining three parameters.

5.5.2. Setting the Data Storage Interval

With the selection of the storage interval you determine how frequently measurement parameters and results will be placed in memory. Storage frequency can be set in one-minute steps from 15 minutes to 59 hours and 59 minutes. Set the storage interval as follows:

1. When in the **Setup Transfer** menu select Memory interval and confirm your choice.
2. Turn the jog dial to change the value (displayed inverse) for the hours (h); press the jog dial to confirm the new value.
3. Turn the jog dial to change the value (displayed inverse) for the minutes (m); press the jog dial to confirm the new value.

5.5.3. Setting the Baud Rate

The baud rate used for data transmission can be set optionally for 1200, 2400, 4800 or 9600. Make this setting as follows:

1. When in the **Setup Transfer** menu select Baudrate and confirm your choice.
2. Turn the jog dial to change the value (displayed inverse) for the baud rate; press the jog dial to confirm the new value.

5.5.4. Choosing the Serial-Input/Output-Mode

You may choose from three different input/out modes for the serial interface:

1. BH-Protokoll: All twelve of the measurement values registered by the system will be transferred in accordance with the Bavaria-Hesse protocol, see also 11.1
2. Interval 4M: Of the measured values, the four selected values (see 5.5.1) will be transferred in CSV file format, using the semicolon as the separator, through the serial interface
3. Interval all: All twelve of the measurement values registered by the system will be transferred via the serial interface in CSV file format, using the semicolon as the separator, in addition to the following information: date, time of day, device number, filter number, type of measurement, periods set, current period, event reports, error reports

Specify the serial I/O mode as described below:

1. When in the **Setup Transfer** menu select Siomode and confirm your choice.
2. Turn the jog dial to change the mode (displayed inverse); press the jog dial to confirm.

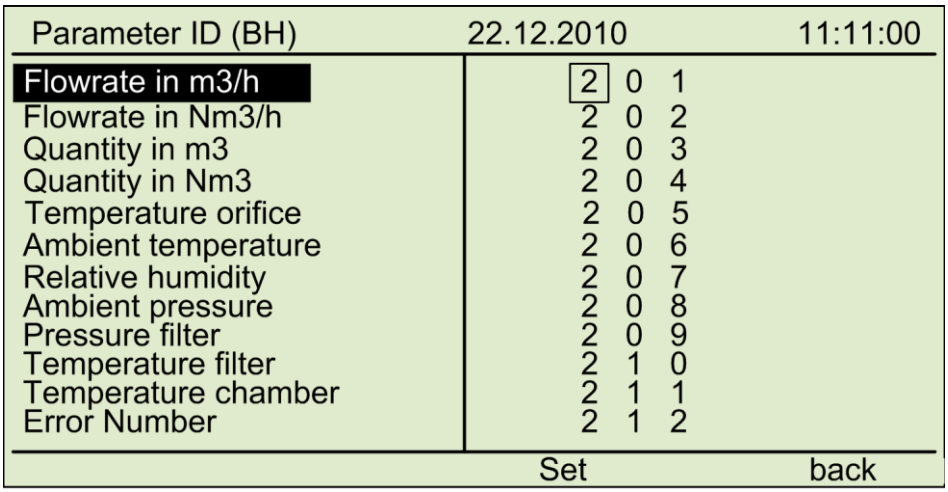


Fig. 16: Setting the Measurement Value Identifiers

5.5.5. Setting the Measurement Value Identifiers

The menu item entitled Parameter ID can be used to encode the twelve individual parameters for data transfer. The code for each value comprises three digits. Specify the individual codes as follows:

1. When in the **Setup Transfer** menu select and confirm Parameter ID.
2. The uppermost parameter Flowrate in m3/h is shown inverted in the display; move the outline surrounding the digits on the right-hand side so that the digit you wish to change is outlined.
3. Press the jog dial, turn the dial to change the digit, and press it again once the desired value has been reached.
4. Change the other digits in the code as described at step 3.
5. Repeat steps 2 to 4 for all the other parameters.
6. Go to Set and confirm in order to store the modified codes.

5.6. Administrator Settings

In order to access the **Administrator** settings it is necessary first to select Administrator in the **Setup** menu and then to enter the administrator password, digit by digit, and to confirm the entry by selecting OK and pressing on the jog dial (Fig. 17). Then you can make the settings described below in the administrator menu. The password set at the factory is “0000”.

5.6.1. Restoring Factory Defaults

To return all the device’s settings to the factory default settings:

1. When in the **Administrator** menu select and confirm Factory defaults.
2. Select “Yes” in the pop-up window and confirm the choice.

The unit will then be initialized anew and the factory default settings will be restored.

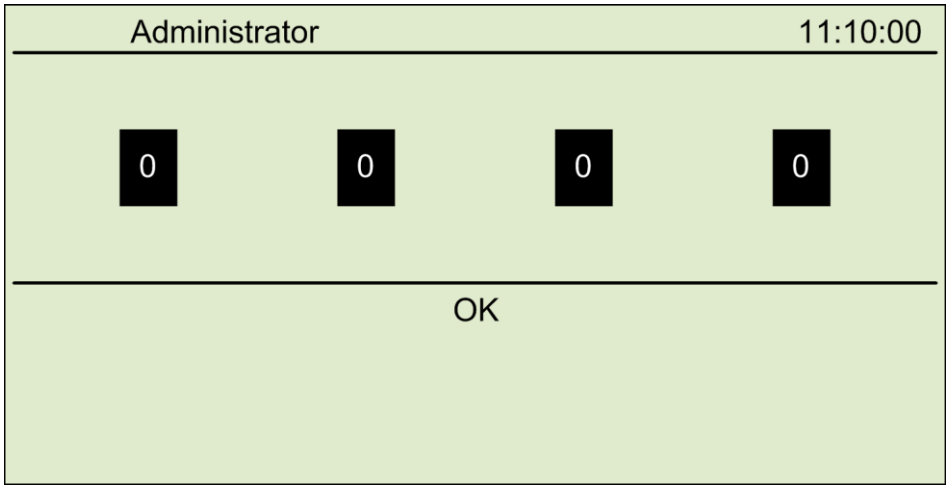


Fig. 17: Setting the Administrator Password

5.6.2. Changing the Password

Change the four-digit administrator password as follows:

1. When in the **Administrator** menu go to the line Admin-Password.
2. Click on the left-hand digit, turn the jog dial to change it, and confirm the change by pressing on the jog dial.
3. Proceed for the other three digits as described in step 2.

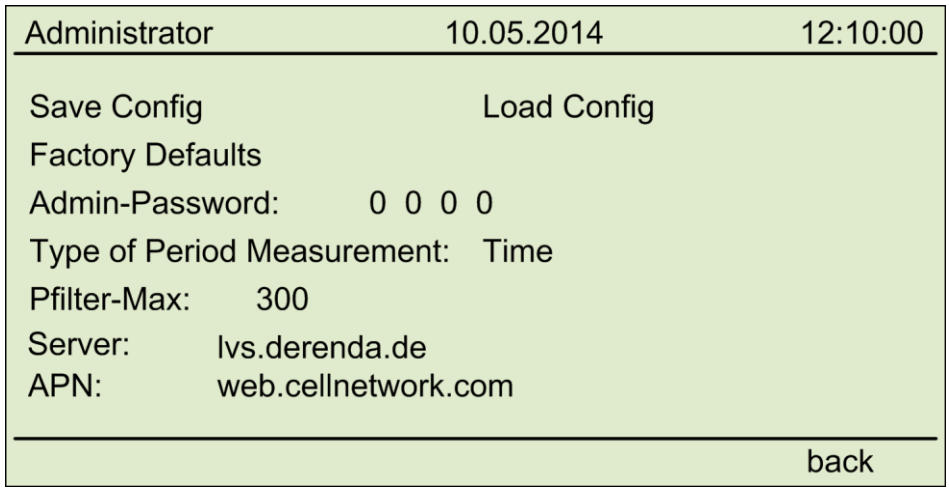


Fig. 18: Administrator Menu

5.6.3. Setting the Type of Period Measurement

You can select one of two options for determining the duration of the measurement period:

- Time: Change the filter when a pre-determined time period has elapsed
- PFmax: Change the filter when the maximum filter pressure has been reached

Do this as described below:

1. When in the **Administrator** menu go to the line Type of Period Measurement.
2. Press the jog dial until the desired setting is reached.

5.6.4. Device Adjustment Menu

The Device Adjustment menu enables authorized service technicians to make changes to specific system settings. The limits for PFmax and PFmin can be found here. To protect the pump from damages, PFmax must not be changed. This menu is protected by a special password.

6. Setting Parameters and Activating the Sampling Process

Once you have made the system settings described at 5.3 to 5.5, you can now parameterize and activate the planned sampling routine. Here you have a choice of three different operating modes: TIME, PERIOD and QUANTUM.

The general procedure is identical for all three operating modes. After selecting the desired operating mode, the parameters for sampling are specified in the corresponding menu. Start is then automatic at the time specified.

During operation various data on sampling will be shown in the display. An overview of the data will be shown when sampling has run to completion.

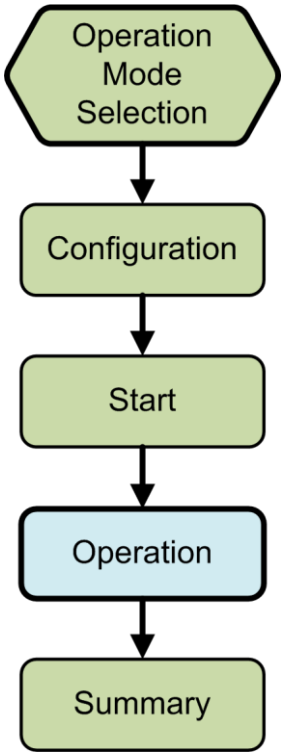


Fig. 19: The Sampling Process

6.1. TIME Mode

The TIME operating mode is used to expose the filter for a predetermined length of time. The time at which sampling begins and sampling duration may be specified as desired. Volume flow through the filter during sampling can be set at will (LVS 3.1: 1.0 to 3.5 m³/h, MVS 6.1: 1.0 to 5.5 m³/h); the system will regulate to the specified value. The unit starts and terminates sampling automatically.

6.1.1. Setting Parameters in TIME Mode

To parameterize sampling in the TIME operating mode, first select Time in the main screen and confirm by pressing the jog dial. Then make the following adjustments in the **Time** screen:

1. Set start time: In the **Begin** line, specify the date (day, month, year) and the time of day (hours and minutes) at which sampling is to start. Do this by placing the outline around the first value to be adjusted; press the jog dial; turn the jog dial to change the value and then press it again. Repeat this procedure for all further values in the line.

