GASERA

GASERA ONE

User Manual

GASERA ONE

Document Information:
Product name: GASERA ONE
Title: GASERA ONE User Manual
Version: Rev. e
Release: March 2018

Device versions:
UI version: 1.9.1

Publisher
Gasera Ltd., Finland
Web: http://www.gasera.fi
Email: support@gasera.fi

Warranty Information
Information presented in this document are not guaranteed declarations.

Table of contents

1. Preface

GASERA ONE is a single or multi-gas analyzer for continuous gas measurements. GASERA ONE is delivered with a light source optimized for the application. The sample gas is taken into the instrument from the sampling point through a tube. The internal pump draws the sample gas through the instrument. The analyzer measures and analyzes the infrared spectrum of the sample gas using a photoacoustic sensor based on the cantilever-enhanced optical microphone patented by Gasera. Concentrations of the gas components are extracted from the spectrum and displayed to the user, and furthermore stored to internal memory.

This document must be read carefully before performing any operations with the analyzer.

The Gasera product, that the document is describing, can change without prior notice as a consequence of product development practices. In case of questions or inconsistencies between your device and documentation, please contact Gasera customer support as instructed in chapter 11.

The device may not be altered in any way unless specified by the manufacturer. Altering the instrument, will void the warranty by the manufacturer and may make the instrument dangerous to use.

GASERA ONE should be used only by personnel who have the necessary technical training and knowledge as well as knowledge of the regulations affecting the use, and who can recognize the possible hazards involved.

The device must be used only as described in this User Manual. The manufacturer does not take responsibility for any other use.

The device should be maintained as described in this manual. All other maintenance and service must be performed only by a trained service person or the manufacturer.

Local laws, rules and operating directives must be followed when operating this instrument.

Product name:	GASERA ONE
Product model:	Described in the nameplate on the rear panel
Product serial number:	Described in the nameplate on the rear panel
Manufacturer:	Gasera Ltd.
Country of manufacture:	Finland

2. Safety

The GASERA ONE Single- and Multi-Gas Analyzer complies with IEC/EN 61010-1:2010 safety requirements for electrical equipment for measurement, control, and laboratory use. To ensure safe operation, follow the instructions below.

- EXPLOSION HAZARD! To avoid the possibility of an explosion, monitoring of flammable gases in explosive concentrations must never be attempted.
- Do not operate the instrument in a potentially explosive environment.
- When monitoring gases that may have health effects, always follow local laws, rules and operating directives.
- The instrument contains a laser product. An open instrument should not be used under voltage.
- If the function or the operating safety of the instrument has been deteriorated, the instrument must be made inoperative and secured against unintended operation.
- If the instrument gives a failure notification that indicates that its correct function may be deteriorated, consult your local Gasera representative or Gasera customer support. Under no circumstance should repair be attempted by a person who is not qualified in the service of GASERA ONE products.
- Any adjustment, maintenance or repair of the instrument, other than as instructed in this manual, must be carried out only by trained service personnel.
- Before using the instrument, verify that the available mains voltage meets the instrument technical specifications, and that the correct fuse is installed.
- The instrument should be positioned so that easy access to disconnecting the device is possible.
- Turn off all electrical equipment before connecting/disconnecting to the instrument. Failure to do so can damage the equipment.
- If the instrument has been transferred to a warmer and more humid environment, condensation may occur inside the instrument. To prevent shorts, let the instrument warm up about an hour to avoid any failure due to the condensation.
- Never allow the absolute pressure of the incoming gas to exceed 2.0 bar.
- If the instrument has been measuring wet gas, flush the gas line and the sample cell with dry gas before turning it off or continuing the actual measurements.
- If corrosive compounds are measured, the sample concentration must not exceed 15 ppm in continuous measurements.
- Never connect GASERA ONE to an unsafe network or internet access without a firewall. Before connecting the instrument to the network, please consult a trained network administrator.
- Equipment shall only be used according to manufacturer's instructions. Equipment safety is impaired if not used according to manufacturer's instructions.

3. Product information

3.1. Product sales package contents

- GASERA ONE analyzer product
- Mains cable
- 2 pcs of particle filters
- GASERA ONE User Manual
- Test sheet

3.2. Product technical specification

Pressure sensor: Patented ultra-sensitive optical microphone based on a MEMS cantilever sensor coupled with a laser interferometer to measure microscopic movement of the cantilever sensor.

Total internal gas volume: approx. 30 ml (depends on the model)

Materials in direct contact with the sample gas:

- Viton (FPM, fluoroelastomer rubber, used in O-rings)
- NBR (nitrile rubber)
- BaF_2 (optical window)
- SiO_2 glass (optical window)
- Gold (PA cell)
- Brass (gas inlets)
- Nickel (gas exchange unit block, tube connectors)
- PTFE (tubes, particle filters)
- Anodized aluminum
- Stainless steel
- Polyurethane, PU (exhaust)
- Nafion™ (only in selected models)

Weight: approx. 13 kg (depending on the model)
Dimensions: 48.4 cm W x 13.9 cm H x 40.5 cm D (19.1 in W x 5.5 in H x 16.0 in D)

Operational conditions:
Operational temperature range: 0°C…+40°C
Operational humidity range: Below 90% RH (non-condensing)
Pressure range: ambient level
Dust/water resistance: IP20 (IEC 529)

Sample gas conditions:
Temperature: 0°C…+49°C
Humidity: non-condensing
Pressure: 750 mbar…1050 mbar
Gas flow: approx. 1 liter/minute

Electrical:

- Input voltage: 100…240 Vac, 50…60 Hz
- Input power: 100 W max.

Safety standards: IEC/EN 61010-1:2010, CAN/CSA-C22.2 No. 61010-1 (2012), ANSI/ISA-61010-1 (82.02.01), UL 61010-1 and IEC 60825-1

EMC standards: EN 61326-1:2013, EN 61000-3-2:2006, EN 61000-3-3:2008

3.3. Product models

Table 1 presents models of GASERA ONE. The updated list of available GASERA ONE models can be retrieved from Gasera website at www.gasera.fi. Overview of models and technologies is given in Appendix A on page 81.

Table 1. GASERA ONE models and technologies

Model	Technology	Light source
GASERA ONE Pulse	NDIR-PAS	Electronically pulsed miniature broadband IR source and optical bandpass filters
GASERA ONE Chopper	NDIR-PAS	Mechanically chopped broadband IR source and optical bandpass filters
GASERA ONE EC-QCL	TDL-PAS	External cavity quantum cascade laser (EC-QCL)
GASERA ONE DFB Laser	TDL-PAS	Distributed feedback Bragg grating (DFB) tunable diode laser
GASERA ONE QCL	TDL-PAS	Quantum cascade laser (QCL)
GASERA ONE FORMALDEHYDE	TDL-PAS	Quantum cascade laser (QCL)
GASERA ONE SHED	TDL-PAS	External cavity quantum cascade laser (EC-QCL)
GASERA ONE Tradeshow Demo	N/A	This model is for demonstration purposes and cannot perform real measurements. It has no light source.

3.4. Product overview

GASERA ONE is available as a 19-inch rack-mounted instrument with connectors accessible from the front and back panels.

3.4.1. Front panel

The front panel contains a display, a rotatable button called the GASERA ONE button and a USB connector. The front panel is presented in Figure 1. The user can control the device with the button. Use of the button is explained in chapter 5 on page 20. The USB port is used for connecting an external USB data storage device for data transfer or software update.

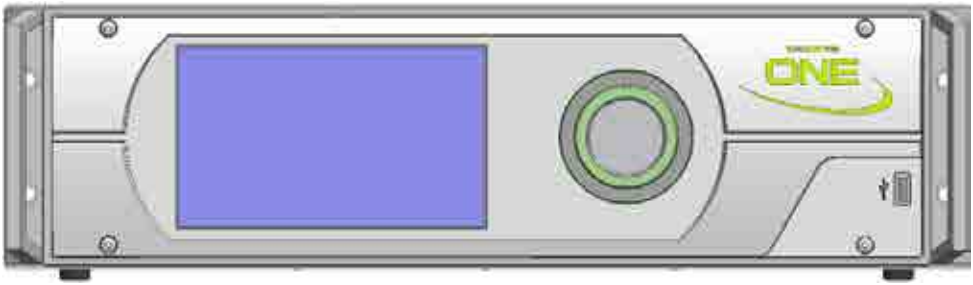

Figure 1. Front view of GASERA ONE.

3.4.2. Rear panel

The rear panel contains a cooling fan, mains connector, power switch, RJ-45 Ethernet connector and gas connectors. The layout of the rear panel depends on the model. Rear views of commercially available models are presented in Figure 2 and Figure 3.

Figure 2. Rear view of GASERA ONE EC-QCL. The gas connectors are in the middle of the rear panel. The Ethernet connector, mains connector and power switch are on the bottom right corner.

Figure 3. Rear view of GASERA ONE Pulse, GASERA ONE Chopper and GASERA ONE DFB. The gas connectors are in the left side of the rear panel. The ethernet connector, mains connector and power switch are on the bottom right corner.

3.4.3. Gas connectors

The connectors for the gas are:

- SAMPLE 1 IN: The first connector with a particle filter for an incoming gas sample
- SAMPLE 2 IN (model dependent): The second connector with a particle filter for an incoming gas sample
- SAMPLE OUT: Connector for the exhaust gas
- PURGE: Connector for purging the optical path inside the device. The purge option is available only in selected models.

Gas connector type, requirements for gas tubes and instructions for connecting the tubes are outlined in chapter 4.2 on page 12.

3.4.4. Electrical connectors

GASERA ONE has a USB connector, mains power connector and Ethernet connector (RJ-45). Mains voltage rating is given in the product label near the mains connector.

If the device is ordered with optional connections, e.g., for multi-sampler use, there are special connectors for it. The multi-sampler is described in Appendix A on page 81 .

4. Installation: starting up and shutting down

4.1. Installation of device on site

The installation should follow requirements concerning operational conditions listed in chapter “3.2. Product technical specification”, and also safety listed in chapter 2. Not following these requirements may void the warranty by the manufacturer.

GASERA ONE Single- and Multi-Gas Analyzers include a highly sensitive pressure sensor for detecting small pressure pulses inside the closed sample cell, which are generated by the absorption of modulated infrared light in the sample gas. To achieve an optimal signal-to-noise ratio, high amount of vibrational noise should be avoided.

The device is intended to be used under laboratory, light-industry, or clean-industry conditions. It will not tolerate direct contact with water, high amounts of dust or heavy vibration.

The device can be assembled either in a 19-inch standard instrument rack or on a solid surface capable of supporting the device in a horizontal position with a maximum inclination of ten degrees in any direction. In any case, a sufficient space in the back of the device must be secured for the gas tubes and for the mains cable. When assembled in a rack, the handles must be removed, and the device must be mounted in the rack with screws. In the rack assembly, it is recommended that other instruments producing lot of heat not be installed directly underneath the device.

If multiple devices are stacked, proper ventilation must be provided. The instrument mains power switch is in the back; thus, it is recommended to arrange easy access to the switch.

> **!**
>
> The device is equipped with a mechanical vibration isolation system. Tilting of the unit will reduce the efficiency of the vibration damping resulting in reduced accuracy of measurement data.

Device is ready for operation after it is powered to mains. It is recommended to not power the device until gas line installation is completed.

If the instrument has been transferred from a cold environment to warmer and more humid conditions, condensation may occur inside the instrument. To prevent shorts and other malfunctions, do not switch power on before letting the instrument warm up to the new environment for about half an hour. For efficient removal of the condensed water inside the sample cell, see instructions how to flush the sample cell in chapter 4.2.3 on page 16.

4.1.1. Automatic transport lock (most models)

Most models of GASERA ONE are equipped with an automatic transport lock system, which is deactivated only for measurement and calibration time. The purpose of the transport lock is to secure the analyzer internals for shipment. In order for the automatic transport lock to operate correctly, the user must follow the shutdown procedure from chapter 4.3.3.

4.1.2. Manual transport lock (some models)

Some models of GASERA ONE product are protected with a manual transport lock to secure the analyzer during the shipment. For these models, the transport lock must be removed manually when installing the device on site and before starting up the analyzer.

Transport lock, as presented in Figure 4, is located at the bottom plate of the analyzer and includes 4 M4x25-mm stainless steel screws with hexagonal nut. To remove the transport lock, a hex head wrench of 2.5 mm is needed.

The lock can be removed in the following steps:

- Place the analyzer on a rigid table, upside down.
- Locate transport lock screws with hexagonal nuts. Depending on the model, there are 3 or 4 screws. Please refer to Figure 4.
- Unscrew transport lock screws and store them for possible future use.
- Place the analyzer back to normal position facing upwards.

Figure 4. Location of transport screws on the bottom of the GASERA ONE analyzers. This model has four screws, but some models have three.

If available for the model, the manual transport lock must always be used when shipping the unit.

4.2. Gas line installation

4.2.1. Instrument gas flow

Internal gas lines of GASERA ONE products are illustrated in Figure 5. There is two separate gas lines:

1. Line for sample gas
2. (optional) Line for purging the Measurement Unit

The diagram is simplified for illustrative purposes.

Gas Management Unit in the sample gas line exchanges the sample gas and adjusts the sample pressure in the photoacoustic cell. The vacuum pump and pressure sensor are in this unit.

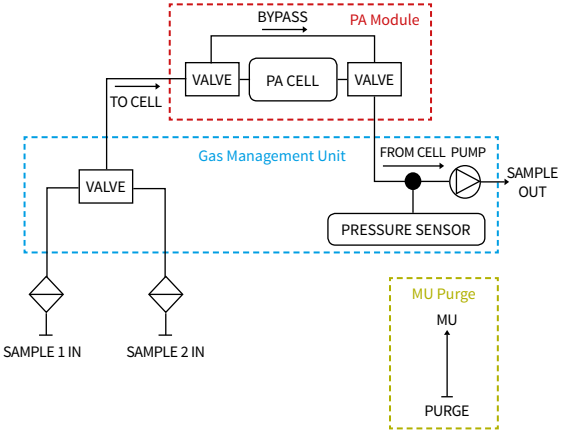

Figure 5. GASERA ONE internal gas lines.

PA Module has the photoacoustic cell and a bypass line which can be used to ensure that the sample taken to the cell is as fresh as possible. The input valve for sample gas is attached directly to the cell, to minimize the distance from the sampling point to the sample cell. For setting the gas exchange, see chapter 8.3 on page 48.

Purge line is available only for selected GASERA ONE models. If available, purge line has tubing from the rear panel to the Measurement Unit. This line has no valves or other active components.

Internal gas tubes are typically polytetrafluoroethylene (PTFE) except for the pressure-sensor tube, which is short polyurethane (PU). The filters right after SAMPLE 1 IN and SAMPLE 2 IN are located inside particle filter cartridges in the rear panel.

4.2.2. Setting up gas line

The location of gas connectors for specific instrument models is presented in 3.4.3 on page 10. When connecting gas to the instrument, always refer to instructions provided by connectors, fittings and tubing producers.

The incoming sample gas should be connected to SAMPLE 1 IN or SAMPLE 2 IN. Sampling input selection can be set for individual measurement as a Measurement Task parameter (sampling input port) and can be set individually for specific measurement. SAMPLE 1 IN is configured as a default sampling input.

> **!**
>
> To ensure the reliability of the results, the incoming sample gas pressure should not exceed 1050 mbar. Do not allow the incoming gas pressure to ever exceed 2.0 bar.

The exhaust gas line should be connected to SAMPLE OUT gas connector. It is recommended that the exhaust gas be conducted to the output of the room ventilation or in a similar way to minimize any possible health effects of harmful gases. If the exhaust gas line is not connected, the device will discharge the incoming gases from the SAMPLE OUT into the ambient air next to the analyzer. Gas piping connections are presented in Figure 6.

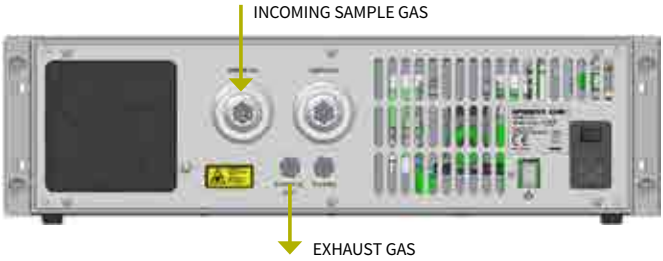

Figure 6. Connecting gas lines to GASERA ONE.

All connectors are, by default, are for tubes of 6 mm outer diameter and 4 mm inner diameter. Other types of connectors are available upon request. It is recommended that stainless steel, PTFE (polytetrafluoroethylene) or PVDF (polyvinylidene difluoride) tubing be used for incoming gas to prevent the adsorption of gas in the line. For details on how to connect tubes to the connector, refer to the next chapter.

Both incoming gas lines have particle filters for preventing dust and other small particles entering to the instrument. GASERA ONEs are delivered with filters assembled in the factory. The filters are user replaceable. See chapter 9.2 on page 65 for instructions on how to replace the particle filters.

> **!**
>
> Never use the device without particle filters in the incoming gas lines. Particles introduced inside the measurement cell may break the gas sensor.

4.2.2.1. Connecting gas line

In general, there are two types of gas fittings available to connect GASERA ONE to gas tubing: Swagelok and plug-in.

Both fitting types, with and without a gas line connected, are presented in Figure 7 and Figure 8. If the analyzer is connected to the gas flow system, the fittings should be always connected to T-type fitting as presented in Figure 7.

Plug-in fittings can be used under some conditions by trained staff, as they might be not reliable. Plug-in fittings sometimes are preferred, as they are easier to connect and disconnect. Plug-in fittings are connected to the gas line by plugging the tube into the connector, and disconnected by unplugging it.

GASERA ONE is delivered with Swagelok fittings. Swagelok fittings should be used for normal operations, as they offer more reliability.

Figure 7. Comparison of both fittings with gas tube attached- on the left side plug-in fitting connected to SAMPLE 1 IN connector and on the right side Swagelok fitting at SAMPE 2 IN. Please note also plug-in fitting on SAMPLE OUT output.

Figure 8. Comparison of fittings ready with gas tubing disconnected - on the left side, plug-in fitting is connected to SAMPLE 1 IN connector; on the right side, Swagelok fitting is at SAMPLE 2 IN.

> ! It is recommended to use Swagelok fittings with GASERA ONE instrument. Plug-in fittings should not be used during normal operations.

The gas connectors are the Swagelok type with a hexagonal nut for tightening the tube to the fitting. The particle filter holder has standard M4 threads for the gas connector. Swagelok fitting installed without gas tube is illustrated in Figure 9.

In order to install the gas tubing first the nut should be opened. Figure 8 presents the view with opened nut (see SAMPLE 2 IN on the right side of the figure).

Next, the gas tube mounting should be secured with inner bushing and the cone as presented in Figure 10.

Figure 9. Swagelok tube fitting in the particle filter holder.

Then, the tube should be inserted inside the fitting: Slide the bushing and the cone into the fitting and tighten the nut by hand until the tube will not turn. Then rotate the nut one turn further while holding the fitting body still. Figure 7 presents the view of an installed Swagelok fitting with gas tube installed (see SAMPLE 2 IN on the right side).

To disconnect the gas tube: Turn the nut counterclockwise while holding the fitting still. Pull out the tube. The inner bushing and the cone of the fitting should be replaced after use.

Figure 10. Securing Swagelok fitting to gas tube. Please note the cone at the end of the tube.

4.2.3. Flushing

Several applications might require additional flushing, i.e., flushing should be considered when handling wet, reactive and corrosive gases. Flushing can be configured as a special measurement task as described in chapter 8.3.2 on page 51.

4.2.3.1. Measurement with high water concentration

If the instrument was measuring gas composition with a high concentration of water before it was turned off, sample gas residues might be still present in the measurement cell. This not only affects measurement results but also potentially causes corrosion inside the cell. It is recommended to always conduct long flush sessions after and before measurements sessions where high water concentrations are handled.

4.2.3.2. Measurement of reactive gases

If the instrument measures reactive, so-called “sticky” gases, it is recommended to use long flush cycles between different measurement sessions. Reactive gases include e.g. ammonia, ethanol, formaldehyde, HCl, HF, and xylenes.

4.2.3.3. Measurement of corrosive gases

If the instrument measures corrosive gases, it is recommended to use long flush cycles between different measurement sessions to remove residues of corrosive gases. Additionally, the user should follow the restrictions concerning maximum allowed concentrations listed in chapter 2.

4.2.4. Purging (if available)

Purge line and connector are optional and are used only in selected models. Purging is not usually required in normal conditions because the open path for infrared light is short. However, the measurement unit can be purged with pure nitrogen (grade 5.0 or better) or instrument-air, free of

dust particles, moisture and oil. Purging may be beneficial, for example if the surrounding air has very high humidity or contains high concentrations of analyte compounds such as CO_2.

The benefit of purging depends also on the GASERA ONE model. The performance of Pulse and Chopper models usually will slightly increase if purged, but models based on laser sources benefit from purging only in special cases.

The gas between the IR source and the gas cell absorbs infrared light depending on the gas components in the air and the length of the open path of infrared light. For example, if the measurement unit contains room air, the water and CO_2 would absorb the infrared light before the PA cell, slightly influencing on the signal levels.

To purge Measurement Unit:

- The purge gas source should have capability to adjust the gas flow, such as a regulator attached to the gas cylinder.
- Connect the purge gas source with gas flow still stopped to PURGE connector in the rear panel; see chapter 3.4.2 on page 9. Instructions for using gas connectors are in chapter 4.2 on page 12. Internal gas lines are illustrated in Figure 5.
- Gradually increase the purge gas flow until it is 1000 ml/min. The flow rate should be between 500…1500 ml/min.

The purging can be active while measuring. However, this might have a small effects on repeatability, since overly high purge flow inside the measurement unit can generate fluctuations, for example in the infrared source emission.

Time required for purging all traces of undesired compounds from the measurement unit cannot be generally defined. Time depends on the gas mixture inside the measurement unit at the beginning of the purging, the purge flow rate and the GASERA ONE model. One way to determine that the purging has achieved an acceptable level is to monitor the trend of the measurement results for some compounds in the air, such as water. After the possible trend in the results disappear, the purging has reached the steady state.

4.3. Starting up, logging in and shutting down the analyzer

4.3.1. Start-up

After installation is completed, the device is ready to start. Before starting up, please read safety considerations and make sure that the mains cable and gas tubes are connected correctly. Make sure there are no closed valves on the gas line – the start-up procedure includes gas-line testing that require open gas lines.

Device can be started by switching the mains power switch in the rear panel into position “—“.

The GASERA ONE will initialize **Startup procedure** where software is loaded, and an automatic self-test routine is performed. The startup display is presented in Figure 11.

Figure 11. The startup display of the GASERA ONE.

Details of the startup procedure and corresponding information displayed on the screen are presented in Figure 12. After the procedure is completed the device will automatically open the Main menu with Measure option highlighted and user can start the measurements - see the last step in Figure 12.

If the self-test results in an error, or if the device displays warnings during the startup procedure, please refer to Diagnostics in chapter 10.

Please note that the instrument needs some time to warm up. Depending on the initial temperature of the device, this may take anywhere from a few minutes to approximately 15 minutes, or even longer if initial temperature is very low. During the warm-up period, an active error icon is displayed on the indication bar, as presented in Figure 13.

It is important to acknowledge that warm-up is a gradual process. During the first stage of the warm-up after a power-on, the measurement cell temperature

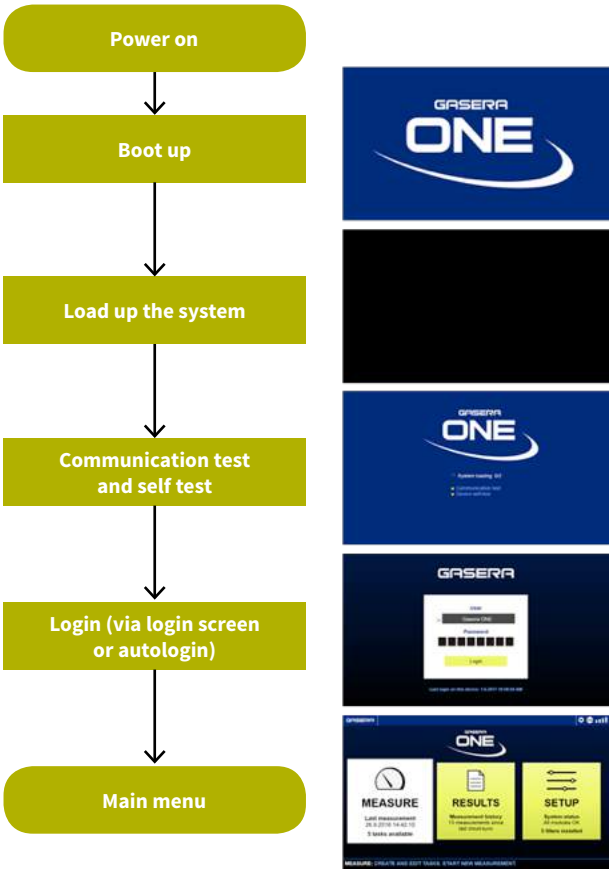

Figure 12. GASERA ONE startup procedure flow chart and corresponding user interface screen.

is too low for measurements, and the blocker type of error is active (for more information about error types, refer to chapter 10.2.) In this stage, a Measurement cannot be started; however, the user interface is accessible. Clicking on the error indication icon displays error details with the blocking condition of “Cell temperature low”.

Figure 13. The main menu of the GASERA ONE during warm-up phase. Warning icon (yellow triangle) is visible in upper right corner of the screen in indication bar area.

During the second stage of warm-up, the cell temperature reaches the target temperature, and the GASERA ONE is ready for measurements. As an indication of this, the blocking error disappears and enables the user to start a measurement.

However, for performance critical measurements, such as calibration process, it is recommended to let the GASERA ONE stabilize the cell temperature and light sources for another 30-60 minutes, or at least until the warning icon in the indication bar disappears.

4.3.2. Logging in

The login screen is optional, and it can be disabled if the system is set to login automatically with the selected account. The configuration of Auto-login is described in chapter 8.2.1. If the login screen is disabled, the start-up procedure will move directly to the **Main Menu**. The login screen is presented in Figure 14.

Figure 14. The login screen during the startup of the GASERA ONE.

The instrument operator can select a user profile to log in from the User selection box. The selection visible in User selection box consists of default user profiles as well as user profiles added for this particular GASERA ONE instrument.

Each GASERA ONE has at least two preconfigured default accounts:

1. Username: “Administrator”, password: none configured.
2. Username: “Gasera Demo”, password: none configured.

For details concerning default accounts please refer to user account configuration from chapter 8.8.2.

If other user accounts are used, their configuration is defined as presented in chapter 8.2 on page 43.

4.3.3. Shutting down the analyzer

The analyzer can be turned off by switching the mains power switch in the rear panel into position “O”.

It is recommended that sufficiently inert gas, such as room air, is measured or flushed for about 15 minutes before shutting down. This flushes the sample gases out of the gas cell. Particularly when the sample has been highly humid or has contained corrosive, toxic or reactive compounds, flushing is strongly recommended.

> **!**
>
> Shutting down the device during the measurement is not recommended.

If the device is shut down during the measurement, the results of the last completed measurement iteration are stored. Please note that measurement interrupted by power cut is not restarted automatically. For details of measurement procedures, please refer to chapter 6.

If the analyzer is equipped with an automatic transport lock, and the device is shut down when measurement is in progress, the transport locking system will not be activated. In this case, the operator should ensure the automatic transport lock is activated by starting the analyzer up again and shutting it down when the system is idle and in the main menu, and no measurement or calibration is running.

It is recommended to always wait a few seconds before starting the device again after the shutdown.

5. Operating GASERA ONE analyzer

The user interface of the GASERA ONE is based on a display and GASERA ONE button operations. GASERA ONE button is a rotatable push button located on the front panel of the device. The button allows the user to move within the user interface presented on display, make selections, and enter text labels and parameter values. The color of the LED ring surrounding the GASERA ONE button indicates instrument status for the user.

5.1. Display view

GASERA ONE display has four sections as illustrated in Figure 15. The top section has the navigation bar and the indication bar. is dynamic and depends on the current state of the analyzer, for example shows the main menu or real-time measurement results. The bottom bar is a context help bar providing guidance and additional information on the currently selected item.

Figure 15. Sections of the GASERA ONE display. The example is from the main menu.

The navigation bar shows the current location in the menu structure. By rotating the GASERA ONE button, the user can browse through items of the menu level. For instructions on using the GASERA ONE button, see chapter 5.2 on page 22.

The indication bar contains shortcuts to commonly used functions and system notifications, such as information about possible warning and error conditions. The items in the indication bar can be selected using the GASERA ONE button. Indication bar shortcuts are listed in Table 2.

Table 2. Indication bar shortcuts.

Indicator bar icon	Action
⚠	Indicates an error condition or a notification. Shortcut to error log. For Error log, see chapter 8.7 on page 55. For error messages, see chapter 10.2 on page 68.
⚙	Shortcut to **Setup**. See chapter 8 on page 41.
IK	Shortcut to **Accounts**. See chapter 8.2.2 on page 44.
▂▄▆▇	Indicates the signal strength of the wireless network of which the device is connected. Disabled by default. See chapter 8.8.3 on page 58.

5.2. Operating with GASERA ONE button

The GASERA ONE button is used for navigating in the menu structure, selecting items and entering values or text. Detailed operation of the GASERA ONE button is described in Table 3.

Table 3. Device status indicated by the GASERA ONE button LED ring.

Movement of the button	Action
Rotate the button clockwise	Moves the selection forward
Rotate the button counterclockwise	Moves the selection backward
Short-press	Selects the currently highlighted item
Long-press (hold down for about 2 s)	The selection moves one step backwards in the menu level without saving current information
Continuous press (hold down continuously)	The selection steps further back in the menu level, until the button is released, or the main menu is reached

The LED ring surrounding the GASERA ONE button indicates the status of the device.

In general, yellow light indicates warning, red light indicates critical error and green and blue colors are used in normal operation. Details of LED indications and device status are described in Table 4.

Table 4. Using the GASERA ONE button.

LED ring indication	Device status
Green light with three step pulsing of full LED circle	Device is starting up, or is idle
Brightening blue light of full LED circle	Long-press of GASERA ONE button
Light circulating through LED circle	Indicates progress of an action such as a measurement. Please note, that portion of the ring indicates the task progress from a point up to full circle
Blue light circulating	Indicates progress of the action without active warnings
Yellow light circulating	Indicates progress of the action with warning(s) activated
Slowly pulsed red light	Critical error detected, for further diagnostics please refer to chapter 10.2 on page 68.
Constant red light	Instrument operation is stopped, e.g. software update is ongoing, see chapter 8.8.2 on page 57.

5.3. Entering text and numbers with the GASERA ONE button

Some fields require text or numerical values as input. A typical example is naming a new task or measurement. These values can be entered using the GASERA ONE button. Depending on the field, it is possible to enter:

- letters: from A to Z
- numbers: from 0 to 9
- special characters: _ - . , ( ) %

Entering and editing text or numbers has two modes:

1. The **character selection mode** allows selecting the field position to edit or modify.

2. The **character edit mode** – special mode inside character selection mode that allows for adding, replacing or removing a character.

When the user uses short-press in the GASERA button on a field that requires numerical or text input, the **character selection mode** is started automatically. User is then able to select a position to add or modify characters. Another short-press moves the user to **character edit mode**, where the user can edit characters using the selection table as presented in Figure 16.

Figure 16. Entering text using GASERA ONE button.

Characters are selected from the table using short-press, and at the same time the next position is opened for editing. This makes the adding of multiple characters quick and easy. When the last character is added, the user should leave **character edit mode** by using long-press, which returns to **selection mode**. User can leave **character selection mode** with another long-press.

It is recommended that the user exercises the operation of entering text and numerical values with the button before start of operational measurements. These most common operations are:

- Switching between selection and edit modes. When operating with short- and long-press of GASERA ONE please pay attention to path information available at the upper part of the screen:
  path Measure->Edit-> ▶ denotes **character selection mode**, whereas
  path Measure->Edit-> ▶ -> ▶ denotes **character edit mode**

- Editing existing character: Move the cursor to the character until it is underlined. Short-press opens the character list where the character can be changed. Another short-press accepts the table selection and moves to editing of the next character. A long-press exits to selection mode.
- Inserting new character: Move the cursor between two characters or at the end of the line (so using the vertical line instead of underline). Short-press opens the character list where the character can be changed. Please note that another short-press accepts table selection and moves to insertion of the next character. A long-press exits to the selection mode.
- Deleting a character: Simply overwrite it with “empty” character from the table.
- Deleting all current field: To remove all characters at once, open the selection mode and select © icon at right edge of the field.

6. Measuring with GASERA ONE analyzer

6.1. Measurement principles

This chapter describes measurement concepts.

Measurement Task is a measurement template with preconfigured measurement parameters. Based on Measurement Task the user can create similar type of measurements without the need to configure parameters for each measurement.

GASERA ONE comes with a default Measurement Task configured for standard type of gas exchange routine and factory selected gas components. Modification of measurement parameters should be performed only by users understanding the impact of these changes on instrument operations. Adjustment of parameters critical for instrument performance, such as target pressure or CIT, is not recommended

When modification of measurement parameters is needed, a new Measurement Task should be created to keep parameter modifications consistent for all measurements. An example of Measurement Task configuration is presented in Figure 17. Measurement Task setup is described in details in chapter 8.3 on page 48.

Measurement is a continuous process consisting of multiple measurement iterations. When individual measurement is started, GASERA ONE repeats measurement iterations automatically until the measurement is stopped. An example of configuration of individual measurement is presented in Figure 18. Measurement setup is described in detail in chapter 6.2 on page 27.

Figure 17 and Figure 18 illustrate the concept of Measurement vs. Measurement Task.

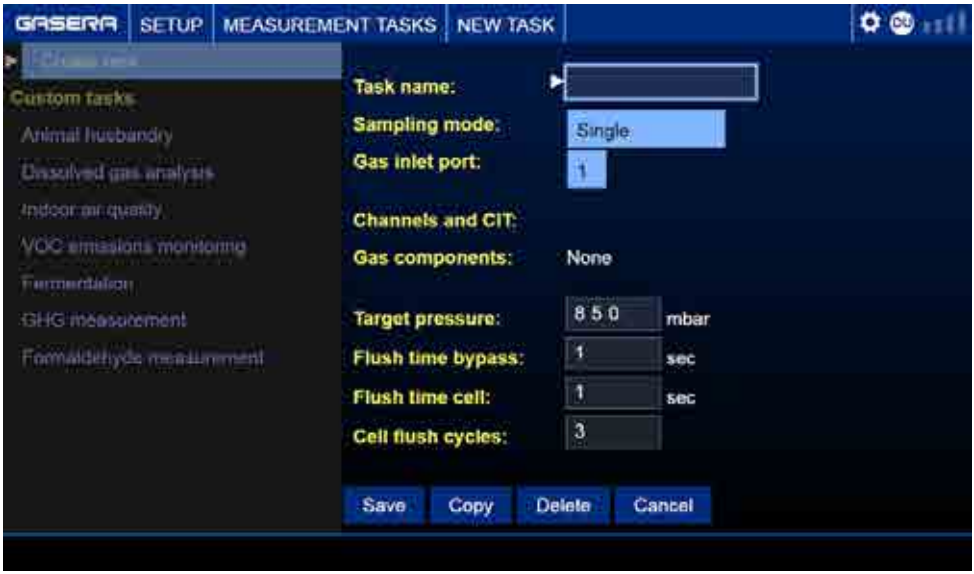

Figure 17. Configuration of Measurement Task.

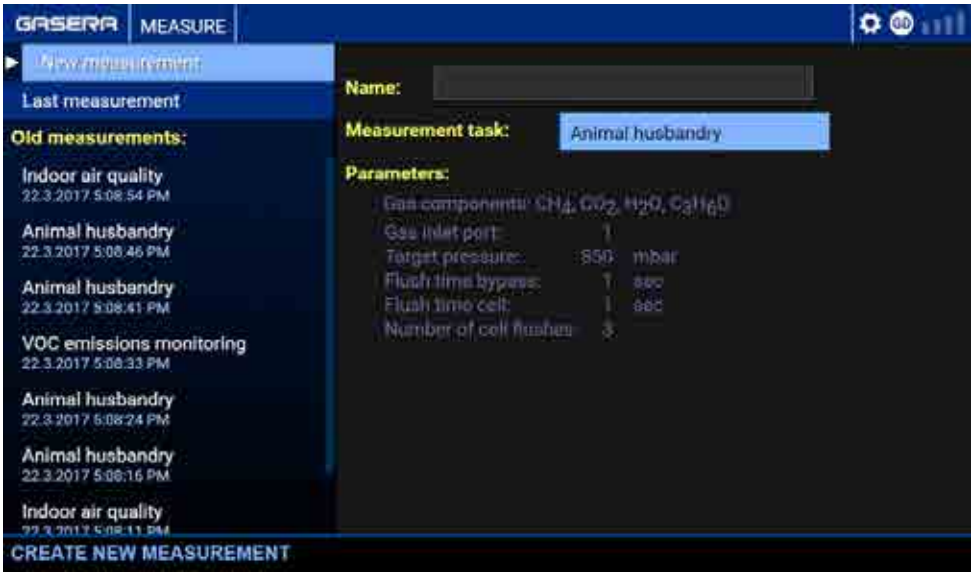

Figure 18. Configuration of individual Measurement.