2. Set stop time: In the **End** line specify the date (day, month, year) and the time of day (hours and minutes) when sampling is to stop. Proceed as described at step 1.

3. Set volume flow: In the line labeled **V (m3/h)** set the desired volume flow during sampling. To do so place the outline around the value to be set (either in m³/h or in scm/h), press the jog dial, turn the dial to change the value and then press again.

The menu item **Mag. Pos** is relevant only when using a filter changer.

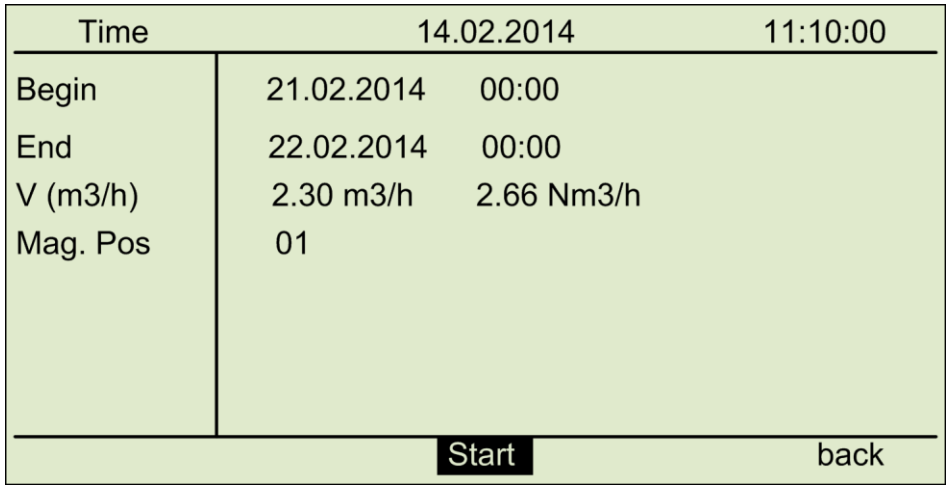


Fig. 20: Setting Parameters in TIME Mode

Practical example:

You want to conduct sampling using the filter in magazine slot 1 at volume flow of 2.3 m³/h, with the following start and stop times:

- Start of sampling: 21.02.2014 (21 Feb. 2014) at 00:00 hours
- End of sampling: 22.02.2014 (22 Feb. 2014) at 00:00 hours (24 hours later)

Enter, as described above, the values shown in Fig. 20.

6.1.2. Activating the Sampling Process

Once parameterization has been completed, activate the sampling process by selecting the Start menu item in the **Time** screen and confirm the selection by pressing the jog dial. Sampling is then started automatically at the predetermined time. You will see the start screen in the display.

The start screen for the TIME operating mode shows not only the specified starting time but also the current date, time of day, the standard conditions selected and the volume flow correction method. The measured values shown on the left in the display (volume flow, motor output and air volume) will of course read zero before the start of sampling.

The selected starting time, the ending time and the duration of the current sampling cycle can be displayed by selecting and confirming the Time menu item.

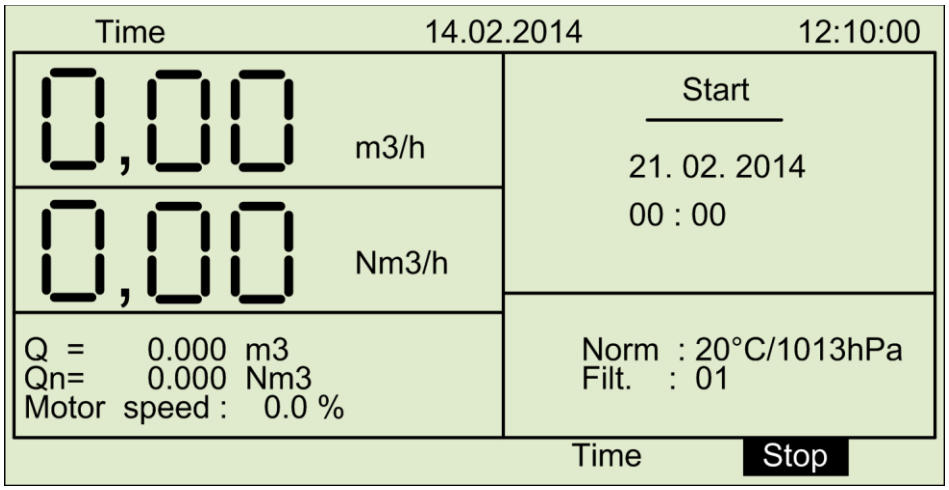


Fig. 21: Start Screen in TIME Mode

Use the menu item Stop to interrupt the planned sampling cycle. To do so, select and confirm Stop and answer the confirmation message which follows. Subsequent to deactivation, a data overview screen will displayed; any data shown here are, however, irrelevant since no sampling had been undertaken. Use the Back button to exit the overview screen and return to the main menu.

6.2. PERIOD Mode

The PERIOD operating mode is used to expose the filter periodically over a defined length of time, with predetermined pauses taking place between each cycle. The time for the start of sampling, the duration of sampling, the length of the pauses and the number of periods can be set as desired. The volume flow for the air passing through the filter during sampling can be specified as desired (LVS 3.1: 1.0 to 3.5 m³/h, MVS 6.1: 1.0 to 5.5 m³/h); the system will regulate to the specified value. The unit starts and stops sampling automatically. The filter will automatically be replaced by the changer unit once each period has elapsed.

6.2.1. Setting Parameters in PERIOD Mode

To parameterize sampling in the PERIOD operating mode, first select Period in the main screen and confirm by pressing the jog dial. Then make the following adjustments in the **Period** screen:

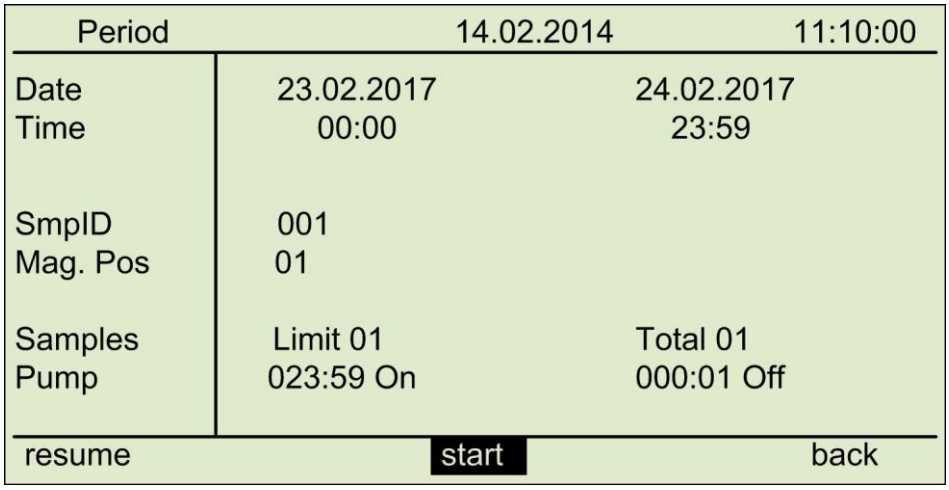


Fig. 22: Setting Parameters in PERIOD Mode

1. Set start time: In the **Date** line, specify the date (day, month, year), and in the **Time** line the time of day (hours and minutes) at which sampling is to start. Do this by placing the outline around the first value to be adjusted, press the jog dial, turn the jog dial to change the value and then press it again. Repeat this procedure for all further values in the line.

2. Duration of sampling: In the line labeled **Pump**, specify the duration of a period (**On**) and the following interruption (**Off**).

3. Samples: In the line labeled **Samples** specify the limit for sampling (**Limit**). If you choose 01, one sampling period will be executed. If you choose a higher value, the filter will be loaded several times, according to the chosen limit and duration of the periods.

The end of the sampling is not to be specified. It results from parameterization. The values in the lines labeled **Smp ID** and **Mag. Pos** are for use with an automatic filter changer. You can leave it at the default values. For further information, please refer to the instruction manual for systems with an automatic filter changer.

6.2.2. Activating the Sampling Process

Once parameterization has been completed, activate the sampling process by selecting the Start menu item in the **Period** screen and confirm the selection by pressing the jog dial (Fig. 22). Sampling is then started automatically at the predetermined time. You will see the start screen in the display.

The start screen for the PERIOD operating mode shows not only the specified starting time but also the current date, time of day, the standard conditions selected and the volume flow correction method. The measured values shown on the left in the display (volume flow, motor output and air volume) will of course read zero before the start of sampling.

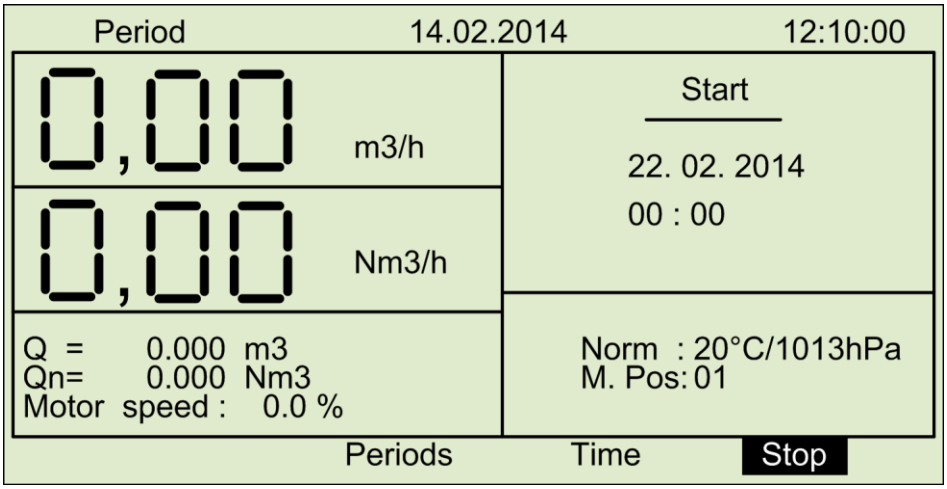


Fig. 23: Start Screen in PERIOD Mode

Selecting and confirming the Time menu item will cause the specified starting time, the stop time and the duration of the current sampling cycle to be displayed. At the Periods menu item, you can call up a list showing all the periods specified, including the start and stop times in each case.