Measurement iteration is a process of creating single measurement results. Measurement results can be provided every time a single measurement iteration is completed. Figure 19 presents the process behind single measurement iteration.

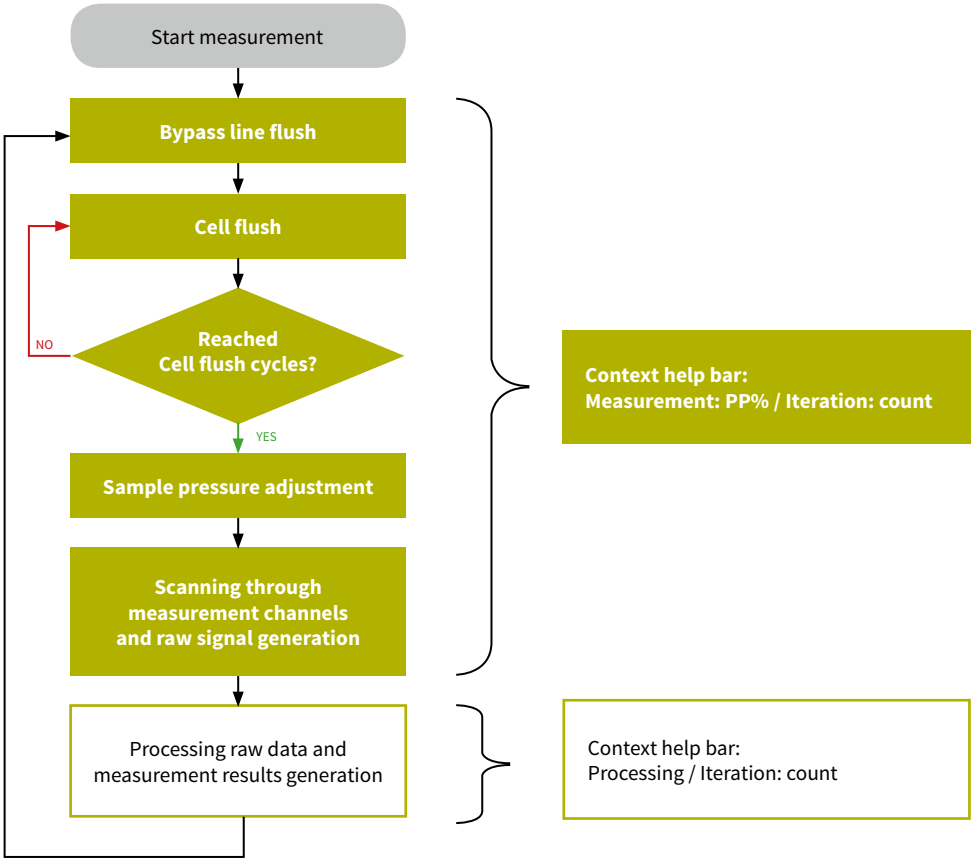

Figure 19. Process behind one single measurement iteration in GASERA ONE. Right side describes information about measurement iteration process progress as visible on screen.

When a new measurement iteration starts, the instrument first prepares the device by flushing the bypass line and then the cell, capturing a new sample and adjusting sample pressure. Bypass line flush and cell flush removes remains of old sample from the instrument.

Parameters related to measurement and flushing can be modified in Measurement Task configuration. For details on how to set up Measurement parameters, refer to chapter 8.4 on page 52, and for setting up long-term flushing, please refer to chapter 8.3.2 on page 51.

All parameters related to measurement iteration, such as number of flushes or target pressure, might affect measurement performance. Therefore it is usually recommended to retain default settings. In case the default settings need to be changed to tune the performance of measurement, finding optimal values might require multiple tests with the help of the Gasera support team and an application specialist.

Pressure must be adjusted accurately, since photoacoustic sensor response depends on the pressure in the cell. The target pressure value depends on application.

After the gas exchange phase, the actual measurement starts by scanning via **measurement channels**. For every **Measurement channel**, photoacoustic signal amplitude is integrated over time as specified by Channel Integration Time (CIT) generating **raw signal data** values. Typical measurement iteration scans either through all available channels or through selected **measurement channel groups** where a channel group is in the specific range of measurement channels.

When the measurement is ready, the device continues to the processing phase, where raw signals data are analyzed and measurement results generated. The analysis is based on a chemometrics algorithm for multi-component samples. Concentration values, raw data, time stamp and sensor parameters are stored into the internal memory. GASERA ONE models with laser sources might also, at this phase, perform automated wavelength calibration of the laser wavelength to maintain laser stability. Typically, the automated calibration takes approximately 10 s and is run every fifth iteration. Wavelength calibration is described in appendix A.4.2 on page 84.

6.2. Starting the measurement

When the instrument is started, the Main Menu is loaded with **Measure** option highlighted as presented in Figure 20, so the user can directly proceed the measurement procedure.

Selecting **Measure** by clicking the GASERA button will open Measure view as presented in Figure 21. Measure view allows the user to perform all operations related to making measurements, including creating and starting measurements and tracking real-time results.

Figure 20. The Main Menu with Measure highlighted (default instrument view).

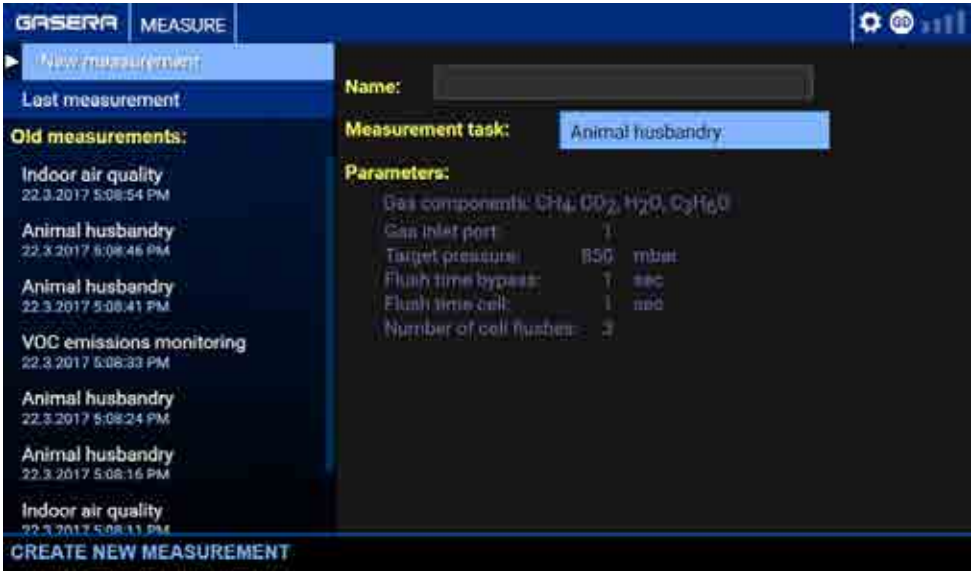

Figure 21. The Measure view.

6.2.1. Starting measurements by creating a new measurement

The standard way to start the measurement is to use the **New measurement** menu that allows the user set both name and new parameters.

Selecting the New measurement menu item activates the right side of the screen, where the user can assign measurement **Name** and choose **Measurement task** template for setting measurement parameters. Measurement parameters can be modified by using the **Edit task** option, which will guide the user to the Measurement Task configuration page.

After name and Measurement Task is selected, the measurement configuration is ready. Measurement can be started simply by pressing **Start**.

The example in Figure 22 presents a Measurement named "MY_MEASUREMENT" with loaded parameters, as specified in the Measurement Task template named "Animal husbandry". After the measurement is started, the instrument will start sampling gas

Figure 22. Example of a measurement configuration in New measurement menu.

from the SAMPLE 1 IN gas inlet port and flushes the bypass line for 1 second. Then it flushes the cell 1 second for 3 times, sets sample pressure to 850 mbar and proceeds with measurement iterations, producing measurement result for CH4, CO2, H20, and C3H6O components. The procedure will be repeated until measurement is stopped. For details of the measurement process and parameters' impact, please refer to chapter 6.1 on page 24.

> **!**
>
> Please note that modification of measurement parameters, i.e., modification within Measurement Task configuration, should be avoided. If Measurement Task needs to be modified, it is recommended to create a new one.

6.2.2. Recalling old measurements

The alternative, faster way to start the measurement is to recall one of the measurements listed under **Old measurements,** menu as presented in Figure 23.

Figure 23. Recalling an old measurement.

This allows setting up a new name, but does not allow changing measurement parameters (e.g., does not allow for changing a preset Measurement Task) when starting the measurement.

Clicking the GASERA button on one of measurements will open the measurement configuration screen, where the task name can be modified but Measurement Task cannot, as presented in Figure 24.

Figure 24. Recalling an old measurement- measurement configuration.

This way of starting the measurements is recommended for executing multiple measuring sessions, where measurement parameters remain the same. A good example consists of all comparative measurement sessions, where results should be compared for different measurement environments or setups.

> Please note, that when creating a new measurement by recalling an old measurement, measurement parameters cannot be modified.

6.2.3. Fast start by recalling the last measurement

Finally, the fastest way to start the measurement is to recall **Last measurement** as presented in Figure 25.

The measurement starts directly after selecting **Last measurement**, so this setup does not allow for measurement name modifications or measurement parameter modifications.

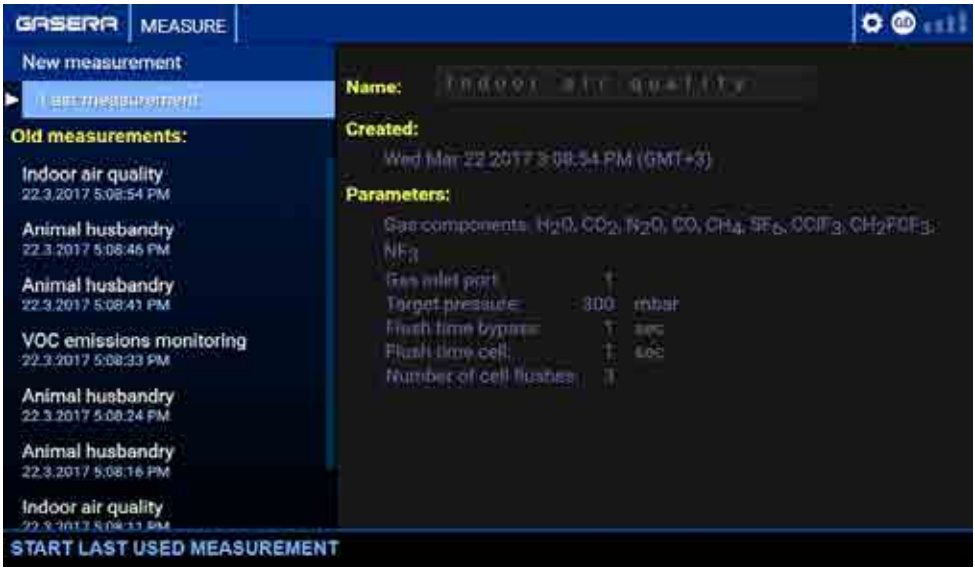

Figure 25. Recalling last measurement.

> **!** Please note that creating measurements by recall of the last measurement does not allow for name or parameter modification, and individual measurements can be identified only by their timestamps.

This way of starting the measurements is recommended for executing long-term measurement sessions, when it is enough to identify individual measurements just by their starting time stamp.

6.3. Viewing results real-time

The progress of the current cycle in the measurement procedure is presented on the bottom of the screen with a progress bar. The progress is also indicated by the LED ring around the GASERA ONE button.

GASERA ONE also provides several views for measurement data during the measurement. Availability of these depends on the instrument configuration and the user level logged in. The typical measurement results views are:

- **Concentrations** view. List of compounds and their concentrations from the latest measurement. The view has different layouts for single gas and multi-gas measurements.
- **Trend** view. Line chart showing measurement concentrations and their changes in time (see

chapter 6.3.2 on page 33). The view provides additional tools enabling analysis of result changes in time

- **Column chart** view. Column chart with raw signal values from the latest measurements (see chapter 6.3.3 on page 35)
- **Task parameters** view. List of current measurement parameters, including: gas components, gas inlet port, target pressure, flush time bypass, flush time cell and number of cell flushes.

6.3.1. Concentrations view (default view)

When the measurement is started, the instrument will switch to default **Concentrations** view. This view provides a basic information view by displaying the latest measurement results for all gases measured by the instrument (left side) and additional component information (right side).

Concentration view is different for single and multi-gas analyzers. Multi-gas analyzer is presented in Figure 26 and single-component analyzer in Figure 27.

Note that the view presents always the last measurements for all components measured by the device. Therefore, it is not possible to, for example, hide individual measurements or gases. Therefore, for more detailed analysis, the **Trend view** should be used.

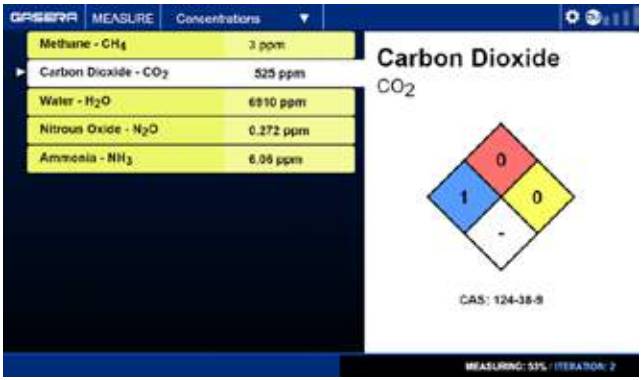

Figure 26. The measurement report view in a multi-gas analyzer, in this example an NDIR based GASERA ONE. The view presents the latest analysis results and information about the gas component.

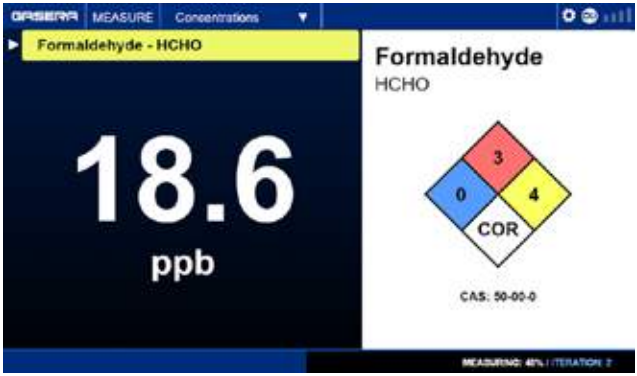

Figure 27. The measurement report view in a single gas analyzer, in this example the GASERA ONE FORMALDEHYDE. The view presents the latest analysis result and information about the gas component.

6.3.2. Trend view

The **Trend** view provides additional tools for measurement results analysis. It shows the analyzed gas components with respect to time and provides tools for tracing. An example is presented in Figure 28. **Trend** view consists of component list (left side) and their trend lines (right side).

The individual trend lines can be highlighted for further trace analysis by selecting a relevant component. Individual measurement points are visible on highlighted line as points. Note that a new point will be added to the line every time the measurement iteration is completed. The concentration axis is automatically scaled to show all displayed data.

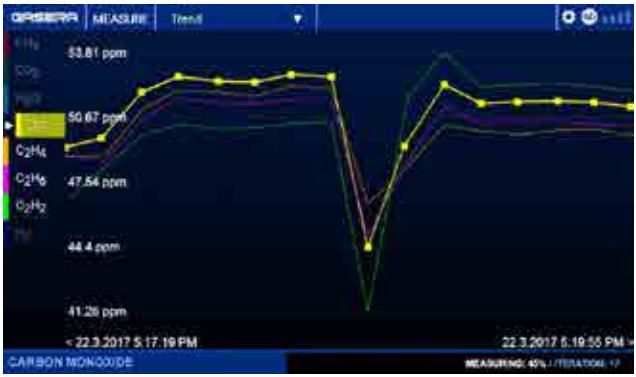

Figure 28. Trend view for concentrations with highlighted CO component (trend line with points), hidden CH4 and H2O components (grayed components on left side) presented at 51% of current measurement iteration cycle (bottom bar).

Individual trend lines can be selected, hidden and unhidden by using the component selection on the left side. Selection will activate a pop-up window as presented in Figure 29 and the following options will be available:

- **Trace** – selecting component trend lines for tracing (trace analysis)
- **Hide/Show** – hiding and unhiding selected component trend lines
- **Show only** – hiding all other components than selected
- **Show all** – displaying all components.

Figure 29. The trend view pop-up for tracing, hiding or showing the selected analyte data.

6.3.2.1. Trace analysis on selected trend line

Trend view enables trace analysis for selected components. When the **Trace** is selected for an individual component, a cursor is displayed on top of the most recent data point as presented in Figure 30 and the user can move between line points (so between individual measurement results).

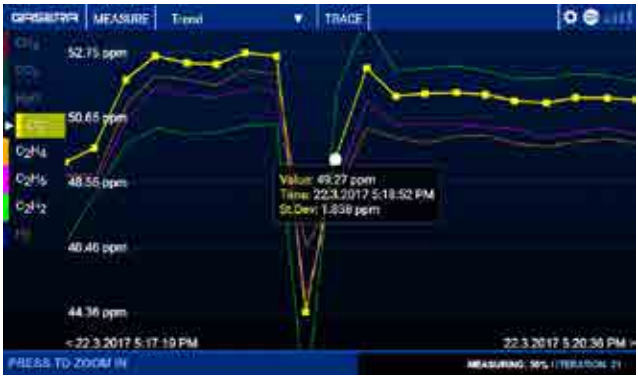

Figure 30. The trace shows values for the individual data points in the trend curve. Pressing the GASERA ONE Button will activate zoom in and zooming pop-up.

The following information displayed for every data point:

- **Value** - Concentration of the sample gas at data point
- **Time** - Exact measurement time stamp of the data point
- **St.dev** - Standard deviation of data point. Standard deviation is calculated based on all the data points currently displayed and therefore it is recalculated when e.g. changing zoom level, for example.

Trend line can be zoomed into and zoomed out of by selecting the data point and clicking the GASERA ONE button. The click will open the zoom level pop-up as presented in Figure 31. The user can zoom in and out in the pop-up window from level 1x to level 512x. A long press on the selected zoom level in the pop-up window will turn it off and will return the user to the trend line, which will be displayed at the selected zoom level.

Figure 31. Selecting the zoom level for tracing on selected point. Zoom value is also visible in path in upper bar. Long click will accept selected value and return to trace line.

If Moving average is enabled as the display mode, the trend can be viewed as an actual data point or as average over a selected time. For information on the **Moving average** feature and its configuration. please refer to chapter 8.4.

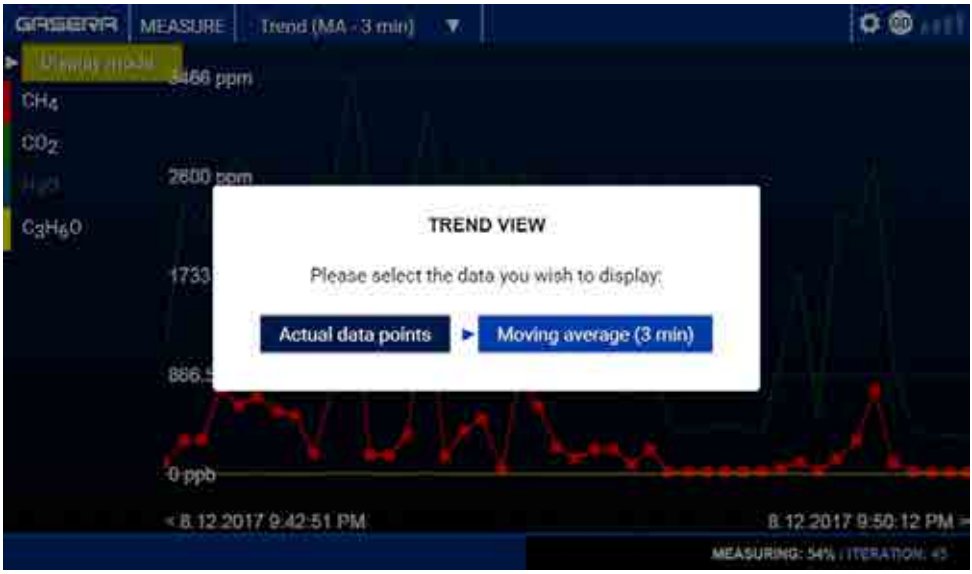

Figure 32. Selecting trend view with moving average display mode enabled

6.3.3. Column chart view

The column view shows the raw signal values per the measurement channel.

Channel values describe measured channels either as individual frequencies or as spectral bounds defined by the center channel wavenumber and bandwidth. Grouping the channel as spectral bounds helps display data and speeds up the measurement cycle. Column **Amplitude** values represents a raw signal value averaged for each channel.

> The number of channels depends on the instrument. Whereas the GASERA ONE model with single laser or single optical filter displays only one channel, the EC-QCL-based models can include thousands of channels, and therefore channels are organized into groups.

Example from Figure 33 presents a column view for the GASERA ONE model based on NDIR technology, where the shortest column represents raw signal values for the channel with center wavenumber at 2270 cm^{-1} with a wavenumber range (in NDIR case - filter width) of 23 cm^{-1}.

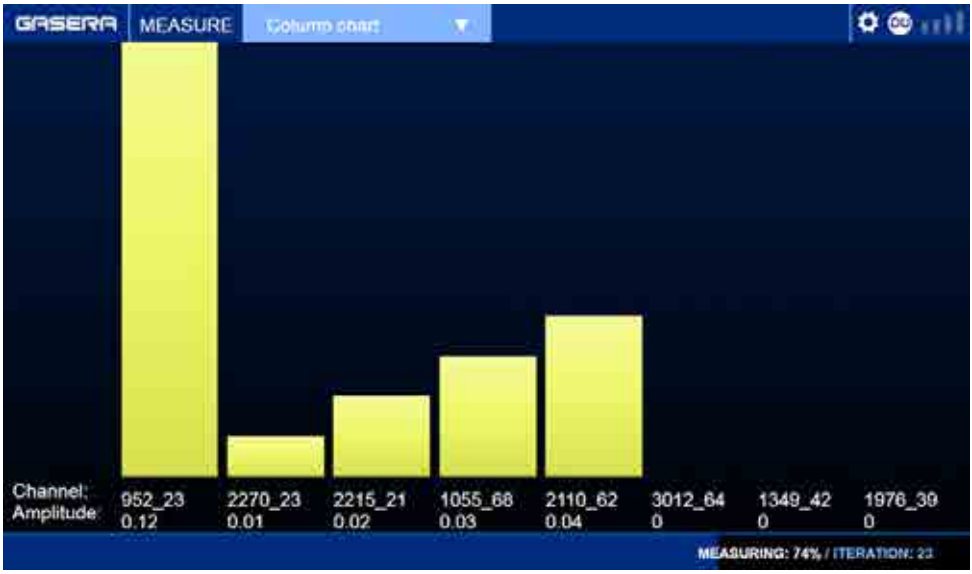

Figure 33. The column view displays raw signal values per channel of optical bandpass filters. In certain GASERA ONE models, channels are replaced by channel groups.

The example in Figure 34 presents a column view for the GASERA ONE model based on DFB technology, where the right column represents raw signal values for the channel at water peak wavenumber of 1164 cm^{-1} and the left column represents raw signal values for the channel at HF component wavenumber of 1169 cm^{-1}.

Figure 34. The column view displays raw signal values per channel of optical bandpass filters. In certain GASERA ONE models, channels are replaced by channel groups.

6.4. Stopping the current measurement

The user can stop the ongoing measurement by pressing the GASERA ONE button until the system prompts the user to stop the task. The user is asked to confirm via a pop-up window. The instrument will stop measurement activities and return to the main menu. Data and results collected so far are stored in the internal memory and are accessible from the **Results** menu.

7. Post-measurement analysis with GASERA ONE

Measurement results and measurement data can be viewed, analyzed, deleted and exported using the **Results** option from the Main Menu as presented in Figure 35.

When **Results** option is selected, the Result view will display all measurements stored in the device and provides tools for results analysis, exporting and deleting the data. Results view functions are presented in detail in following subchapters.

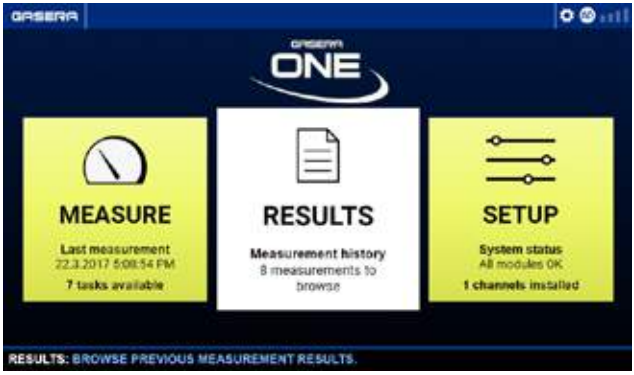

Figure 35. The Main menu display of the GASERA ONE with the Results menu item selected.

7.1. Viewing measurement results

The left side of the **Result** view displays all the measurements available for the device. Measurements are named using the name defined in the **Measurement** menu and a time stamp. The time stamp is given in descending order, or YYYY-MM-DD hh:mm:ss.

The right side contains a trend-type preview of data for every viewed measurement, as presented in the example in Figure 36. If the measure-

Figure 36. Results view with list of measurements. Preview of highlighted measurement is shown.

ment has a lot of data, preview generation might take longer. “Processing data” is displayed when the preview is generated.

The preview is replaced by a full-screen trend view when the user selects the given measurement data. Please note that trend view functionality is identical to the Trend view available during real-time measurements described in chapter 6.3.2 on page 33. That is, the GASERA ONE button can be used for tracing the data and selecting regions to zoom in on. An example of the full screen trend view is shown in Figure 37.

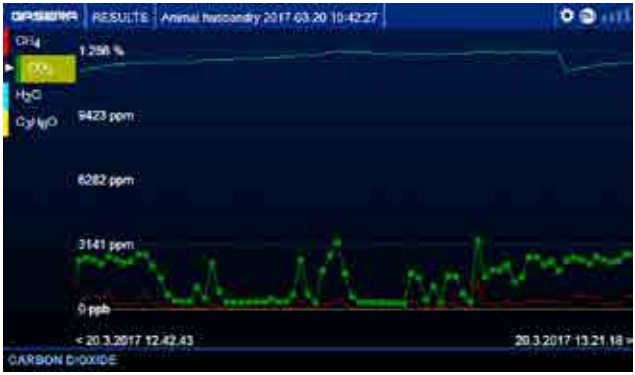

Figure 37. Example of the trend view of measurement data.

7.2. Exporting data to USB storage

The measured data and results can be exported for further analysis by using a USB mass storage device. The data will be exported in csv format.

At first, the USB mass storage device is connected to the USB port located in the front panel (see chapter 3.4 on page 8). The storage device should have at least 512 MB of available space. It must be formatted with file system FAT32 or ext3. It is recommended that the storage be emptied before connecting it to GASERA ONE. All files are created to the root of the file system in the USB storage device.

Figure 38. Starting to export the results to USB storage.

When a USB storage device has been connected, the exporting is started by selecting **Save to USB storage** in the **Results** view. After that, check boxes appear for each item in the measurement list. Selecting which measurements will be exported is done by entering a check mark in the box, as presented in Figure 39. All measurements can be easily selected by pressing **Select all**. Pressing the **Export selected** item in the menu will start copying the measurement data to the USB storage.

An example is presented in Figure 39. The system gives a message that exporting is ongoing. The system will indicate when the export is complete. A warning is given if any errors occurred during the data transfer.

Figure 39. Exporting the selected results to USB storage. All measurements can be selected using **Select all**.

7.3. Removing measurement data

Measurement results can be removed from the memory by selecting the **Delete measurement** in the Result view as illustrated in Figure 40. After that, check boxes appear for each item in the measurement list. Selecting which measurements will be removed is done by entering a check mark in the box, as presented in Figure 41. Then, pressing the **Delete selected** item in menu will erase the selected measurements and their data from memory.

Figure 40. Delete measurement is used to remove a measurement and its data.

Be careful when deleting a measurement, because it is a permanent action. Once erased, measurement data cannot be recovered later.

Figure 41. Selecting Delete selected will remove the measurements selected by check boxes.

It is recommended to remove unnecessary measurement results periodically, because the internal memory is limited. After deletion is complete, the user must run Compress service database in Instrument status under Setup view. If the memory becomes full, no new measurement results can be stored until the old results are removed. Almost full memory may also decrease the performance of the internal computer. Results can be exported to other storage facilities via the USB mass storage device. See chapter 7.2 on page 38 for instruction on exporting data.

8. Instrument settings and parameters and their modification

GASERA ONE can be tailored to respond to different measurement needs by customizing GASERA ONE settings using Setup configurations available directly from the main menu, as presented in Figure 42. **Setup** enables user account management, setting up measurement tasks, calibration, monitoring device status or updating the software and other functions, as listed later in this chapter.

Figure 42. The Setup can be selected directly from the Main menu of the GASERA ONE.

Selecting Setup will open Setup view, as presented in Figure 43. Setup enables configuration of settings listed on the left side of the screen.

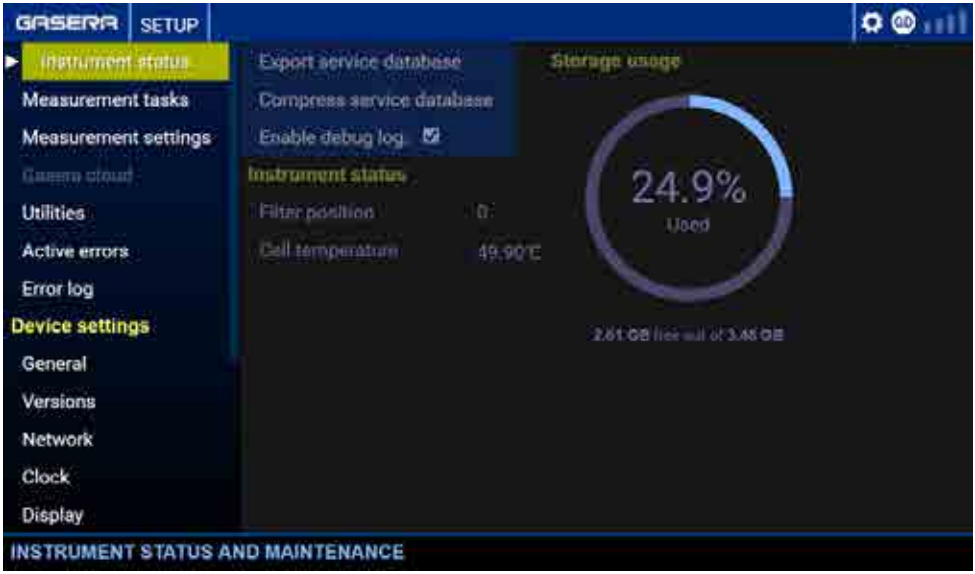

Figure 43. The Setup view with Instrument status displayed.

8.1. Instrument status

The **Instrument status** view is presented in Figure 43. It displays basic sensor information (model-specific), the amount of storage space available and provides access to instrument status functions.

The information about storage usage includes percentage of space available and occupied space. Based on this information, the user can predict timing of maintenance actions. If more space is needed, the user can remove or export old measurements or compress the service database. Before the disk space becomes full, a warning message is displayed and the user is requested to free some more space by deleting old measurements.

Figure 44. Exporting the service database for diagnostic and service purposes.

Functions are used mainly for maintenance and diagnostics purposes and are typically performed under the guidance of the customer support.

Export service database takes a snapshot from the internal service database and exports it to the USB storage attached to analyzer.

Compress service database function can be used to compress internal database to free up some internal memory. Compressing is recommended to run, for example, always after deleting old measurements.

Enable debug log starts logging more data for debug purposes.

8.2. User accounts

The **User accounts** view provides two functions: auto-login configuration and user management. The view also displays all accounts currently available for the device, as presented in Figure 45.

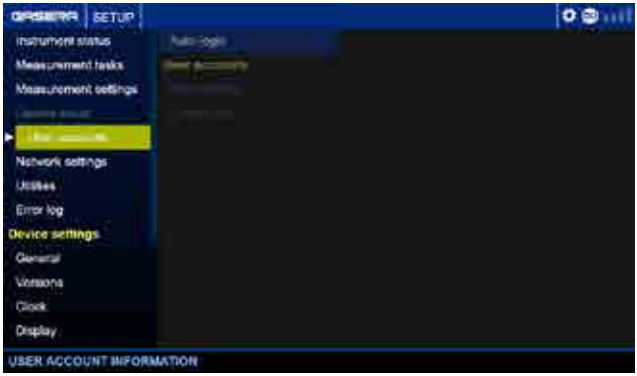

Figure 45. User accounts in the Setup menu.

Auto-login function enables automatic login for the instrument when user management is not needed. User Accounts configuration should be used when the instrument is shared between multiple different users. Default users are not sufficient.

User accounts function allows creating additional user accounts and managing all user accounts, passwords and permissions.

8.2.1. Auto-login settings

Auto-login configuration view allows enabling and disabling auto-login functionality. If **Enable auto-login** is unchecked, the login credentials are prompted with a login screen when the instrument is started up.

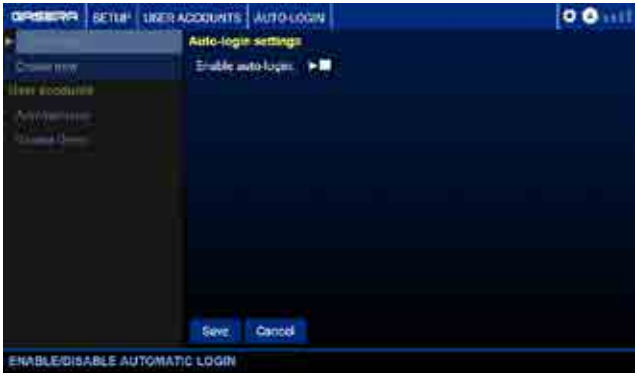

Figure 46. Auto-login configuration.

When the **Enable auto-login** check-box is checked, the user will be requested to select auto-login account, as presented in Figure 47. The selected account will then be used automatically when device starts; no login window is prompted. For startup details, please refer to chapter 4.3 on page 17.

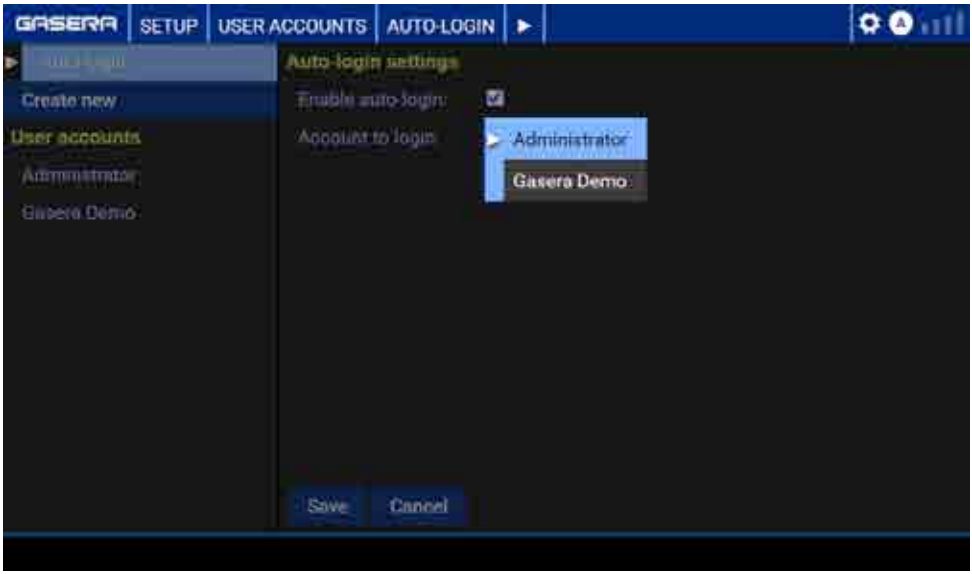

Figure 47. Auto-login configuration.

8.2.2. User accounts

User accounts allow the user to create and modify users and their rights. All accounts currently available in the instrument are displayed on the left side of the view, and their configuration can be previewed by highlighting a specific user account name as presented in the *Administrator* example in Figure 48.