Use the menu item Stop to deactivate the planned sampling cycle. To do so, select Stop and answer the confirmation message which follows. Subsequent to deactivation, a data overview screen will be displayed; any data shown here are, however, irrelevant since no sampling had been undertaken. Use the Back button to exit the overview screen and return to the main menu.

6.3. QUANTUM Mode

The QUANTUM operating mode is used to expose a filter to a defined volume of air. The time at which sampling begins and the air volume to be processed during sampling may be specified as desired. The volume flow through the filter during sampling can also be set at will (LVS 3.1: 1.0 to 3.5 m³/h, MVS 6.1: 1.0 to 5.5 m³/h); the system will regulate to the specified value. The unit starts and terminates sampling automatically.

6.3.1. Setting Parameters in QUANTUM Mode

To parameterize sampling in the QUANTUM operating mode, first select Quantum in the main screen and confirm by pressing the jog dial. Then make the following adjustments in the **Quantum** screen:

1. Set start time: In the **Begin** line specify the date (day, month, year) and the time of day (hours and minutes) at which sampling is to start. Do this by placing the outline around

the first value to be adjusted, press the jog dial, turn the jog dial to change the value and then press it again. Repeat this procedure for all further values in the line.

2. Set air volume: In the line labeled **Quantum**, set the volume of air to be processed during sampling. To do so, place the outline around the value to be set (either in m³/h or in Nm³/h resp. scm/h), press the jog dial, turn the dial to change the value and press it again.

3. Set volume flow: In the line labeled **V (m3/h)**, set the desired volume flow rate during sampling. To do so, place the outline around the value to be set (either in m³/h or in Nm³/h resp. scm/h) and change it as previously described.

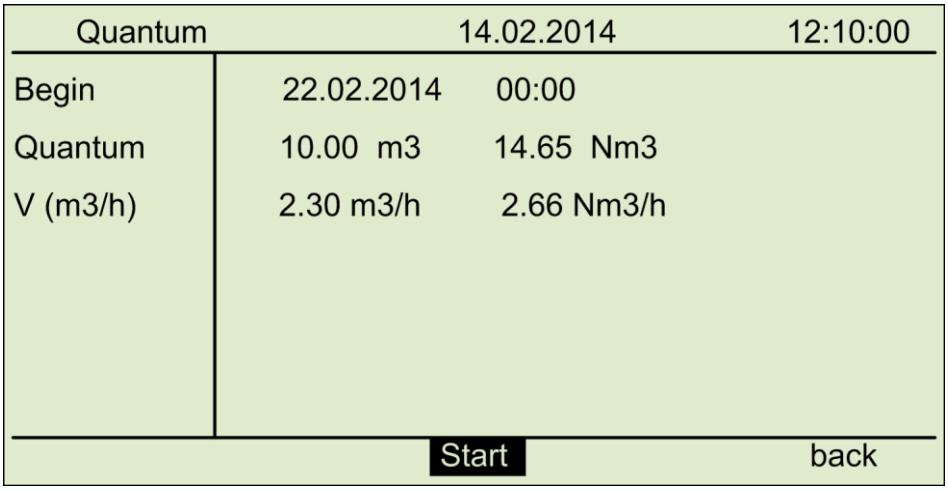


Fig. 24: Setting Parameters in QUANTUM Mode

Practical example:

You want to conduct sampling at a volume flow rate of 2.3 m³/h, with the following start and stop times:

- Start of sampling: 22.02.2014 (22 Feb. 2014) at 00:00 hours
- End of sampling: After 10 m³ of air have passed through the filter

Enter, as described above, the value shown in Fig. 24.

6.3.2. Activating the Sampling Process

Once parameterization has been completed, activate the sampling process by selecting the Start menu item in the **Quantum** screen and confirm the selection by pressing the jog dial (Fig. 24). Sampling is then started automatically at the predetermined time. You will see the start screen in the display.

The start screen for the QUANTUM operating mode shows not only the specified starting time but also the current date, time of day, the standard conditions selected and the volume flow correction method. The measured values shown on the left in the display (volume flow, motor output and air volume) will of course read zero before the start of sampling.

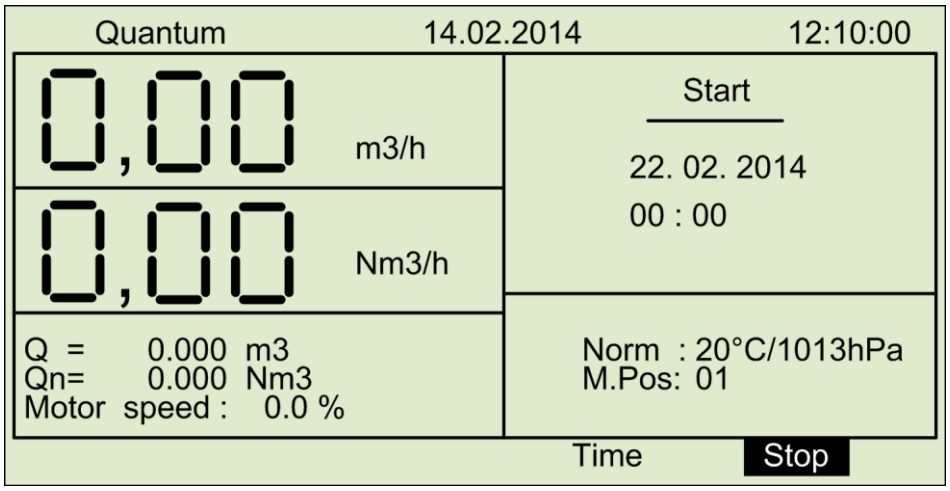


Fig. 25: Start Screen in QUANTUM Mode

The selected starting time, the ending time and the length of the current sampling cycle can be displayed by selecting and confirming the menu item Time.

Use the menu item Stop to interrupt the planned sampling cycle. To do so, select and confirm Stop and answer the confirmation message which follows. Subsequent to deactivation, a data overview screen will displayed; any data shown here are, however, irrelevant since no sampling had been undertaken. Use the Back button to exit the overview screen and return to the main menu.

7. The Sampling Process

Sampling will start automatically once the predetermined starting time has been reached. The pump runs up and the programmed volume flow value is maintained by the integrated controller. The operating screen is shown in the display.

7.1. During Sampling: The Operating Screen

The operating screen shows a number of important data during the entire sampling period. The structure of the screen is almost identical for all operating modes (TIME, PERIOD, and QUANTUM). The only difference is the Periods menu item in the PERIOD operating mode.

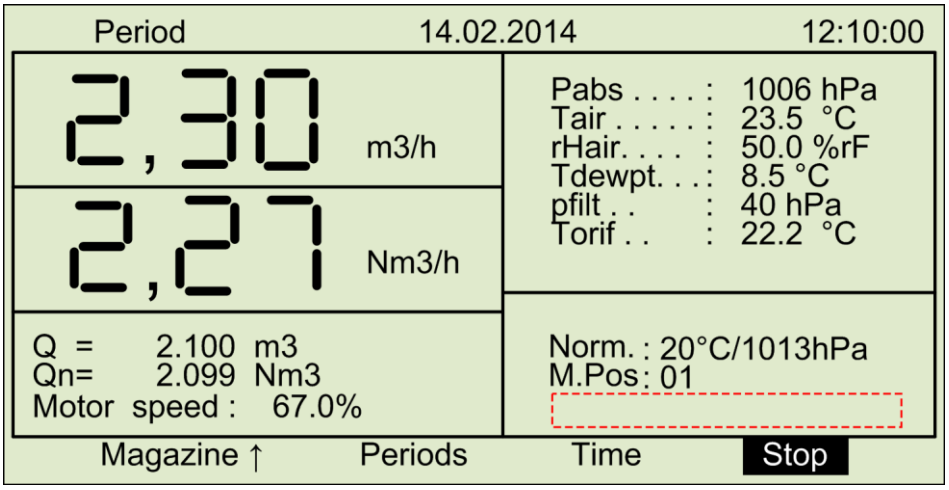


Fig. 26: Screen Shown During Operation in PERIOD Mode

Shown at the upper edge of the operating screen are the operating mode, the current date and the time of day. You will see the following values in the left-hand section of the screen:

- Current volume flow in m³/h and Nm3/h resp. scm/h
- Air volume moved so far (Q/Qn) in m³ and Nm³ resp. scm
- Motor speed in %

The following information is shown in the right-hand side of the screen:

- Current air pressure (Pabs) in hPa
- Current air temperature outside the unit (Tair) in °C
- Current relative humidity (rHair) in % RH
- Dew Point temperature (Tdewpt) in °C
- Pressure differential at the filter relative to the ambient air (pfilt) in hPa
- Temperature at the orifice plate (Torif) in °C
- Standard conditions currently selected
- Number of the filter currently being exposed

- The event field (dotted outline) in which malfunction messages may be shown; see also 12.1.

The following menu items are seen at the lower edge of the screen:

The Stop button may be used to interrupt the current sampling cycle. To do so, select and confirm Stop and answer the confirmation message which follows. Subsequent to deactivation, an overview screen with various data on the sampling will displayed (Fig. 27). Use the Back button to exit the overview screen and return to the main menu.

Selecting and confirming the menu item Time will cause the selected starting time, the ending time and the length of the current sampling cycle to be shown.

The Periods menu item, which calls up a list of the starting and stop points for each period, is visible only when in the PERIOD operating mode.