Selecting the highlighted user account name will allow the user to modify user account settings, unless it is restricted by the operating user's rights.

User account name can be modified using **Account name**. Password protection is disabled by default and can be enabled by checking **Enable password** checkbox and setting up a new password.

Permission level displays the information about level

Figure 48. User account view displaying Administrator user account settings.

of user rights, where level 1 denotes the highest level of user and level 4 the lowest. Permission levels are presented in more detail in the following section. User rights level can be edited by clicking on the Edit button displayed next to Permission option when scrolling over the text. The Edit button is not displayed if the logged-in user does not have permission to change level rights (it is typically reserved for administrators).

Each GASERA ONE has at least two preconfigured default accounts:

- Username: “Administrator.” Password: none configured. This is the default account used for instrument operations. This user account has administrative rights and can be used for all operations, including measurements or adding users. Therefore, it is suggested that the password for this account be added after device is taken in to use.
- Username: “Gasera Demo.” Password: none configured. Please note that this user account has special rights definition with the level named “Gasera Demo”. This account can be used for demonstration purposes only, e.g., during tradeshows or showcases. When logged in to this account, the instrument has no capability to measure or calibrate actual gas measurements. The presented data is for demonstration purposes only.

8.2.2.1. Creating new user account

Figure 49 presents the example of New user configuration as visible for the administrator type of operating user. Parameters of user account configuration are described in the section above.

The figures below present user rights assigned to specific user levels, where level 1 denotes the most powerful user-level rights.

Figure 49. User accounts in the Setup menu. “Edit” button is displayed only when scrolling over Permissions option.

Please note note that only administrator account can manage user rights, i.e. create accounts and modify user levels.

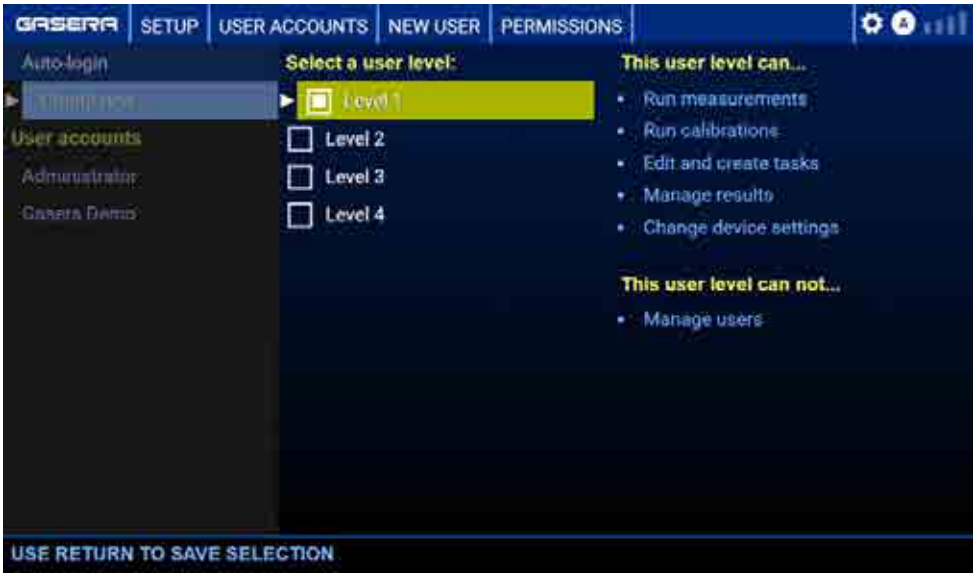

Figure 50. Level 1 user level rights.

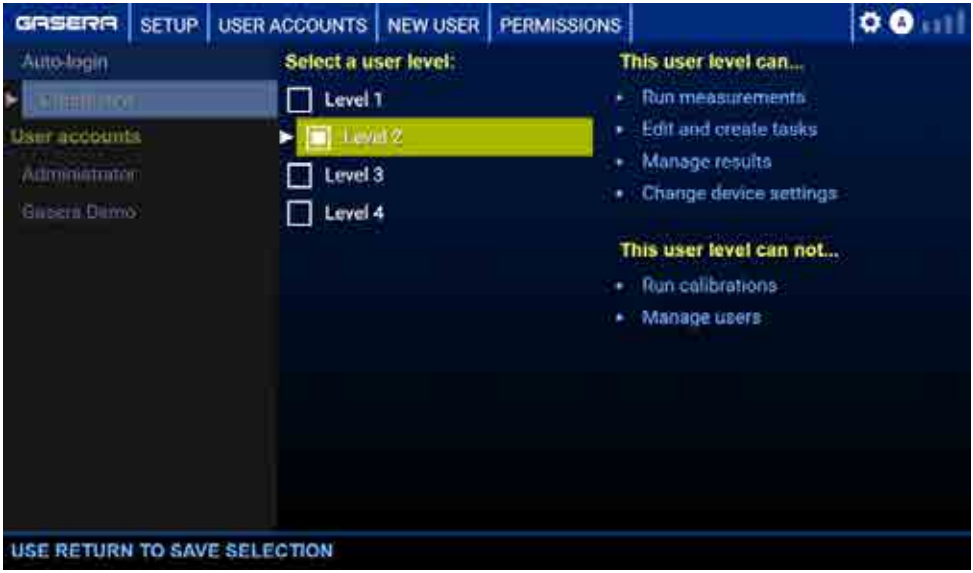

Figure 51. Level 2 user level rights.

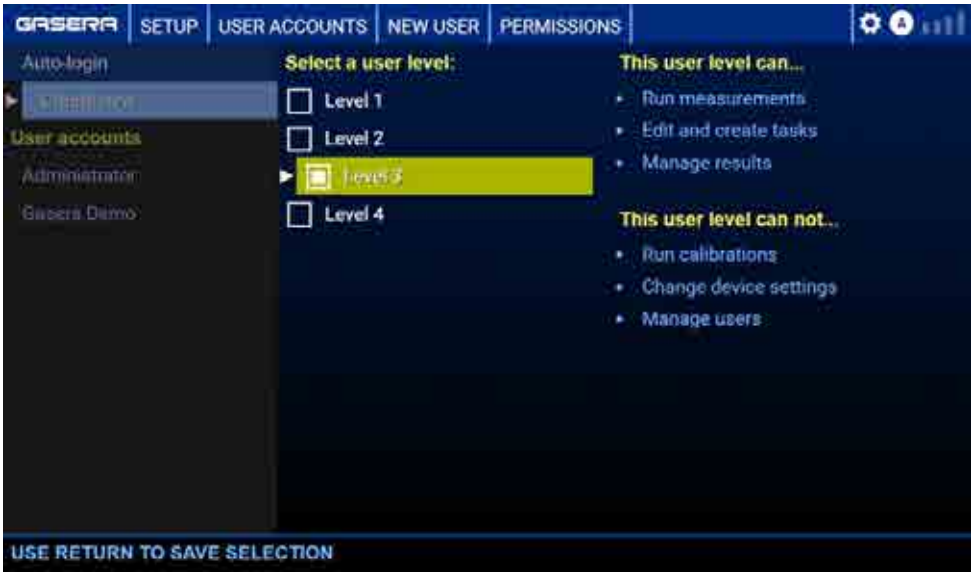

Figure 52. Level 3 user level rights.

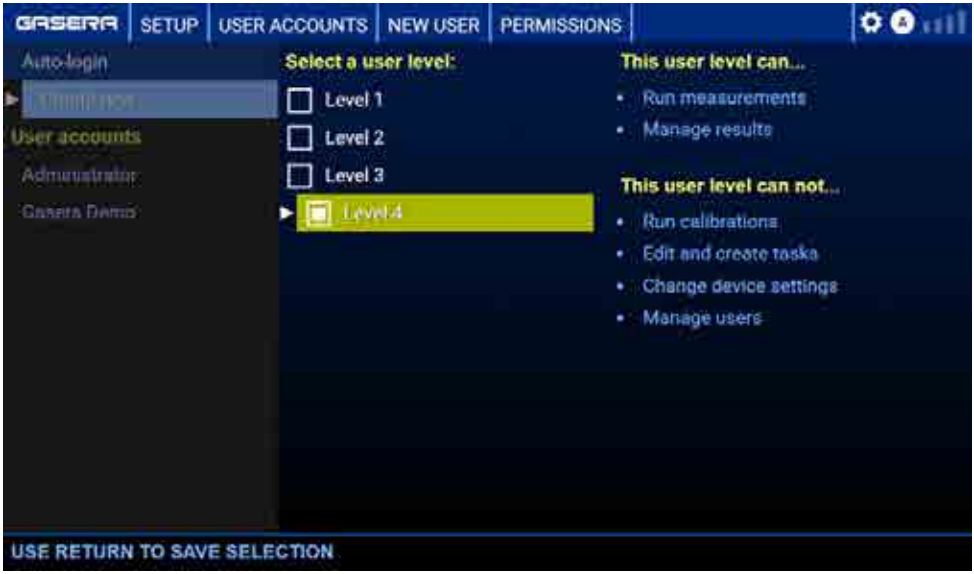

Figure 53. Level 4 user level rights.

8.3. Measurement tasks

Measurement Task helps the user to create templates for measurements without a need to reconfigure and reselect all measurement parameters when creating and starting new measurements. More information about measurement concepts is presented in chapter 6.1 on page 24.

Measurement Task configuration allows the user to create new, modify existing and manage all Measurement Tasks to be used on the device.

Figure 54 presents the Setup view with the **Measurement Tasks** option highlighted and Measurement Tasks configuration previewed, and with a list of currently existing measurement tasks visible.

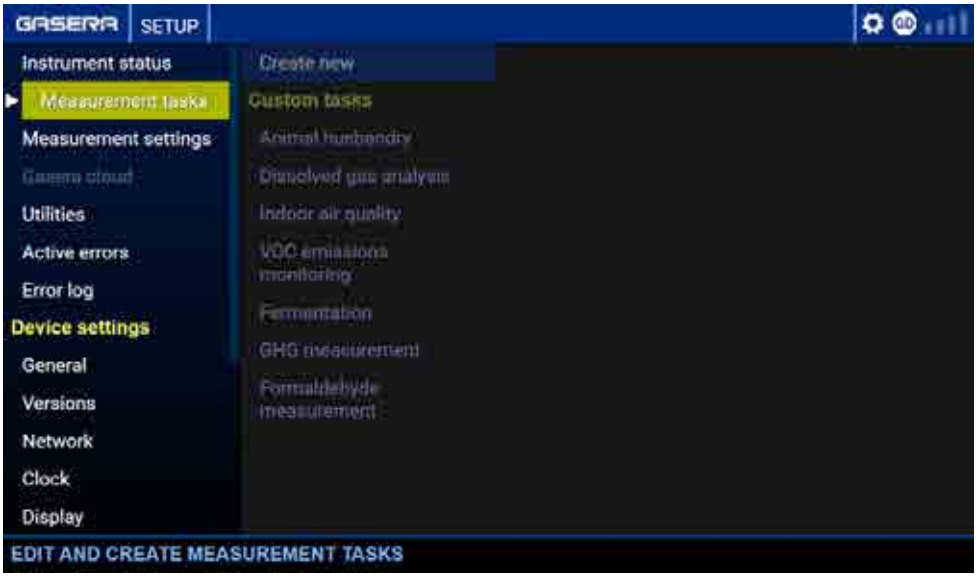

Figure 54. Measurement tasks view.

Modifying an existing task is done by first selecting the task from the list and then modifying its parameters as in creating a new task. The task is saved by pressing **Save**. The task can be removed by pressing **Delete**. **Copy** creates a new task with equal parameters as in the original task. **Cancel** returns to the Measurement tasks menu without changing the task.

Please note that if an existing Measurement Task is changed, the results obtained using the old and new Tasks may not be comparable anymore, although they might have similar names in **Results** menu. Therefore, to avoid confusion, it is recommended to create new Measurement Tasks when parameter modifications are needed.

8.3.1. Creating new Measurement Task

To create a new task, select **Create new** and enter desired task parameters as presented in Figure 55. Task parameters are described in Table 5 on page 50. The same task name cannot be used for multiple tasks. More information on parameters' effect on the measurement sequence is in chapter 6.1 on page 24. The measurement task is saved by pressing **Save**. A new task based on an existing task can be created by opening the existing task and pressing **Copy**, and entering a new name for the new task. **Cancel** returns to the Measurement tasks menu without saving the task.

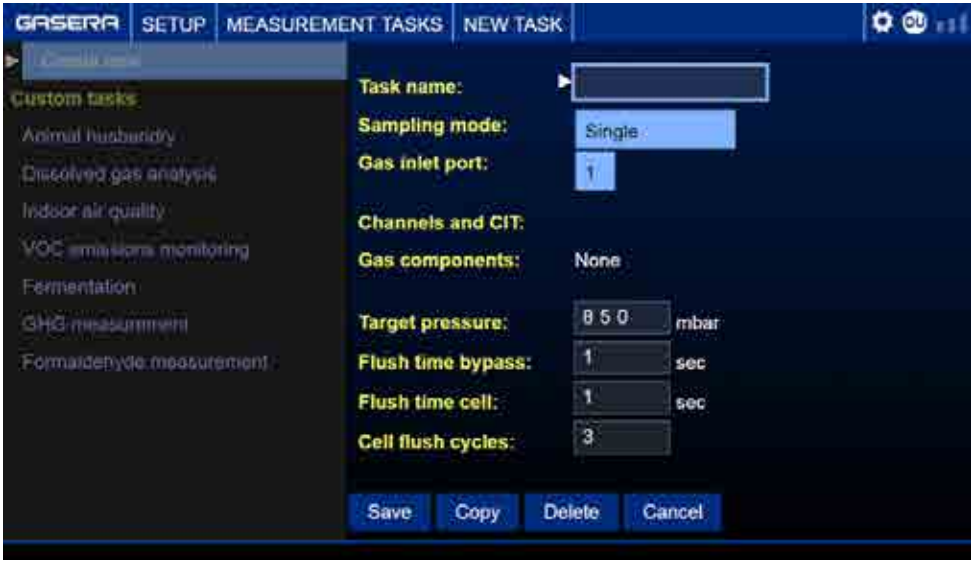

Figure 55. Creating a new task or editing an existing one in Measurement tasks view.

Table 5. The parameters of the Measurement Task.

Parameter	Description
Task name	Name of the task as it appears in the **Measurement** menu. Must be unique for each task.
Sampling mode	Single: One sample input is used. Options depends of the model. Usually, only single mode is available.
Gas inlet port	This defines which of the **Sample input** gas ports is used for taking a new gas sample. The possible values are 1 or 2 indicating gas inlets SAMPLE 1 IN and SAMPLE 2 IN. The location of gas inlets is presented in chapter 3.4.3 on page 10.
Channels and CIT	Defines which channels are being used and channel integration times (CIT) defining how long the signal will be integrated per channel. Please refer to measurement information from chapter 6.1 on page 24. WARNING: Never change these settings without deep understanding of their effects. Incorrect values will reduce instrument performance. See more information below the table. WARNING: The original factory settings are not stored separately in the device, so they cannot be restored automatically.
Gas components	Defines what gas components are displayed in analysis. Note: In some models, the gas component list contains components that are mutually exclusive, as those are being measured using the same channel, e.g., the same optical filter in NDIR. The device automatically prevents selecting components that are exclusive.
Target pressure	The device adjusts automatically the gas pressure in the sample cell. This is the target value for the cell pressure. WARNING: Keep this equal to the value used in the calibration because calibration is valid only when measuring at the correct sample pressure.
Flush time bypass	Defines how long by-pass gas line is being flushed during the gas exchange. The bypass line is the tubing parallel to the gas cell enabling to take as fresh gas sample as possible. The optimal flush time depends on the length of the tubing before GASERA ONE sample inlets. See also flow chart in chapter 4.2.1 on page 12. More information on parameters' effect on the measurement sequence is in chapter 6.1 on page 24. If Flush time bypass is set to zero, the unit will skip the bypass flushing.
Flush time cell	Defines how long the measurement cell is being flushed during the gas exchange. See also flow chart in chapter 4.2.1 on page 12. More information on parameters' effect on the measurement sequence is in chapter 6.1 on page 24.
Cell flush cycles	Defines the number of the cell flushes done during the gas exchange. See also flow chart in chapter 4.2.1 on page 12.

Avoid any changes to **Target pressure** or **Channels and CIT,** since the current calibration is valid only with default values of these settings. The original factory settings are not stored separately in the device, so they cannot be restored automatically to factory defaults.

Target pressure: All GASERA ONE models are based on photoacoustic measurement technology which is always sensitive to the gas cell pressure. The instrument has calibration only with one cell pressure, so the calibration is not valid for any other pressure than the pressure in calibration.

Channels and CIT: Channel integration times (CIT) set the time for averaging the signal from each channel. Value for CIT is entered as a multiplication factor of the shortest possible integration time, which depends on the GASERA ONE model. The effect of **Channel and CIT** settings depend on the properties of sample gas and also instrument specifics, e.g., error rejection algorithm used. For example, if the sample gas in not reactive, or is "non-sticky", the CIT has a rather minor effect on the measurement performance. In this case, the CIT is limited mainly by the instrument drift. However, with reactive or "sticky" gases, the CIT value has a critical role in the performance. Proper sampling of the "sticky" gases requires expertise because of complicated phenomena between the gas and the cell, the tubes and other surfaces in contact with the gas. These effects are minimized by using the most inert materials and coatings possible, but factory defaults for CIT should not be changed.

8.3.2. Flushing configuration

Flushing the sample cell and internal gas lines is useful for example getting rid of traces of previous samples, drying the cell or before calibration. Flushing operation can be configured as a special type of **Measurement Task**. An example of such configuration is presented in Figure 56, where Measurement Task template is configured with the first 100 sec of bypass flush and then 999 of 2-sec-long cell flush cycles.

When FLUSH Task configuration is completed, the user can start flush as a normal measurement based on template from "FLUSH" Measurement Task. For information on how to start the measurement, please refer to chapter 6.2 on page 27.

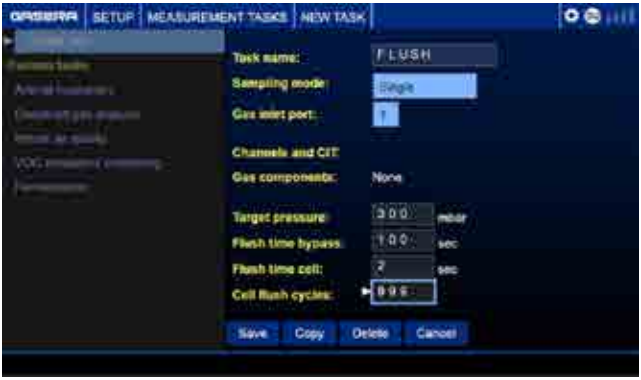

Figure 56. Measurement task for Flushing operation.