7.2. After Sampling: Data Review and Storage

The pump is automatically shut down once the preselected sampling period has elapsed. The data overview screen appears in the display; the following data on sampling are shown here:

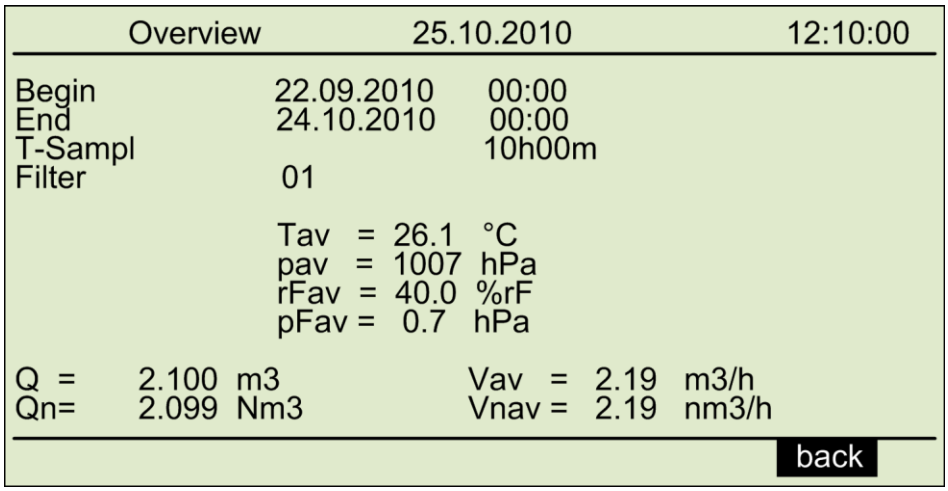


Fig. 27: Data Overview Screen Following Sampling

- Start time for sampling (**Begin**; date and time of day)
- End of sampling (**End**; date and time of day)
- Overall sampling duration in hours and minutes (**T-Sampl**)
- Filter number (**Filter**, only relevant when using a filter changer)
- Average outside temperature during sampling in °C (**Tav**)
- Average air pressure during sampling hPa (**pav**)
- Average relative humidity during sampling in % RH (**rFav**)
- Average pressure differential across the filter during sampling in hPa (**pFav**)
- Volume of air throughput in m³ and scm (**Q** / **Qn**)
- Average volume flow during sampling in m³/h and scm/h (**Vav** / **Vnav**)

Use the Back button to exit the overview screen and return to the main menu.

You can also have the data overview for the most recent sampling cycle displayed retroactively, using the Overview menu item in the **Data** menu.

All the data are automatically stored on the SD memory card (if present).

8. Data Management

The **Data** menu serves to manage the measurement data in internal storage and/or on the SD memory card. You access this menu via the Data menu item in the main screen.

Shown at the right in the screen is the memory usage in bytes. The total free capacity of the data memory is 3.5 MB. The following data and parameters for sampling are automatically stored in the unit's memory, individually for each sampling filter:

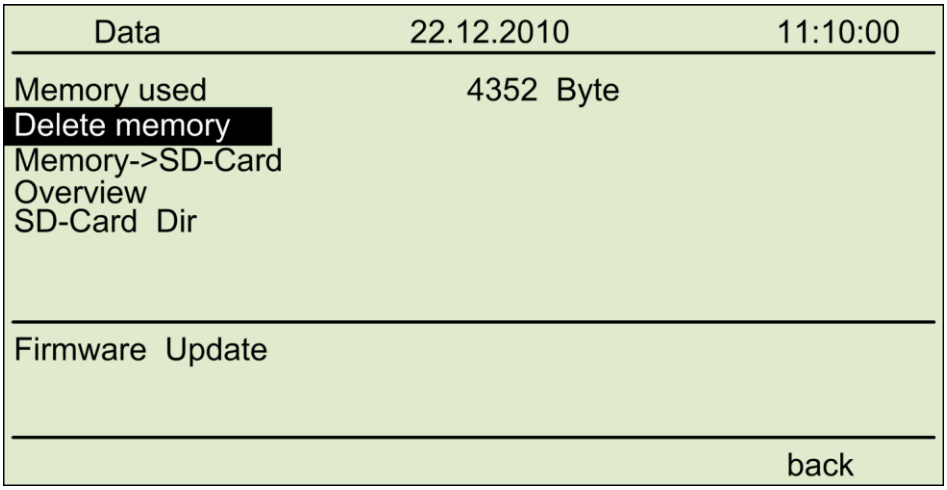


Fig. 28: Data Menu

- Date, start time and duration of sampling
- Unit model and serial number
- Hours in operation and pump motor speed
- Average volume flow during sampling, in m^3/h and scm/h
- Air throughput, in m^3 and scm
- Outside air pressure and pressure differential across the filter
- Temperatures of the outside air, in the sampling chamber, at the orifice plate and at the filter
- Relative humidity
- Filter number
- Operating mode
- Period number and total number of periods
- Any reportable events and errors

The system uses a nonvolatile memory; the data will not be lost if the unit is switched off. If an SD memory card is present in the device, then the data will automatically be written as a text file (CSV file format) on the SD memory card.

In addition, all the data can also be transferred manually from the internal memory to an SD memory card. To do so, select and confirm the menu item Memory->SD card. This function is useful if, for example, no SD memory card was mounted in the unit during sampling.

It is recommended that the internal memory be cleared occasionally. To do so, select and confirm the Delete memory menu item and answer the confirmation message which follows.

It is with the Overview menu item that you call up the data overview screen showing the data for the most recent sampling cycle (Fig. 27).

You can use the SD card dir item to display the data stored on the SD memory card. You can open the .csv text files containing the sampling data and stored on the SD memory card on any PC and use a suitable program such as Microsoft Excel® to view and edit the data.

9. Special Functions

Described below are some of the device's functions that are irrelevant to normal operations but which nonetheless may occasionally be required.

9.1. Updating the Firmware

It may occasionally be necessary to update the equipment's operating program. An SD memory card with the software to be installed is required for this purpose. Please apply to Comde-Derenda GmbH to receive the latest version. Proceed as follows to update the firmware:

1. Mount the SD memory card with the update file in the SD card reader at the upper right hand corner of the control unit.
2. In the main menu, select the Data menu item and confirm by pressing the jog dial.
3. In the **Data** menu, select the Firmware Update item and confirm your choice.
4. Confirm with Yes the query as to whether you want to proceed with the update.

The update will now be installed. A bar appears, showing the progress of the copying procedure. Once the update has run successfully to completion, the display will show **OK**. The unit will then automatically be reset and restarted.

WARNING! The unit must not be switched off while the software is being upgraded. This would cause data loss, the device could no longer be used and it would have to be returned to the factory for repairs before it could be returned to service.

9.2. Calibrating the Flow Sensor

Prior to starting the calibration procedure, allow the system to warm up by selecting a sampling duration of 15 min in the TIME mode menu. Then proceed as follows:

1. Remove the sampling inlet, the filter holder and the air intake tube by proceeding in the reverse order of the assembling process (see 4.2).
2. Connect the reference flow meter to the air intake opening using the respective hose.
3. In the main menu, select Setup and confirm by pressing the jog dial.
4. In the setup menu, select Flow Calibr. and confirm.
5. In the administrator menu, enter code "0000", select OK and confirm.

You will then see the **calibration menu**, in which the currently valid data for 6 calibration points with different flow rates (depending on model) are shown. To accurately calibrate the flow sensor, it will be necessary to check and adjust the settings for all 6 calibration points as described below.

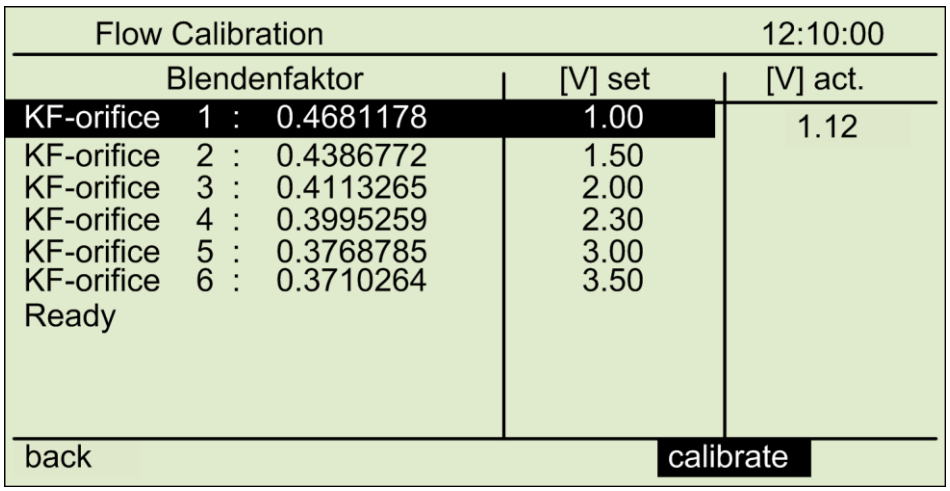


Fig. 29: Calibration Menu (LVS-3.1)

6. Select calibrate and confirm (Fig. 29).

7. Check the values shown for air temperature (**TLuft**) and atmospheric pressure (**Pa**) at the lower right part of the screen (Fig. 30). If these differ from the values indicated by the calibrated reference instrument by more than 2 K resp. 4 mbar, then the temperature and/or pressure sensors will first have to be calibrated or adjusted (see 9.4).

8. Select the first line, KF-orifice 1:, and confirm.

9. Observe the indicator on the external flow meter and adjust the pump motor speed, if necessary, by turning the jog dial until the reading on the flow meter matches the reading under **[V] set**.

10. When the correct value has been reached, press the jog dial for approx. 2-3 seconds to confirm the motor speed setting (the message "**saved**" will flash at the bottom of the screen, Fig. 31).

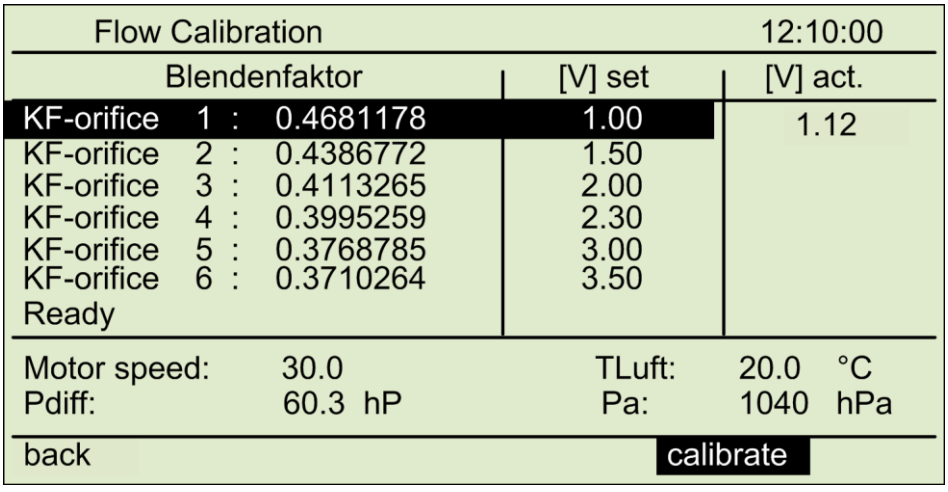


Fig. 30: Adjusting the Motor Speed

11. Repeat steps 8 through 10 for all 5 remaining calibration points.

12. After having adjusted the motor speed settings for all 6 volume flow rates, select Ready and confirm to save the settings.