8.4. Measurement settings

Measurement settings, presented in Figure 57, contains the configuration of advanced settings. The settings and parameters configured under this view are used for all the measurements.

The user can select the **Default data display mode** from two options:

- **Normal** - All individual measured concentration values are displayed as they are, or without filtering or other post-processing. This is the factory default value.
- **Moving average** - Measured concentration values are filtered with the moving average. Moving average length has three options: 1 min, 3 min or 5 min as illustrated in Figure 58.

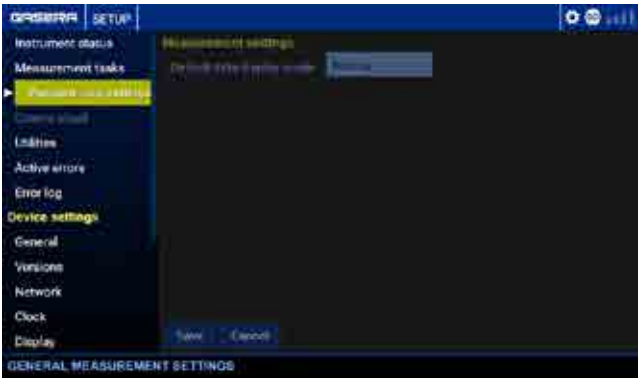

Figure 57. Measurement settings menu for advanced options.

The default data display mode is used for any display of results, so it is used both in the real-time measurement under **Measurement** menu and in viewing the old results in **Results** menu. The selected mode is stored in the device as a new default.

The moving average is calculated point-by-point, every time a new measurement result is ready. The moving average is calculated based on measurement results with timestamps within the selected moving average length. Thus, the number of data points for moving average is not fixed and may differ in certain cases when the measurement time, or its multiplication, is close to the moving average length. When starting a new measurement, the moving aver-

Figure 58. Setting the length of the moving average.

age is calculated from all the available data points until the moving average length begins to limit the data set. If the moving average length is shorter than the interval between new measurement values, which might be the case in some GASERA ONE models, the moving average is calculated from single points being equal to original values.

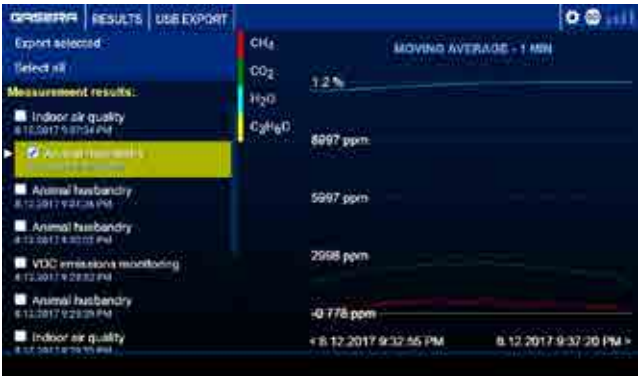

Figure 59. Measurement preview displayed with Moving average of 1 minute.

The figures below present two examples of measurement averaged with different moving average configurations. Figure 59 presents animal husbandry measurement results previewed with minute period average.

Figure 60 presents the same measurement displayed with 3 minute Moving average settings.

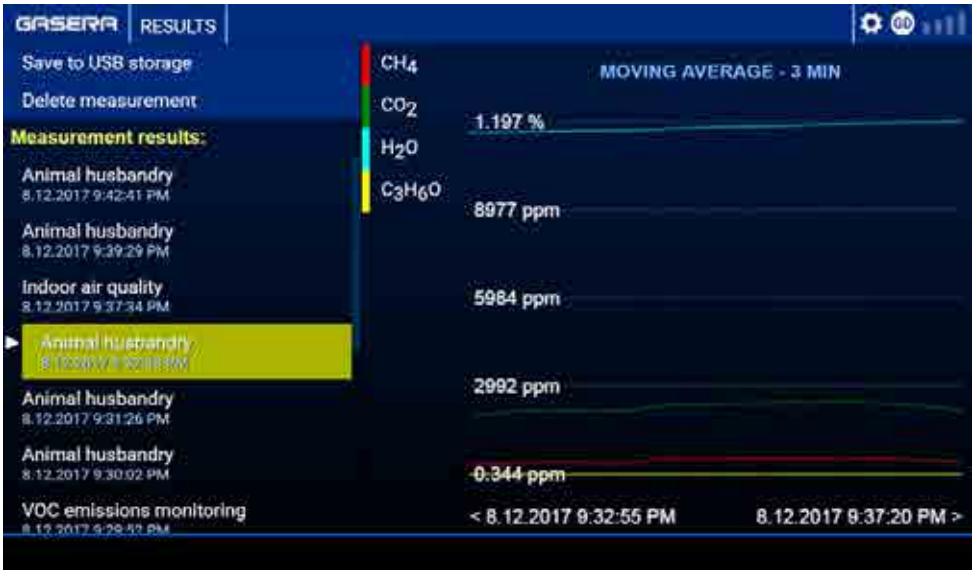

Figure 60. Measurement preview displayed with Moving average of 3 minutes.

8.5. Utilities

8.5.1. Self-test

GASERA ONE automatically runs a self-test during the startup. Self-test is a routine test of instrument operations and includes:

- Filter wheel drive test (for selected models)
- Internal gas line test
- Interferometer intensity and fringe parameters check the condition of optical microphone

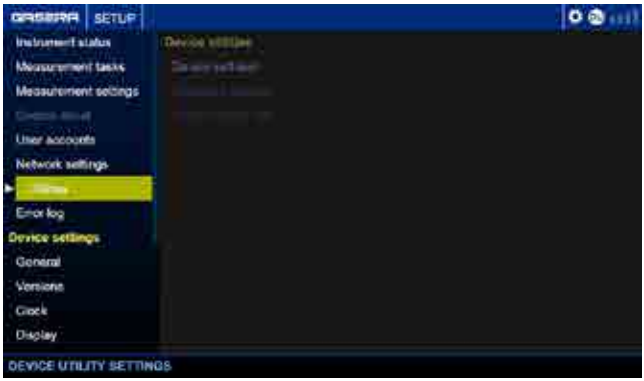

Figure 61. The Utilities menu and its functions.

Internal gas line testing includes pressure sensor and gas exchange test and consists of several tests:

- Pressure sensor and pump test
- Leak tests of the gas line and the sample cell
- Test if any gas line has a blockade

The self-test can be manually executed from **Utilities** menu as presented in Figure 61. The self-test is executed by pressing the **Device self-test** and then **Start self-test** as presented in Figure 62.

If the instrument has been operated a long time without a restart, it is recommended to run the self-test.

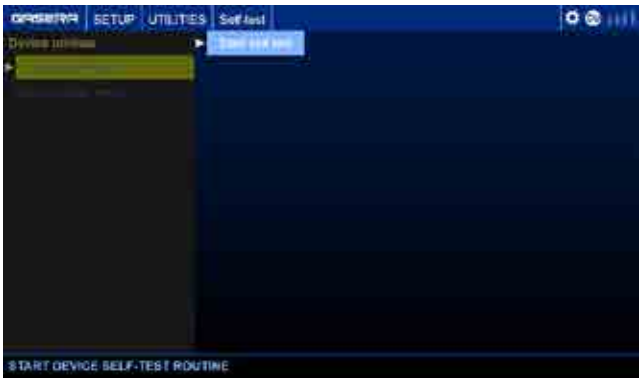

Figure 62. Manually executing the device self-test in Utilities menu.

8.6. Active errors

GASERA ONE has an internal error management system which indicates the user about error situations using:

- Alert icon on indication bar on the top right corner of the display
- Change of color of the LED ring around the GASERA ONE button

For more information about indications, see chapter 5.1 on page 21.

Active errors list displays currently active errors as shown in Figure 65. The error codes and the severity levels are listed in chapter 10.2 on page 68.

Opening highlighted **Active Errors** list enables the user to scroll through currently active errors as presented in Figure 64. The same view can be opened also by clicking on the error icon on the indication bar of the display.

Figure 63. Active errors view.

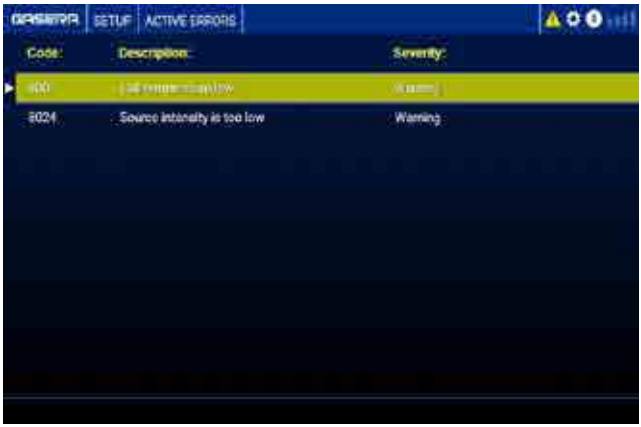

Figure 64. Scrolling through Active errors.

8.7. Error log

Information about all active and past error states is required for diagnostic purposes. Error logs can be exported for diagnostics as instructed in chapter 8.1 on page 42.

Error log view displays a list of all errors that have been active since the last instrument start. This is presented in Figure 65.

Figure 65. Error log menu item showing the error list.

The list can be opened for scrolling by clicking highlighted **Error log**. An example of opened Error log list is presented in Figure 66. It presents an **Error log** view right after the cold start of the device. In this example, the error "Cell temperature too low" is a normal condition after cold startup. It is blocking the start of any measurement. Another error is a warning-level notification "Source intensity too low" indicating that the IR source is not yet in its stable condition.

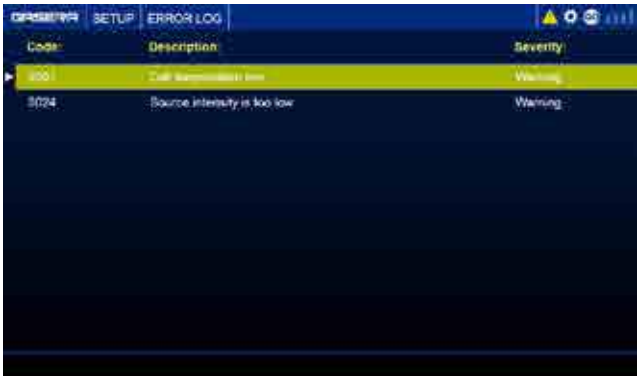

Figure 66. The Error log view showing two active error items.

Please note that both "Cell temperature low" and "Source intensity is too low" are part of the warm-up procedure. Their role is to block measurement start until thermal conditions are stabilized. Both errors will be cleared automatically when instrument warm-up is completed.

8.8. Device settings

8.8.1. General

General menu shows information about the GASERA ONE unit, such as the serial number. Each GASERA ONE unit has a unique serial number printed on the rear panel and stored to the internal memory. It is also possible to give a user defined name to the unit as presented in Figure 67.

Figure 67. Defining a name for the GASERA ONE unit and the serial number.

8.8.2. Versions

The **Versions** presented in Figure 68 lists the versions of the software modules loaded into the instrument. All the GASERA ONE software and firmware can be updated from this view. For instructions, how to update the software, see chapter 9.4 on page 66.

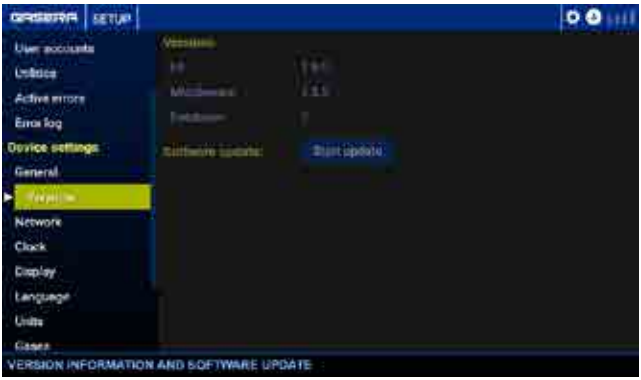

Figure 68. Versions view lists the software versions and provides the software update.

8.8.3. Network

The instrument can be connected to a local area network via the Ethernet connection in the rear panel of the instrument. Ethernet connection is used mainly for maintenance and support functions and is not recommended when it is not necessary.

> Never connect GASERA ONE to unprotected networks or the internet without a secure firewall. For IP network settings and security, please consult your network administrator.

GASERA ONE can be connected to a network using either DHCP assigned IP address (default option) or static IP address as set in **Network settings** configuration as presented in Figure 69.

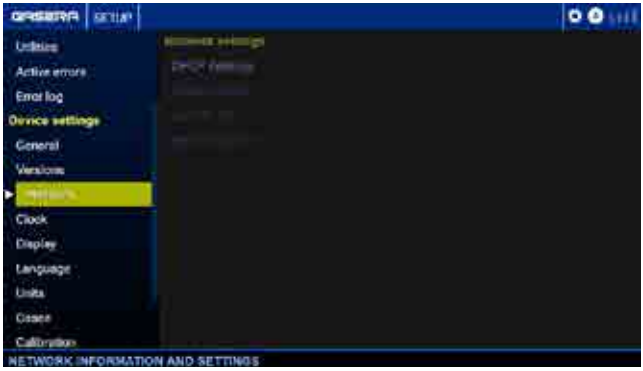

Figure 69. The Network settings view.

The DHCP is set under the **DHCP Settings** submenu. DHCP can be enabled or disabled using the check box **Use DHCP**. When DHCP is disabled, the **IP address**, **Subnet mask** and **Default gateway** must be defined manually. The settings are saved by pressing **Save** or discarded by pressing **Cancel**. The new network settings will be applied after restarting the device.

8.8.4. Clock

Clock view, presented in Figure 70, enables adjustment of instrument internal clock to match the current local time and date.

Figure 70. The Clock view for setting the time and date for the device.

Time zone can be selected from the drop-down menu as presented in Figure 71. The instrument will convert time stamps to the selected time zone from UTC time used to store time stamps in internal database. Thus, time values of the old measurement results will be displayed in the new time zone, after the zone has been changed.

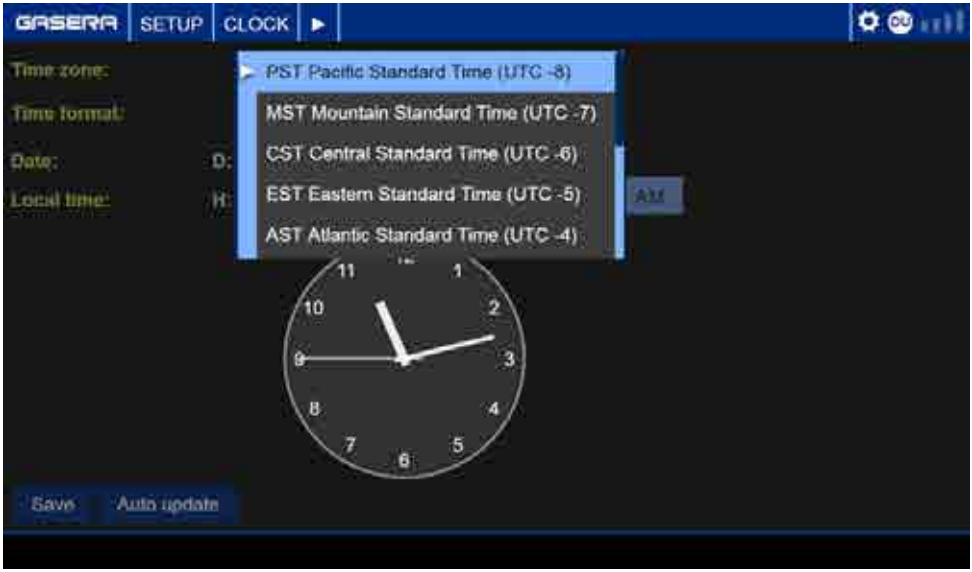

Figure 71. Selecting Time zone settings.

Time format can be selected as either 24-hour or 12-hour time format. Please remember to set correct AM/PM value if 12-hour mode is selected as presented in Figure 72.

Figure 72. Selecting AM/PM Local time for 12h Time format.

New **Date** field values can be entered as numeric values. New **Local time** values can be entered either as numeric values as presented in Figure 73 or by manipulating highlighted (selected) clock hand using GASERA ONE button as presented in Figure 74.

Changes are accepted by pressing **Save** button.

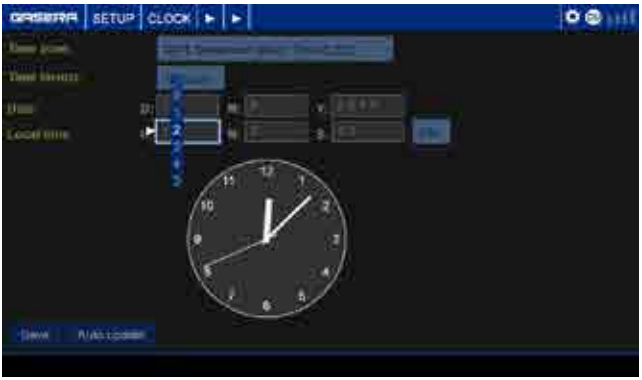

Figure 73. Setting the correct time by entering a new time value as numbers.

Figure 74. Setting the correct time by rotating the hand of the clock. The longer hand is highlighted and can be rotated using GASERA ONE button.

Please note that whereas new Clock settings are applied to the UI by pressing the Save button. Please note, that after pressing Save, a full device restart is required.

8.8.5. Display

The **Display** setup view is shown in Figure 75. It enables the user to set up the screensaver and adjust brightness (if available).

The **Screensaver** settings can be changed by pressing **Screensaver** and then checking the **Enable screensaver** box as illustrated in Figure 76. If the user wants to activate the screensaver during a measurement, the user can select **Show during measurements**. The time in seconds after the screensaver is activated is entered to the **Set idle time (seconds)**. The changes are stored by pressing **Save** and discarded by pressing **Cancel**.

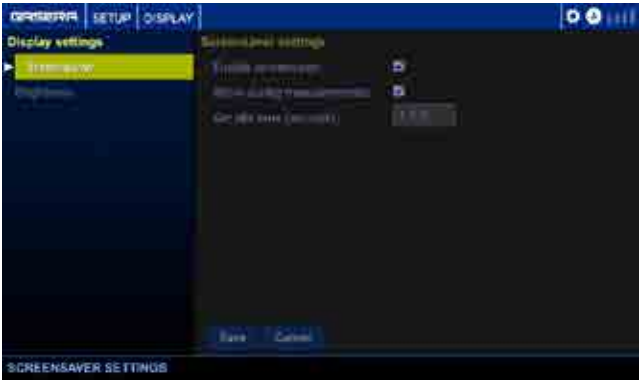

Figure 75. Display view with access to screensaver preview.

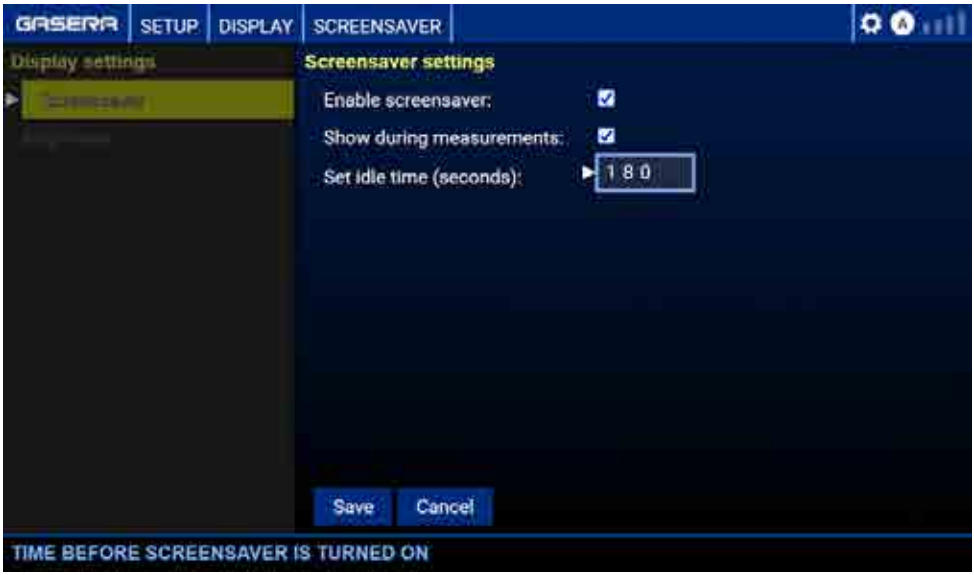

Figure 76. Screensaver configuration.

8.8.6. Language

The instrument localization is set under from the **Language** view. Default language is English. Contact the local distributor or Gasera customer support for more information concerning possible localization options.

8.8.7. Units

The view is enables the user to view units for length, pressure, temperature and gas component concentrations as presented in Figure 77.

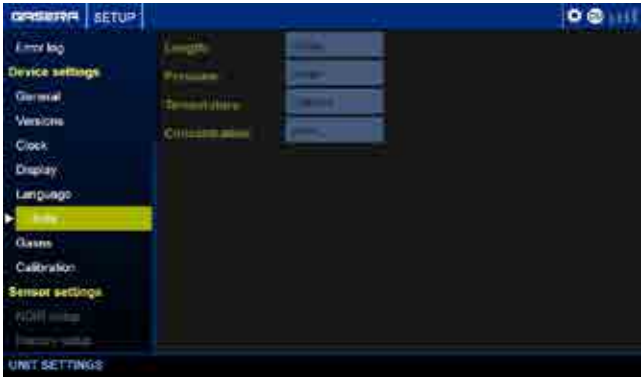

Figure 77. Setting the default displayed units.

8.8.8. Gases

GASERA ONE identifies the gas components by their standard and unique CAS-numbers. Because CAS-numbers are sometimes inconvenient, the user can give a more familiar name to each gas component in the **Gases** menu presented in Figure 78 and Figure 79. Any gas component can be also hidden by selecting **Show in concentration view.** Hidden components are still measured if they are selected for the Measurement task. To prevent measuring a component, see chapter 8.3 on page 48.

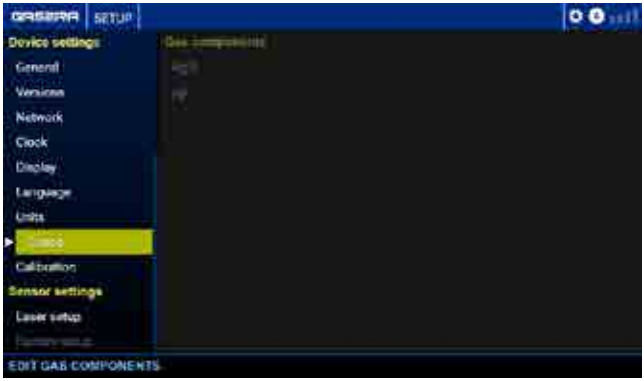

Figure 78. Gases menu for setting the user-defined name for gas components.

Figure 79. Example of defining a name for methane gas. GASERA ONE identifies the methane by its CAS number 74-82-8 but the name ‘’METHANE” is more familiar to most users.

8.9. Calibration

Calibration critically influences the device performance, especially accuracy of measured gas concentrations. Thus the calibration is only recommended to be done by Gasera or a trained service representative using proper gas sampling infrastructure. The calibration requires special expertise and knowledge about creating calibration samples and furthermore about the device itself.

All GASERA ONE models are calibrated at the factory.

Calibration view under Setup menu enables instrument recalibration. Figure 80 presents the example of calibration configuration for H2O component.

Figure 80. Calibration view displaying settings for H2O component calibration.

To recalibrate GASERA ONE, please always contact the local distributor or Gasera customer support to get application specific calibration instructions.

8.10. Sensor settings

The **Sensor settings** menu has sensor-dependent parameters and settings, such as Laser setup. All parameters configurable from the **Sensor settings** menu are intended for diagnostic purposes for service personnel. Contact the local distributor or Gasera customer support for more information.

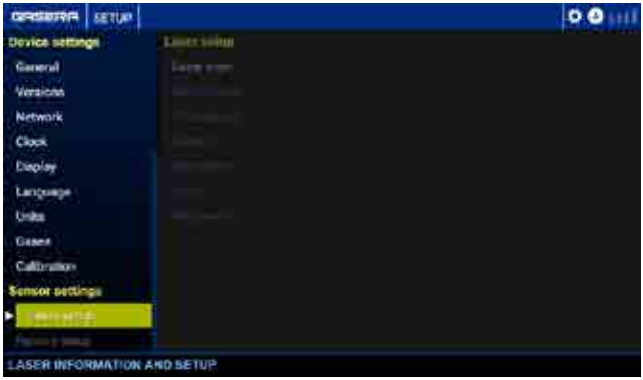

Figure 81. Sensor settings view displaying Laser setup configuration preview.

9. Basic maintenance

9.1. Recovery from a power cut

In a situation of an accidental power cut, the ongoing measurement is stopped. The results of the last complete measurement iteration have already been stored to the instrument memory and are available for reviewing or exporting. After power comes back on, the system restarts to the main menu. The user must manually restart the measurement. Before restarting, the user should make sure that measurement settings were saved correctly.

If automatic transport lock is available in your instrument model, it may stay unsecured after an accidental power cut. Do not ship the device before automatic transport lock is engaged again. To engage automatic transport lock, please restart the device and turn it off when it is in idle mode (e.g., when Main Menu is visible on the display). See also chapter 4.3.3 on page 20.

9.2. Replacing particle filters

The particle filters must be replaced regularly. The replacement interval is once a year at minimum, but the interval may be shorter depending on the application. New filters and O-rings are available as spare parts from Gasera and also from third parties. Always use O-rings made of FPM rubber.

Replacing the particle filters:

1. Locate the particle filter holders in the rear panel. See Figure 82 for examples from Pulse, Chopper and DFB models.
2. Disconnect gas tubes. See instructions in chapter 4.2 on page 12.
3. Open the filter holder cover by rotating it counterclockwise. An exploded view of the filter holder is in Figure 83.
4. Replace the filter disc and all O-rings.
   - The filter disc: 25 mm syringe filter disc with PTFE membrane and pore size 0.2 µm (For e.g. Pall PALLAP-4225T Acrodisc© Syringe filters)
   - O-ring 1: 33x2 mm (FPM rubber must be used)
   - O-ring 2: 6x1 mm (FPM)
   - O-ring 3: 29x2 mm (FPM)
   - O-ring 4: 6x1 mm (FPM)
5. Carefully close the filter holder by rotating the cover clockwise.

Figure 82. Particle filter holders' location.

Figure 83. Exploded view of the filter holder for replacing the particle filter and O-rings.

9.3. Replacing the fuse

The fuse is located inside the mains connector in the rear panel as presented in Figure 84. The fuse ratings are presented in the type label close to the mains connector. To change the fuse:

- Turn off the instrument and remove the mains cable
- Pull out the fuse holder in the middle of the connector
- Replace the fuse with a new one, with correct rating
- Firmly push the holder back into the connector

> Use only a fuse with the correct rating defined in the type label. Always turn off the instrument and remove the mains cable from the mains connector before opening the fuse holder.

Figure 84. Location of the fuse in the mains connector in the rear panel.

9.4. Updating the software

All the GASERA ONE software and firmware can be updated. Contact your local distributor or Gasera customer support to receive a new software package and latest instructions for the update. Once an update package is received, copy it to the root of the USB mass storage device formatted to FAT32 or ext3. Then perform the update:

- Connect the USB mass storage device the USB port in the front panel (for USB location, see chapter 3.4 on page 8).
- Go to the **Setup** menu and select **Versions**. Select the **Start update** button as presented in Figure 85.
- The device starts the update process. If the USB mass storage device is not connected, the user is prompted to plug in a USB device as presented in Figure 86.

Figure 85. Starting the software update from the Versions view in the Setup menu.

- GASERA ONE automatically detects the update package and loads it to the device. During the update, all other functions are not accessible and the LED ring is red. Do not power off the device while updating.
- The device gives a message when the update is complete. Note: All GUI functions are disabled until restart.
- Remove the USB mass storage device.
- Restart the GASERA ONE.

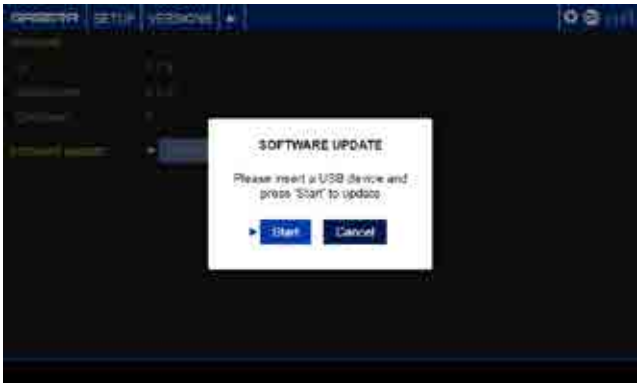

Figure 86. If USB mass storage is not detected, the user is prompted to insert a USB device.

10. Basic diagnostics

GASERA ONE products have an internal error management system that will detect and log most of the possible faults, which helps in troubleshooting. Error situations are categorized as specified in Table 6.

Table 6. Basic diagnostics – error situations.

Error situation	Description
Startup failure: the instrument does not start at all or has a failure during normal startup	For resolving this failure please refer to chapter 10.1 on page 68.
Error code is generated during startup self-test or during operation and displayed in UI	For resolving this failure please refer to chapter 10.2 on page 68.
Other erroneous behavior, e.g., the unit can measure but the performance or accuracy is not as expected	Contact Gasera customer service as instructed in chapter 11 on page 80.

10.1. Startup failure

If the instrument does not start at all when the power-on switch is in the on position, check the following:

- Power cord is in condition and properly plugged in
- The fuse is not broken

If power cord is not in good condition, replace it with a new one. If fuse is broken, replace the fuse as instructed in chapter 9.3 on page 66. If both power cord and fuse are fine, please contact Gasera customer service as instructed in chapter 11 on page 80.

10.2. Warning and error messages

10.2.1. Error severity levels

Errors are categorized into four severity levels, depending on their effects. The severity level defines how GASERA ONE system reacts to the error state and how the user can try to fix the error. The severity levels are defined in Table 7. Error messages and resolving them are given in Table 8 in the following subchapter.

Table 7. Error severity levels.

Severity level	Effects	User action required
Warning	Operation of the device is fully allowed. Some warnings give an early warning for service needed in near future. Warnings have no effect or only a minor effect on the performance.	No immediate action required. Warnings are typically temporary and GASERA ONE fixes most of these situations automatically. For the best performance for e.g. in calibration, wait until the warning message disappears.
Retry	Device rejects the current measurement and will restart the iteration. For data integrity, the iteration counter is not increased and data from rejected measurement will not be stored. This might occur for e.g. if the scanning of EC-QCL source fails.	No action required.

Severity level	Effects	User action required
Blocker	A new measurement cannot be started until the blocking condition has ceased. An ongoing measurement can be continued. Typical cause is that some sensor value is too much out of bounds. There is a blocker right after startup before the gas cell has reached the target temperature.	Wait until a blocker message disappears. Blockers are typically temporary and GASERA ONE fixes most of these situations automatically. If the blocker persists more than 30 minutes, restart the device and wait again. If the blocker does not disappear, write down error code(s) and contact a local distributor or Gasera customer support.
Critical	A new measurement cannot be started until the critical error condition has ceased. An ongoing measurement will stop. Typical cause is that some sensor value is critically out of bounds or there is a HW communication error. The GASERA ONE button LED ring becomes red.	Restart the device. If the problem reoccurs, write down the error code(s) and contact a local distributor or Gasera customer support.
Fatal	Major malfunction. Operation of the instrument is not possible. The GASERA ONE button LED ring becomes red.	Shut down the device immediately. Write down the error code(s) and contact a local distributor or Gasera customer support.

10.2.2. List of error messages

Table 8 lists the most common errors detected automatically by the GASERA ONE. If an error not listed here appears, check Table 7 for possible user action based on the error severity level. If that does not help, please write down the error code(s) and contact a local distributor or Gasera customer support.

The internal error management system and error logging are described in chapter 8.7 on page 55.

Table 8. List of error messages.

Code	Severity level / Message in UI	Description	Repairing
8001	WARNING Cell temperature is low	Photoacoustic cell temperature is slightly below the target. Typically occurs after startup when the system has not yet reached a stable condition. Temperature may also fluctuate during normal operation depending on ambient conditions	Wait until the temperature has been stabilized. Ensure that the environment temperature is in operational temperature limits specified in User Manual.
8002	WARNING Cell temperature is high	Photoacoustic cell temperature is slightly over the target. See Error 8001	See Error 8001
8003	BLOCKER Cell temperature is low	Photoacoustic cell temperature is too low for reliable measurements. Typically occurs after startup when the system has not yet reached a stable condition.	Wait until the temperature has been stabilized. This may take up to 30 minutes. Ensure that the environment temperature is in operational temperature limits specified in User Manual. If problem persists for at least an hour, move the unit to a room of about 20°C–25°C temperature. If problem continues, please contact Gasera support.
8004	BLOCKER Cell temperature is high	Photoacoustic cell temperature is too high for reliable measurements. See Error 8003	See Error 8003
8005	CRITICAL Cell temperature is critically high	Photoacoustic cell temperature is equal to or higher than 55°C which is too high to operate.	Restart the unit to see if the error will disappear. Ensure that the environment temperature is in operational temperature limits specified in User Manual. Test if the error disappears when the environmental temperature is 20–25°C. If problem persists contact Gasera support.
8006	CRITICAL Cell temperature is critically low	Photoacoustic cell temperature is equal to or lower than 10°C which is too low to operate.	See Error 8005

Code	Severity level / Message in UI	Description	Repairing
8011	CRITICAL Sampling line is blocked	There is a blockade in the sampling line last used. The blockade prevents a proper gas flow and thus taking a new sample. This is detected during a measurement or during self-test	Remove any possible blockades from the incoming gas line. For example if the gas cylinder valve has been closed in an incoming sample line, this error may happen. Disconnect tubes from SAMPLE 1 IN and SAMPLE 2 IN, and run the self-test by restarting the unit or manually. If the self-test passes, the blockade is in the sample line outside the unit. Otherwise, see error codes returned by the self-test.
8012	CRITICAL Measured overpressure in sampling line	The absolute pressure in the incoming gas is more than 1.2 bar. The pressure is checked in the start of every gas exchange and during self-test. The operation has been stopped to protect the pressure sensor in the photoacoustic cell.	Ensure that the pressure of the incoming gas is below safe limits given in Chapter 2.
8013	WARNING Cell pressure is incorrect	Sample pressure in the cell deviates approximately 1% from the target value. This level pressure deviation has only minor effect to measurement result.	If the error occurs frequently, run self-test for several times to detect any leaks in the internal sample line of the unit. If the self-test does return any errors about leaks, there is no need to repair. If self-test returns an error, proceed according to the error code.
8015	CRITICAL Gas exchange module is offline	The Gas Management Unit does not respond, or the response is unreasonable.	If problem persists contact Gasera support.
8021	BLOCKER Source intensity is too high	Source intensity is too high for reliable measurements. Intensity may fluctuate during normal operation.	Wait and see if the intensity is within acceptable limits and the error disappears. The device adjusts intensity automatically. If the problem occurs frequently, contact customer support for more accurate diagnostics and further repair instructions.
8022	BLOCKER Source intensity is too low	Source intensity is too low for reliable measurements.	See Error 8021
8023	WARNING Source intensity is too high	Source intensity is slightly higher than the target value. Intensity may fluctuate during normal operation.	See Error 8021
8024	WARNING Source intensity is too low	Source intensity is slightly lower than the target value. Intensity may fluctuate during normal operation.	See Error 8021

Code	Severity level / Message in UI	Description	Repairing
8025	WARNING Source voltage is too low	Source voltage is lower than the target value. Source voltage may fluctuate during normal operation. Used only in GASERA ONE Chopper products.	Wait until the voltage is within acceptable limits and the error disappears. The device adjusts the voltage automatically. If the problem occurs frequently, the broadband infrared source is aged and must be replaced. Contact customer support for instructions.
8026	BLOCKER Source is warming up	The infrared source is warming up to its target temperature. Typically occurs after device startup. Used only in GASERA ONE Pulse units during the source ramp-up.	Wait until the error code disappears after the source has warmed up.
8031	WARNING Chopper period is short	Period of the rotating mechanical chopper is slightly shorter than the target value. Chopper period may fluctuate during normal operation without remarkable effect on measurement results. Used only in models equipped with a mechanical chopper.	If the error occurs frequently, the chopper motor or its controller electronics must be changed. Contact customer support for further repair instructions.
8032	WARNING Chopper period is long	See Error 8031	See Error 8031
8041	WARNING Laser temperature is too low	The temperature of the infrared laser mount is slightly too low but still acceptable. Typically occurs after startup when the system has not yet reached a stable condition. Laser temperature may fluctuate during normal operation.	The device adjusts the laser mount temperature automatically, so this error should disappear after a while. If problem persists, contact Gasera support.
8042	WARNING Laser temperature is too high	The temperature of the infrared laser mount is slightly too high but still acceptable. Typically occurs after startup when the system has not yet reached a stable condition. Laser temperature may fluctuate during normal operation.	See Error 8041

Code	Severity level / Message in UI	Description	Repairing
8043	BLOCKER Laser temperature is too low	The temperature of the infrared laser mount is too low for reliable measurements. Typically occurs after startup when the system has not yet reached a stable condition. Laser temperature may fluctuate during normal operation.	The device adjusts the laser temperature automatically, so this error should disappear after a while. This may take up to 30 minutes. If the error occurs frequently, ensure that the environment temperature is within operational temperature limits specified in Chapter 3. Contact customer support for further repair instructions.
8044	BLOCKER Laser temperature is too high	The temperature of the infrared laser mount is too high for reliable measurements. Typically occurs after startup when the system has not yet reached a stable condition. Laser temperature may fluctuate during normal operation.	See Error 8043
8045	WARNING Source intensity is too low	Source intensity is slightly lower than the target value. Intensity may fluctuate during normal operation.	See Error 8021
8046	RETRY Laser not available	Retries to startup the infrared laser module within the same iteration. Seen in models with an EC-QCL laser.	The device restarts the measurement iteration, which usually solves the issue and measurement process continues automatically. If the laser fails to restart after multiple attempts, the device ends up in error state 8048.
8047	WARNING Laser restart has occurred	Gives a warning to the user that infrared laser module has been restarted. See error code 8046.	If problem persists, contact Gasera support.
8048	CRITICAL Laser restart reached maximum count without success.	The device has tried to restart the infrared laser to the maximum count without the laser running properly. See also error code 8046.	If problem persists, contact Gasera support.
8051	CRITICAL Filter wheel is not turning	System is unable to get the filter wheel position. Incorrect wheel position will lead to incorrect measurement results. Used only in models equipped with a filter wheel.	If problem persists, contact Gasera support.