13. Select and confirm back twice to return to the main menu.

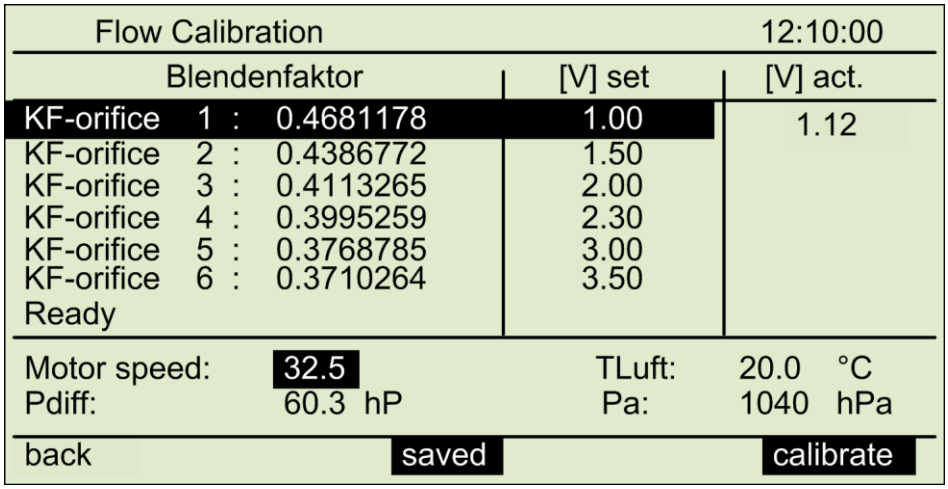


Fig. 31: Saving Your Settings

After finishing the calibration procedure, it is necessary to execute a test run in order to check the settings. To do so, start a sampling cycle in the TIME operating mode and check to see whether the value indicated by the external flow meter corresponds to the flow rates set. If there are discrepancies between the values, then the calibration procedure will have to be repeated.

9.3. System Information and Operating Hours Counter

Proceed as follows to call up the system information:

1. Select the Setup menu item in the main screen and confirm your choice by pressing the jog dial.
2. When in the **Setup** menu select the System info item and confirm your choice.

You will see the following information in the **System information** screen:

- Software and hardware release data
- Serial number and unit number
- Operating hours counter, total and short-term
- CPU part number and revision number
- Date and time of day for the most recent calibration

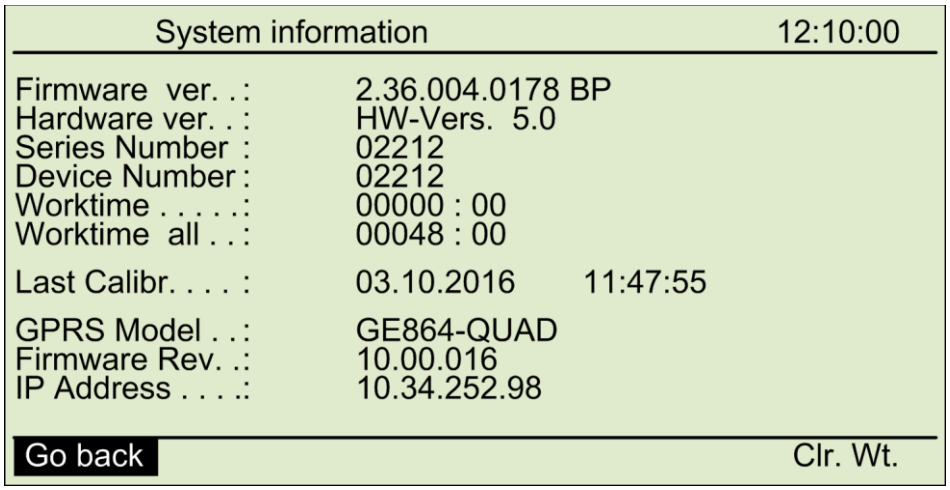


Fig. 32: System Information Screen

There are two operating hours ("worktime") counters, one for the total number of hours and one for shorter terms; the latter can be reset to zero as desired. To reset the short-term operating hours counter, select and confirm the Clr.Wt. button found at the lower right in the **System information** screen. The total operating hours counter can be reset only by the manufacturer. The value shown for the number of hours in operation is of significance for periodic pump maintenance (see 10.2).

9.4. Service Menu

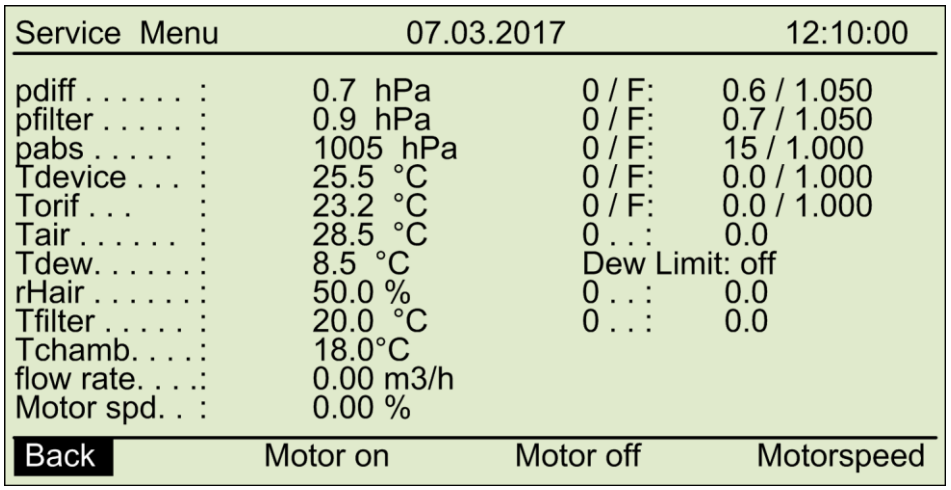


Fig. 33: Service Menu

The **Service** menu is used primarily to check the sensors and for adjustment and maintenance work carried out by service technicians. This menu will not usually be used in normal operations. You access the **Service** menu from the main screen by selecting Setup → Service.

Shown in the **Service** menu are all measured values reported by the unit's sensors together with the corresponding correction parameters. Offset values can be specified on the right half of the window

for most parameters. Here it is also possible to check the pump's motor under manual control of the pump.

Calibrating the individual sensors (temperature, air pressure and relative humidity, especially Tfilter and Tchamb, which can't be influenced by offset values) requires the *PST* software and an external PC. Please contact the Comde-Derenda GmbH for further information.

9.5. Leak Tightness Test

DIN EN 12341:2014 requires the leak rate of the complete flow path of the sampler to be less than 1% of the nominal flow. At a nominal flow rate of 2.3 m³/h, i.e. 38.3 l/min, the maximum permitted leak rate is 0.383 l/min.

9.5.1. Low Pressure Test Method

The low pressure method for testing leak tightness according to section 5.1.7.2 of the above norm requires a pressure drop of at least 400 hPa. The leak rate ϕ_L is then calculated according to the formula below. The test needs to be conducted for a period of 5 minutes, to be repeated 3 times.

$$\varphi_L = \frac{\Delta P \cdot V_{sys}}{P_0 \cdot \Delta t}$$

- Estimated system volume $\mathbf{V_{sys}}$ is 1.2 liters with a standard 800 mm inlet tube, and 4.0 liters with the maximum allowed inlet tube of 3000 mm
- **Δt** is 5 minutes
- $\mathbf{P_0}$ is the starting pressure of typ. 1023 hPa - 400 hPa = 623 hPa
- **Δp** would be 190 hPa if negative pressure drops to 210 hPa

For an ambient pressure range of 800 to 1100 hPa and a system volume of 4.0 liters, a drop of negative pressure from 400 to 210 hPa would equal a leak rate slightly lower than the permitted 0.383 l/min. For a smaller system volume, a drop to 210 hPa would correspond to a significantly lower leak rate.

Fig. 34: Calibration Adapter

9.5.2. Conducting the Leak Tightness Test

Follow the instructions below to conduct a leak test with your device. The required accessories (calibration adapter and closure plug) can be obtained from Comde-Derenda GmbH.

NOTE: In order to successfully conduct this test, your device must be equipped with a valve (automatic check valve or manual ball

valve), installed between the pump and the flow sensor. Devices delivered in or after October 2014 are all equipped with a valve. Please check which kind of valve is installed in your device. If you are uncertain, please contact Comde-Derenda GmbH.

1. Remove the impactor head from the upper end of the air intake tube by unfastening the two retainer clips at either side.

2. Place the calibration adapter (Fig. 34) onto the upper end of the air intake tube and fix it in place with the retainer clips.

3. Select the Setup menu in the main menu and press the jog dial to confirm.

4. Load a filter cartridge, loaded with a filter, into the sampling chamber.

5. In the **Setup** menu, select the Leak Test item and confirm the pop-up prompt by clicking on Yes.

6. In the **Leak Test** menu (Fig. 35), select Pump to start the pump.

7. Wait until the value in the line **Sampling chamber underpressure** has reached slightly more than 400 hPa.

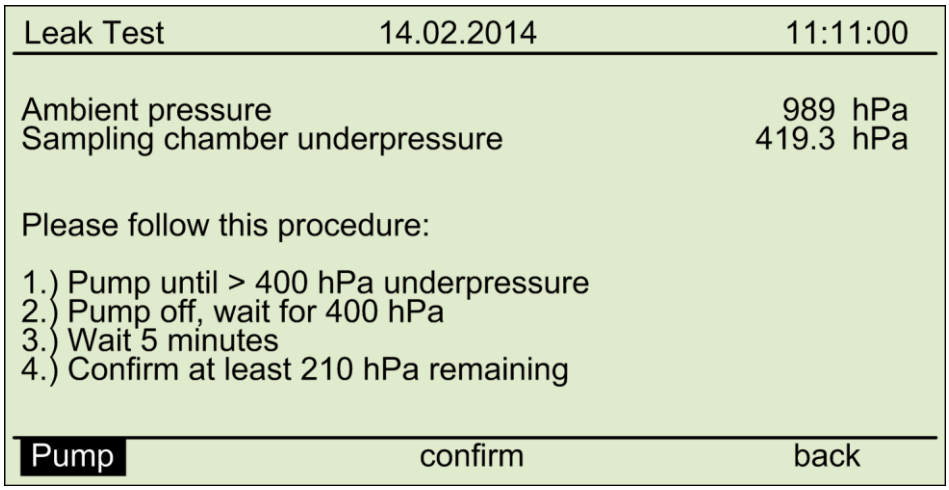


Fig. 35: Leak Test Menu

8. Only if device is equipped with a manual ball valve: Close the ball valve with the red handle (located inside the device between pump and flow sensor).

9. Shut off the pump by clicking on the menu item Pump again.

10. Wait until the negative pressure has reached exactly 400 hPa.

11. Wait for 5 minutes and then note the exact value in the line **Sampling chamber underpressure**.

12. If the value shown is 210 hPa or higher, the device has passed the first test run. Select confirm and acknowledge the pop-up prompt by clicking on OK.

13. Only if device is equipped with a manual ball valve: Open the ball valve. **Important:** Make sure the valve is open before resuming normal operation to avoid damage to the device.

14. In order to finish the complete test as specified in EN 12341:2014, repeat the test procedure (steps 8-14) two more times (for a total of three test runs).

If the value is lower than 210 hPa after any of the three test runs, the device has failed the leak tightness test. In this case, please get in touch with Comde-Derenda GmbH.

10. Maintenance

10.1. Sampling Inlet (PM_{10} and $PM_{2,5}$)

The sampling heads comprise essentially three parts:

1. Multijet unit with jet tubes, flow plate, cover and insect screen
2. Tubular casing
3. Impactor unit with air intake tube, baffle plate, receptacle for rainwater that has entered the system and drain screw

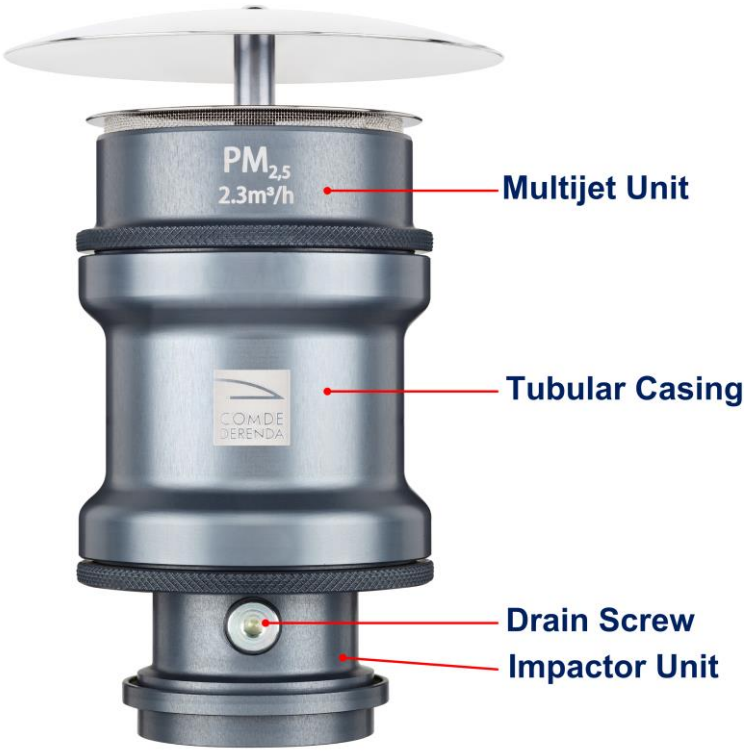


Fig. 36: PM2.5 Sampling Inlet

The inside of the tubular casing, the intake side of the multijet unit, the baffle plate (Fig. 39) and the jet tubes (Fig. 37 and Fig. 38) will have to be cleaned with alcohol after three to five and at the latest after fifteen to twenty sampling cycles, depending on the contaminant level. The insect screen needs to be checked for obstructions regularly and should be cleaned if necessary.

In preparation for cleaning the sampling inlet, the multijet unit and the impactor unit can simply be unscrewed from the tubular casing.

Fig. 37: Multijet Unit (Top)

Fig. 38: Multijet Unit (Bottom)

After cleaning, the baffle plate is to be lubricated with high-vacuum silicone grease (medium) or Vaseline (Fig. 39). To improve slip, the O-rings of the multijet unit and of the impactor unit are to be lubricated, as well. Vaseline is more suitable for this purpose, given the great viscosity of the high-vacuum silicone grease.

Fig. 39: Baffle Plate (Greased)

10.2. Vacuum Pump

The vacuum pumps in this equipment use no oil. It is important to ensure that these pumps do not draw in any liquids such as water or oil. Therefore the unit should not be set up near systems that could emit air containing oil fumes, for instance.

Moreover, the devices should only be operated with a filter in place. This keeps foreign objects from getting into the pump.

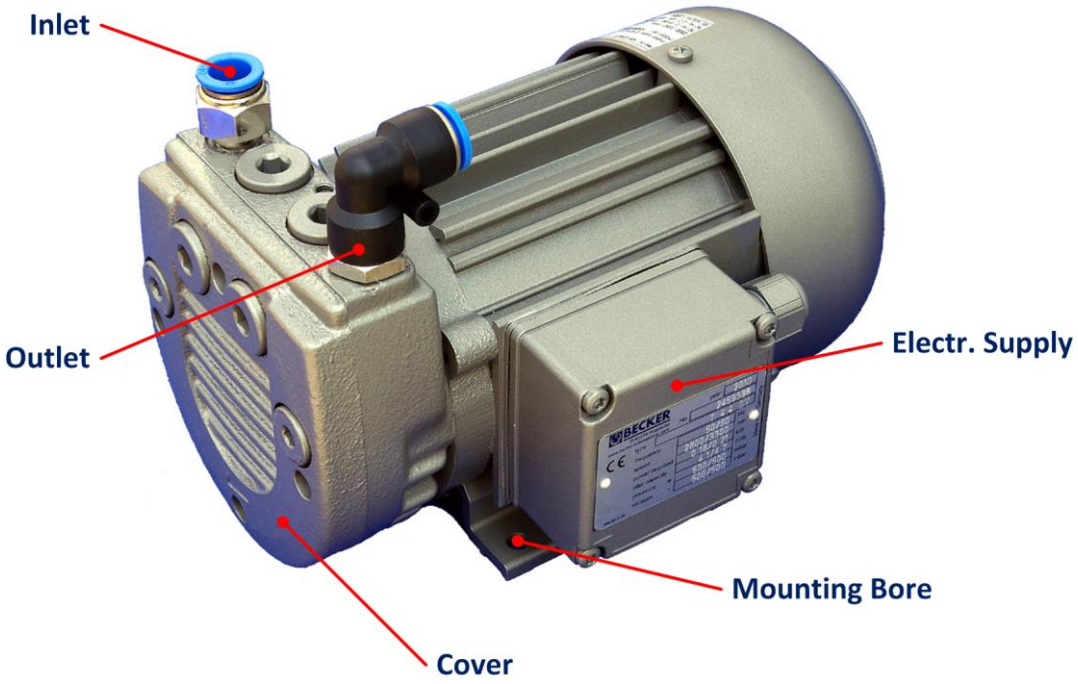


Fig. 40: Design of Vacuum Pump VT 4.4

10.2.1. Removing and Reinstalling the Pump

Proceed as follows to remove the pump:

1. Remove the discharge filter by removing the hose clamps. (The hose clamps can be released by pressing the plastic ring downward. The hose can then be pulled out.)

2. Remove the length of hose from the coupler at the pump inlet.

3. Detach at the 5-pole plug connector the cable joining the pump and the frequency converter unit. (This is located at the upper right in the unit when seen from the rear, and is secured by two screws.) Use a size 1, flat-tip screwdriver to remove the screws. Then carefully remove the cable from the pass-through hole.

4. Remove the mounting nuts at the pump (four nuts on the end of the pump, 10 mm wrench). **Important:** The ground wire is attached at one of the nuts.

5. Remove the pump by lifting and tipping it out of the unit.

Install the pump in reverse order. Ensure that the ground wire is attached correctly.

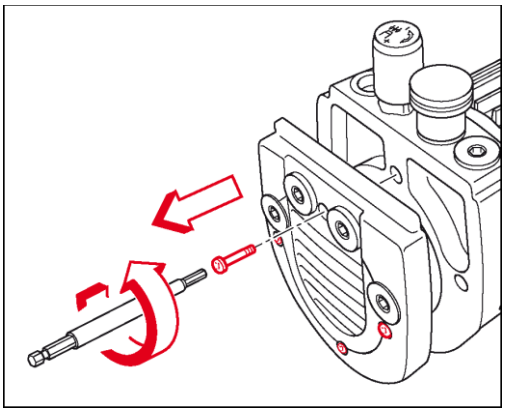


Fig. 41: Removing the Pump's Cover

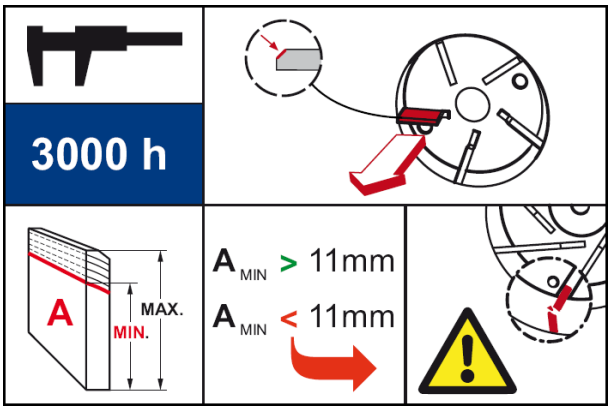


Fig. 42: Checking the Rotary Vanes

10.2.2. Rotary Vanes

The pumps use rotary vanes made of carbon. These will wear in the course of operation. That is why the dimensions will have to be checked after a certain number of hours in service. These vanes are to be replaced when the width reaches the specified minimum.

The width of the rotary vanes in the LVS 3.1 will have to be checked after every 3,000 hours in operation, in the MVS 6.1 every 6,000 hours. The number of operating hours the pump has accumulated can be read in the **System information** screen (Fig. 32).

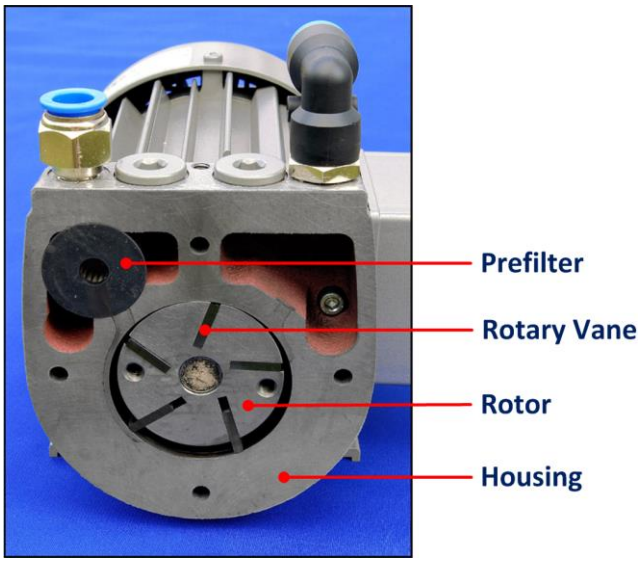


Fig. 43: Pump with Cover Removed

Minimum widths of the rotary vanes:

- LVS 3.1: 11 mm (pumps made by Becker)
- MVS 6.1: 10 mm (pumps made by Rietschle)
- MVS 6.1: 12.5 mm (pumps made by Becker)

Fig. 44: Prefilter

The pump housing will have to be opened in preparation for carrying out maintenance work for the rotary vanes. To do so, the four fixing screws (4 mm Allen wrench) holding the cover are removed; the cover can then be removed from the pump (Fig. 41).

The pump's prefilter and the rotary vanes are now accessible and can be removed from the pump for inspection and/or replacement (Fig. 43).

When reinstalling the rotary vanes it is important to ensure that these are oriented correctly (chamfered edge in the running direction, see Fig. 42).

10.2.3. Pump Prefilter

If there is a decline in pump displacement that cannot be attributed to insufficient width of the rotary vanes, then the prefilter on the intake side of the pump may have to be cleaned or replaced.

Removing the cover at the end of the pump housing (Fig. 41) makes the prefilter accessible, which can then be removed (Fig. 45).

The filter can be cleaned with compressed air. If the filter is heavily soiled, then it should be replaced.

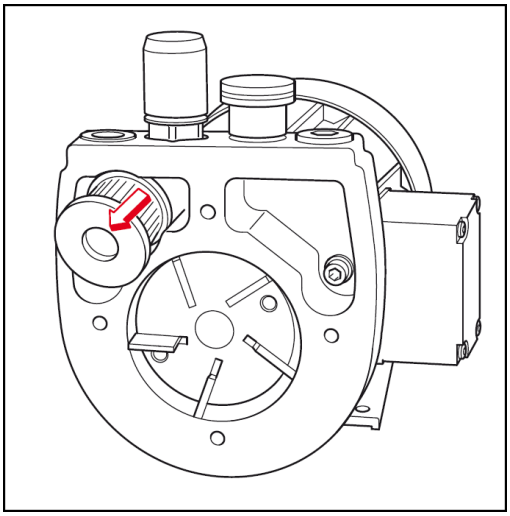


Fig. 45: Removing the Prefilter

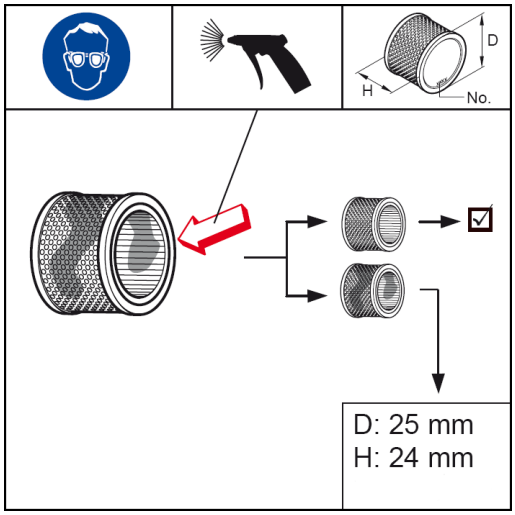


Fig. 46: Cleaning the Prefilter

10.2.4. Discharge Filter

The rotary vanes in the pump wear continuously during pump operation. This generates fine dust particles. A separator filter is located between the pump's outlet and the device's air discharge port. This keeps the dust arising from wear from being discharged to the outside atmosphere.

Fig. 47: Discharge Filter

To check the condition of the discharge filter, the filter needs to be removed from the unit. To do so, the first step is to release the connector hoses from the couplers. Then the hoses can be pulled off the filter. The hoses should be cleaned to remove any particles before reassembling them. Pay attention to the correct direction of flow when installing the filter. This is indicated by an arrow on the filter housing.

The discharge filter is to be replaced every 5000 hours in service.

11. Transfer Protocol

11.1. Bayern-Hessen-Protokoll (Bavaria-Hesse-Protocol)

11.1.1. Interface Definition “Serial Measuring Instruments”

Being used ever more frequently in pollution measurement networks are intelligent, microprocessor-controlled measurement units fitted as standard equipment with an interface to transfer measurement data, operational status information and error status.

To ensure trouble-free attachment of a wide variety of equipment, a standard interface is described below, similar to the “50-pole data plug” described in the “Standardization Recommendation for Automated Air Quality Control Measurement Networks”.

11.1.2. Interface Specification

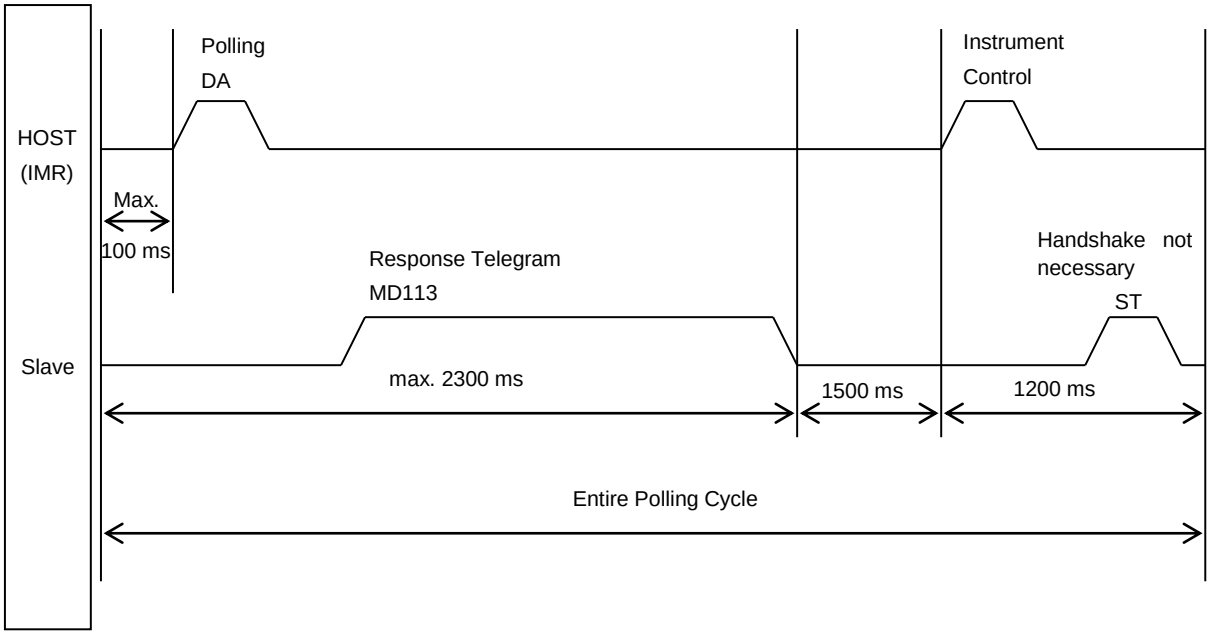
Asynchronous-serial Data Transfer

Baud Rate:	1200 Baud
Data Format:	1 Start Bit
	8 Data Bits
	1 Stop Bit
Handshake:	Full-duplex Operation; Polling Method (MSR = Master)
Connector:	9-pole SUB-D-Connector with the PIN configuration:
	PIN 02: TxD Send Data (Off)
	PIN 03: RxD Receive Data (On)
	PIN 05: GND Ground
Voltage Level:	According to norm V24; not potential-free
	For Data Lines (RxD, TxD):
	-15 to – 3V for logical HIGH
	+3 to + 15V for logical LOW

11.1.3. Data Transfer

Data transmission (MSR ↔ measurement unit) is effected using standardized blocks, each secured with a block check character (BCC).

The characters transmitted here are taken from the USASCII standard character set (0-9, A-Z); check characters are added to the block to facilitate error detection. Maximum block length at present is 256 characters (including control characters and protocol frame).



11.1.4. Transfer Protocol

Data transmission between the measurement point and the MSR takes place in accordance with a strict master-slave procedure. The measurement site itself never initiates contact with the MSR.

The MSR transmits commands to the measurement site, which then responds with an answer block. All the commands contain an address, i.e. the measurement unit identifier. The addresses can be used to address either the entire measurement site or individual measurement units at the measurement site.

Response blocks also contain from one to four measurement device identifiers for the purposes of identification and allocation. See section 0 for the definitions of the individual message blocks.

Data Protocol Structure:

Byte 001:	STX (Start of Text)
Byte 002-nnn:	<TEXT>; Message Text; max. 120 Characters; USASCII coded
Byte nnn+1:	ETX (End of Text)
Byte nnn+2/3:	BCC (Block Check Character)

The response from the measurement site is always in the same format as that of the command it received.

Data Polling

The data registered at the measurement site are transmitted to the MSR in response to a polling request. A polling data block can be used to query either a single measurement unit or all the measurement units connected at a measurement site.

Data Transmission

The data registered at the site are transferred by way of a response message. Where the measurement site has multiple measurement units, the individual values will all be compiled into a single message.

11.1.5. Generation of the Block Check Character

The block check character (BCC) is generated by forming, byte by byte, the exclusive-or sum of all the characters transmitted (including STX and ETX), starting at $00. The result byte block (checksum) thus created is transmitted in hexadecimal code wherein the upper nibble of this byte is transmitted as BCC1 and the lower nibble as BCC2.

The ASCII value range of from 0 to 9 and from A to F (capital letters) is permissible for the BCC bytes so that the nibbles can be expressed in hexadecimal notation.

11.1.6. Telegrams „Serial Measuring Instruments“

In the blocks cited below the required blanks are depicted with a pound sign (#).

The block control characters and the BCC characters are enclosed in <> for emphasis.

11.1.6.1. Data Polling of the Measuring Station

Block Identifier: **DA**

Telegram Length: Variable
Telegram Type: Command

Field No.	Start-Byte	Data Format	Description
1	1	<STX>	Start of Text
2	2	DA	Block Identifier
3	4	<ETX>	End of Text
4	5	<BCC1>	Low Nibble BCC
5	6	<BCC2>	High Nibble BCC

11.1.6.2. Measuring Station Data in Reply to DA

Field No.	Start-Byte	Data Format	Description
1	1	<STX>	Start of Text
2	2	MD	Block Identifier
3	4	nn#	Number Measuring Units
4	7	nnn#	Measuring Unit ID
5	11	±nnnn±ee#	Measured Value
6	20	hh#	Operation Status
7	23	hh#	Error Status
8	26	nnn#	Serial Number
9	30	hhhhhh#	Not assigned
10	37	nnn#	Measuring Unit ID #2 (optional)
11	41	±nnnn±ee#	Measured Value
12	50	hh#	Operation Status
13	53	hh#	Error Status
14	56	nnn#	Serial Number
15	60	hhhhhh#	Not assigned
16	67	nnn#	Measuring Unit ID #3 (optional)
17	71	±nnnn±ee#	Measured Value
18	80	hh#	Operation Status
19	83	hh#	Error Status
20	86	nnn#	Serial Number
21	90	hhhhhh#	Not assigned
22	97	nnn#	Measuring Unit ID #4 (optional)
23	101	±nnnn±ee#	Measured Value
24	110	hh#	Operation Status
25	113	hh#	Error Status
26	116	nnn#	Serial Number
27	120	hhhhhh#	Not assigned
28	127	<ETX>	End of Text
29	128	<BCC1>	Low Nibble BCC
30	129	<BCC2>	High Nibble BCC

Telegram Identification: **MD**

TelegramLength: Variable
Telegram Type: Response

12. Troubleshooting

12.1. Error Messages

Malfunctions that cause sampling to be terminated may in rare cases be encountered while the LVS / MVS is in operation. Generally in such a case a malfunction message will appear in the center of the display screen. This message provides information as to possible causes of the problem and options for rectifying the problem. The individual error messages are explained in greater detail below.

12.1.1. *PFmax Cancel*

When will this message appear?

This message appears if the air pressure at the filter exceeds a predetermined limit value and sampling is terminated to protect the pump.

What might cause such a malfunction?

- The sampling filter is so heavily laden with dust that it no longer lets enough air pass.
- The sampling filter is wet or dirty.
- The air intake to the unit is blocked.

How can this malfunction be rectified?

- Check the condition of the sampling filter and replace it if indicated.
- Check the sampling inlet and air intake tube for blockages caused by foreign objects and remove them if found.
- If this does not eliminate the problem, then please get in touch with Comde-Derenda GmbH.

12.1.2. *PFmin Cancel*

When will this message appear?

This message appears if the air pressure at the filter falls below a predetermined limit value (see 5.6.4) and sampling is terminated.

What might cause such a malfunction?

- There is no filter cartridge with filter present.
- There is no sampling filter in the cartridge.
- The sampling filter is damaged.
- There is a leakage and the device intakes infiltrated air.

How can this malfunction be rectified?

In the TIME or QUANTUM mode, the sampling process stops automatically. In PERIOD mode the sampling process stops and will automatically resume according to parameterization with the next filter. If the problem occurs:

- Check if a sampling filter is in the cartridge and a cartridge is present;
- Check the connections of the pump.
- Otherwise please get in touch with Comde-Derenda GmbH.

12.1.3. Power Failure During Sampling

If the power should temporarily fail during sampling, then the sampling cycle will be automatically resumed and continued as previously specified in the parameters as soon as the power supply is re-stored. The fact that sampling was interrupted by a power failure is indicated by a note in the events field in the operating screen (see Fig. 26 and 7.1). In addition, the duration of the power outage can be determined on the basis of the sampling data.

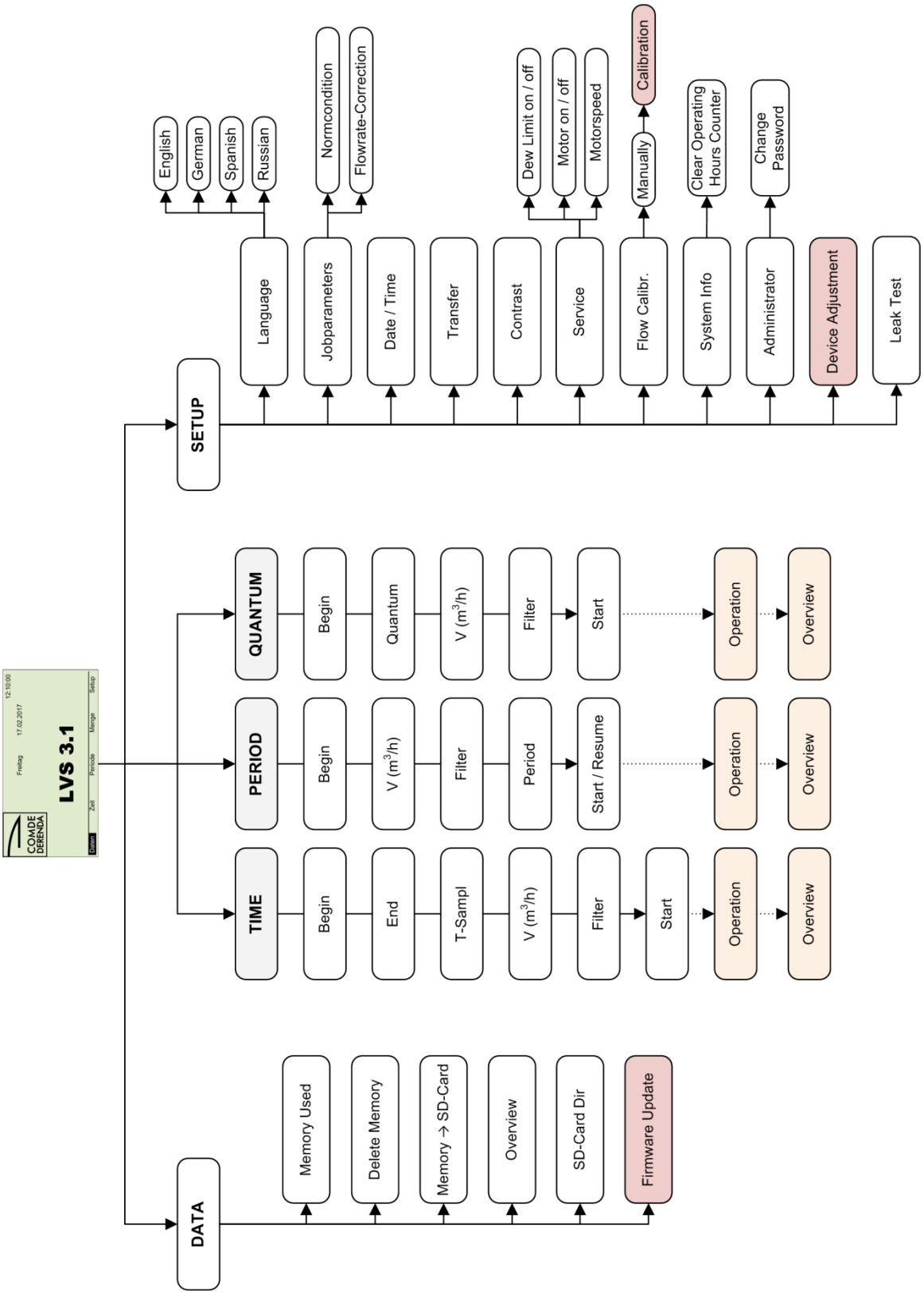
13. Technical Specifications

Volumetric flow rate	LVS 3.1	1.0 … 3.5 m³/h (resp. scm/h)
	MVS 6.1	1.0 … 5.5 m³/h (resp. scm/h)
Nominal flow rate		2.3 m³/h
Constancy of sample volumetric flow	Sampling time (averaged flow)	≤ 2 %
	Rated flow (instantaneous flow)	≤ 5 %
Sampling duration		1 min … 1000 h
Pause between samplings		0 min … 1000 h
Supply voltage		230 V, 50/60 Hz
Power consumption	LVS 3.1	approx. 240 VA
	MVS 6.1	approx. 300 VA
Filter diameter		47 mm (50 mm optional)
Diameter of usable surface		41 mm
Dimensions		300 x 450 x 250 mm (BxHxT)
Length of intake pipe		500 mm
Weight	LVS 3.1	approx. 17 kg
	MVS 6.1	approx. 19 kg
Housing material		Stainless steel
Interfaces		2 x RS232; 1 x SD card drive; 1 x GPRS (optional)
Memory	Internal / external	4 MB / 2 x 128 MB
Noise level (according to DIN EN 3744:2010)		< 35 dBa
IP classification		IP 55
Operational range (temperature)		-30 … +50 °C
Temperature of filter during sampling (for ambient temperatures ≥ 20 °C)		Ambient temperature ± 5 °C
Operational range (humidity)		0 … 100 % RH
Leak tightness of the sampling system		ϕL ≤ 1.0 % of sample flow rate
Uncertainty (95 % confidence) of sampling time measurement		≤ 5 min
Uncertainty (95 % confidence) of sensors for ambient and internal (filter during sampling; filter during storage) temperature measurement		≤ 3 K
Uncertainty (95 % confidence) of sensor for ambient pressure measurement		≤ 1 kPa

14. Accessories and Spare Parts

Item	Item Number	Remarks
Sampling Inlet for PM_{10}	D100868	for 2.3 m³/h
Sampling Inlet for $PM_{2.5}$	D100869	for 2.3 m³/h
Sampling Inlet for $PM_{2.5}$	D100870	for 1.0 m³/h
Sampling Inlet for PM_{1}	D100871	for 2.3 m³/h
Calibration Adapter	D100930	
Sensor for Temp. & rel. Humidity	D110030	Incl. Cable, 1.5 m
Filter Cartridge	D110030	Ø 47 mm
Prefilter for Pump	D100891	For Pump Model VT 4.4
Carbon Vanes	D100890	Pack (5 Pcs.) for Pump VT 4.4
Discharge Filter	D100058	
Prefilter for Pump	D100035	For Pump Model VT 4.8
Carbon Vanes	D100034	Pack (5 Pcs.) for Pump VT 4.8
Magazine for 18 Filters	D100017	Cartridges not included
Magazine for 24 Filters	D100122	Cartridges not included
SD Memory Card (2 GB)	D100004	Other capacities available
SD Card Reader	D100005	
Protective Cover for the External Sensor	D100632	

15. Appendix A: Menu Structure of LVS/MVS



16. Index

Ed. 08/2017