Code	Severity level / Message in UI	Description	Repairing
8061	WARNING Laser 1 temperature is too low	Internal temperature of the infrared laser 1 is slightly lower than the target value. Typically occurs after startup when the system has not yet reached a stable condition. Stabilization may take up to 30 minutes, depending on the environment temperature and the target temperature for the laser. Depending on the model, the unit runs the laser ramp-up on device start-up or after starting a measurement. Temperature may also fluctuate during normal operation.	The device adjusts the laser driving parameters automatically, so this error should disappear after a while. If the error does not disappear after 30 minutes or several restarts, ensure that the environment temperature is within operational temperature limits specified in Chapter 3l. Contact to the customer support for further repair instructions.
8062	WARNING Laser 1 temperature is too high	Internal temperature of the infrared laser 1 is slightly higher than the target value. See Error 8061	See Error 8061
8063	WARNING Laser 1 locking parameter lower limit reached	Infrared laser 1 frequency locking parameter is slightly lower than the target value. Typically occurs after startup when the system has not yet reached the stable condition. Stabilization may take up to 30 minutes, depending on the environment temperature and the target temperature for the laser. Depending on the model, the unit runs the laser ramp-up on device start-up or after starting a measurement. May occur also occasionally during normal operation.	Ensure that the environment temperature is within operational temperature limits specified in Chapter 3. Ensure that the sample has at least some water in it. Laser locking might not function properly with too dry sample (this is model- and application-specific). If the error does not disappear after 30 minutes or several restarts, contact customer support for further repair instructions.
8064	WARNING Laser 1 locking parameter higher limit reached	Infrared laser 1 frequency locking parameter is slightly higher than the target value. See Error 8063.	See Error 8063
8066	BLOCKER Laser 1 temperature is too low	Internal temperature of the infrared laser 1 is too low for reliable measurements. See Error 8061	See Error 8061
8067	BLOCKER Laser 1 temperature is too high	Internal temperature of the infrared laser 1 is too high for reliable measurements. See Error 8061	See Error 8061

Code	Severity level / Message in UI	Description	Repairing
8068	BLOCKER Laser 1 current is too low	Electrical current for infrared laser 1 is too low for reliable measurements.	If problem persists, contact Gasera support.
8069	BLOCKER Laser 1 current is too high	Electrical current for infrared laser 1 is too high for reliable measurements.	See Error 8068
806a	CRITICAL Laser 1 temperature is critically low	Internal temperature of the infrared laser 1 is too low to operate. System has automatically shut down the laser module to prevent permanent damage of the laser component.	If the error does not disappear after several restarts or occurs frequently, ensure that the environment temperature is in operational temperature limits specified in User Manual. Contact customer support for further repair instructions.
806b	CRITICAL Laser 1 temperature is critically high	Internal temperature of the infrared laser 1 is too high to operate. System has automatically shut down the laser module to prevent permanent damage of the laser component.	See Error 806a
806c	CRITICAL Laser 1 current is critically low	Electrical current for infrared laser 1 is too low to operate. System has automatically shut down the laser module to prevent permanent damage of the laser component.	See Error 8068
806d	CRITICAL Laser 1 current is critically high	Electrical current for infrared laser 1 is too high to operate. System has automatically shut down the laser module to prevent permanent damage of the laser component.	See Error 8068
806e	CRITICAL Laser 1 current limit is active	Hardware limit circuit of infrared laser 1 has shut down the laser to prevent too high an electrical current and possible permanent damage of the laser component.	If the error does not disappear after several restarts or occurs frequently, ensure that the environment temperature is in operational temperature limits specified in Chapter 3. Contact customer support for further repair instructions.
806f	CRITICAL Laser 1 is disabled due to unstable conditions	The system has shut down the infrared laser 1 module. This follows the previous error message of codes 8061 to 806e.	See if other error messages appeared at the same time.
8071	WARNING Laser 2 temperature is too low	See Error 8061	See Error 8061
8072	WARNING Laser 2 temperature is too high	See Error 8062	See Error 8062

Code	Severity level / Message in UI	Description	Repairing
8073	WARNING Laser 2 locking parameter lower limit reached	See Error 8063	See Error 8063
8074	WARNING Laser 2 locking parameter higher limit reached	See Error 8064	See Error 8064
8076	BLOCKER Laser 2 temperature is too low	See Error 8066	See Error 8066
8077	BLOCKER Laser 2 temperature is too high	See Error 8067	See Error 8067
8078	WARNING Laser 2 current is too low	See Error 8068	See Error 8068
8079	WARNING Laser 2 current is too high	See Error 8069	See Error 8069
807a	CRITICAL Laser 2 temperature is critically low	See Error 806a	See Error 806a
807b	CRITICAL Laser 2 temperature is critically high	See Error 806b	See Error 806b
807c	CRITICAL Laser 2 current is critically low	See Error 806c	See Error 806c
807d	CRITICAL Laser 2 current is critically high	See Error 806d	See Error 806d
807f	CRITICAL Laser 2 is disabled due to unstable conditions	The system has shut down the infrared laser 1 module. This follows the previous error message of codes codes 8071 to 806e .	See if other error messages appeared at the same time.
8083	CRITICAL Rack unit internal fan speed is critical	Speed of the cooling fan in the rear panel is too low. May lead to over-heating of the unit or instability of the infrared laser source.	If problem persists, contact Gasera support.
8084	FATAL Rack unit internal fan speed is fatal	The cooling fan in the rear panel has stopped. May lead to over-heating of the unit or instability of the infrared laser source.	See Error 8083
8087	CRITICAL Rack unit internal fan speed is critical	Speed of the cooling fan in the Measurement Unit is too low. May lead to over-heating and instability of the infrared laser source.	See Error 8083

Code	Severity level / Message in UI	Description	Repairing
8088	FATAL Rack unit internal fan speed is fatal	The cooling fan in the Measurement Unit has stopped. May lead to over-heating and instability of the infrared laser source.	See Error 8083
8090	CRITICAL Self-test timeout	Pressure sensor will not return a proper value or any value at all. Sensor is offline or broken. Typically detected during the self-test.	If problem persists, contact Gasera support.
8091	CRITICAL Pressure sensor is not responding	Pressure sensor values do not respond to pumping, or the pressure will not decrease while pump is on. Sensor or pump is offline or broken. Typically detected during the self-test.	See Error 8090
8092	CRITICAL Sample input 1 is not responding	Too low pressure is detected in the bypass line. The input valve port is opened and the sytem checks if then the pressure increases normally. Typically detected during the self-test.	Check that sampling line outside the unit is not blocked. For example, disconnect all gas lines from gas inlets when running the self-test. Replace the particle filter inside the cartridge of the inlet and retry the test. If problem persists, contact Gasera support.
8093	CRITICAL Sample input 2 is not responding	As error 8092, but for inlet 2	As error 8092, but for inlet 2
8094	WARNING Internal sample line is leaking	See error 8095	See error 8095
8095	WARNING Internal sample line is leaking	There is a leak in the internal sample line through the bypass line. Usually, this does not affect to measurement results since this leak does not relate to the sample cell. If the user desires to minimize leaks, repair could be considered. Typically detected during the self-test.	If problem persists, contact Gasera support.
8096	WARNING Measurement cell is leaking	There is a small leak in the photoacoustic cell of the PA Module. May affect measurement results. However, if any other error related to sample pressure or cell leakage does not occur, results are affected only slightly. Typically detected during the self-test.	If problem persists, contact Gasera support.

Code	Severity level / Message in UI	Description	Repairing
8097	WARNING Measurement cell is leaking	See error 8096	See error 8096
8098	WARNING Sampling line has a blockade	Internal sampling line from SAMPLE 1 IN to SAMPLE OUT via the bypass line is opened and gas is pumped thorough the line. If pressure decreases too much, the line has a blockade. Typically detected during the self-test.	Check that sampling line outside the unit is not blocked. For example, disconnect all gas lines from gas inlets when running the self-test. Replace the particle filter inside the cartridge of the inlet and retry the test. If problem persists, contact Gasera support.
8099	WARNING Sampling line has a blockade	As error 8098 but for SAMPLE 2 IN.	See error 8098
8101	WARNING Sampling line has a blockade	Internal sampling line from SAMPLE 1 IN to SAMPLE OUT via the sample cell is opened and gas is pumped thorough the line. If pressure decreases too much, the line has a blockade. Typically detected during the self-test.	If this error occurs in self-test, the blockade is most likely in PA Module which must be replaced. Contact Gasera support. If the error occurs in some other case, try to repair it according to Error 8098 before contacting Gasera support.
8102	WARNING Sampling line has a blockade	As error 8101 but for SAMPLE 2 IN.	See error 8101
8103	CRITICAL MU IFM laser intensity is too low	The signal from the optical microphone is too weak for reliable measurements. This might also indicate aging of laser of the optical microphone. Typically detected during the self-test.	If problem persists, contact Gasera support.
8104	WARNING MU IFM laser intensity is low	The signal from the optical microphone is weak but measurements can be continued. This is an early warning about aging of the optical microphone. Typically detected during the self-test.	Monitor to see if this error message starts to occur more frequently. If problem persists, contact Gasera support. See also Error 8103.
8105	CRITICAL Measurement cell is offline	PA Module does not respond in timeout period. May follow the error messages 8103 and 8104. Typically detected during the self-test.	If problem persists, contact Gasera support.
8106	CRITICAL Measurement cell is offline	See error 8105	See error 8105
8110	WARNING Multipoint Sampler under pressure	Too low absolute pressure in the sampling line of Multipoint Sampler unit. Typically caused by a blocked particle filter in some of the inlets.	Replace particle filters at the inlet ends.

Code	Severity level / Message in UI	Description	Repairing
8111	CRITICAL Multipoint Sampler over pressure	Too high absolute pressure in the sampling line of Multipoint Sampler unit. Measurements will stop to prevent permanent damage of the PA Module.	Decrease the sampling pressure.
8112	CRITICAL Multipoint Sampler not connected	GASERA ONE has not detected the Multipoint Sample unit or the connection is lost.	Contact customer support for more accurate diagnostics and further instructions.
8113	CRITICAL Multipoint Sampler invalid input	Invalid internal input for the Multipoint Sampler unit.	Contact customer support for more accurate diagnostics and further instructions.
E001	CRITICAL UART communication not working	An internal communication bus has been disconnected. If this error occurs during device start-up, the startup indicates “Communication error” before starting the self-test.	Contact customer support for further instructions.
E002	WARNING Device disk space low	There is less than 10% of free disc space left.	Back up measurement data from Results menu. Free up disc space by removing old measurement data. After deleting results, run Compress service database in Instrument status view under Setup menu.
E003	CRITICAL Device disk space is critically low	There is less than 5% of free disc space left. No new data can be stored to the disc, because the system needs some free space to work properly. See also Error E002.	See Error E002

11. Contacting Gasera

11.1. Contacting Gasera customer support

Gasera customer support e-mail address: support@gasera.fi

11.2. Shipping GASERA ONE for service

Please contact Gasera customer support via e-mail for authorization and instructions prior to shipping any items for repair.

Package the GASERA ONE unit carefully to avoid any damage during shipment. Send the package to the address provided by Gasera customer support.

11.3. About Gasera

More information about Gasera can be found on the company webpage and social media:

www: www.gasera.fi

Facebook: @GaseraLtd
Twitter: @gaserafinland
YouTube: @GaseraLtd
LinkedIn: Gasera Ltd.
SlideShare: Gasera Ltd

Appendices

Appendix A. GASERA ONE models and technology

A.1. GASERA ONE models

A.1.1. GASERA ONE gas analyzers

GASERA ONE is a photoacoustic single or multi-gas analyzer that serves a wide variety of industrial and research applications. GASERA ONE can be tailored to suit many kinds of applications by selecting an optimal light source for the desired application. Available GASERA ONE models are listed on Table 1 on page 8. The following chapters give an introduction to the photoacoustic technology, and an overview of light source technologies currently available for GASERA ONE.

A.1.2. Multipoint sampler

GASERA ONE Multipoint sampler, illustrated in Figure 87, increases the number of sample inlets up to 16. Multipoint sampler is an optional device available with 8, 12 or 16 sample inlets. Contact your local distributor or Gasera customer support for more information.

Figure 87. GASERA ONE Multipoint sampler with a GASERA ONE analyzer assembled on top of it.

A.2. Photoacoustic technology

GASERA ONE is based on photoacoustic infrared spectroscopy. The photoacoustic detection technology is based on the conversion of optical energy into thermal energy. Modulated infrared radiation is guided into a photoacoustic cell and absorbed by the sample gas, as illustrated in Figure 88. Therefore, a fraction of the ground-state molecular population will excite to higher energy levels, and eventually relax through radiative and non-radiative transitions. The non-radiative part heats the sample gas, which induces a thermal expansion. In an enclosed space, the periodical thermal expansion generates a pressure wave, which can be detected with a microphone. In GASERA ONE, an ultra-sensitive cantilever sensor is used.

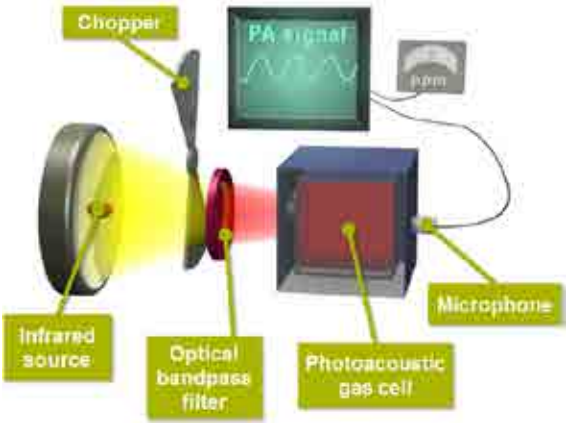

Figure 88. Principle of photoacoustic detection technology illustrated by NDIR setup.

The photoacoustic detection technology offers high sensitivity even with very short absorption path lengths. Only a few centimeters of the path length is needed. Thus, the gas cell dimensions can be minimized without compromising sensitivity. The temperature of the gas cell is stabilized to 50°C to improve measurement stability and to prevent condensation in the cell.

GASERA ONE uses a patented ultra-sensitive optical microphone, illustrated in Figure 89. The microphone has a MEMS cantilever sensor that is highly sensitive to pressure variation. The cantilever microscopic movement is measured with a laser interferometer, providing the detection of even extremely small pressure variations coupled with large and highly linear dynamic range.

Figure 89. Principle of the optical microphone of GASERA ONE.

The light source can be configured based on application requirements, which are typically sensitivity and the number of gas components. Possible configurations include multiple types of laser sources and a broadband infrared emitter with bandpass filters (NDIR) or Fourier Transform infrared technology (FTIR). The available GASERA ONE models and

their light sources are listed in Table 1 on page 8. Photoacoustic cells in GASERA ONE units are always optimized for their light source.

The following chapters describe the principles of infrared light sources used in GASERA ONE models.

The light source can be configured based on application requirements, which are typically sensitivity and the number of gas components. Possible configurations include multiple types of laser sources and a broadband infrared emitter with bandpass filters (NDIR) or Fourier Transform infrared technology (FTIR). The available GASERA ONE models and their light sources are listed in Table 1 on page 8. Photoacoustic cells in GASERA ONE units are always optimized for their light source.

The following chapters describe the principles of infrared light sources used in GASERA ONE models.

A.3. Operation principle of models with NDIR and broadband source

GASERA ONE Pulse and GASERA ONE Chopper are based on non-dispersive infrared (NDIR) spectroscopy providing simultaneous analysis of up to ten gas components. Figure 88 on page 82 presents the principle of NDIR setup with a mechanically chopped source of infrared radiation.

Both models have a light source containing a hot surface emitting radiation, with a spectral distribution close to black body radiation. The spectral band for analysis is selected using optical bandpass filters. GASERA ONE Pulse and Chopper models have eight positions for customizable filters and two positions for fixed filters for CO_2 and H_2O. The number of filters and their pass bands are optimized by the application requirements when the analyzer is ordered.

GASERA ONE Pulse models have a miniature light source that is modulated electronically. GASERA ONE Chopper has a more powerful source modulated by a mechanical chopper. The modulation frequency is selected to provide the best performance.

Photoacoustic signal is measured with all filters for every gas sample. The analysis algorithm compares this data to the calibration data and calculates concentrations of the gas components.

A.4. Operation principle of models with laser sources

A.4.1. Power, wavelength and modulation

Laser light is characterized by its narrow line width and high intensity. The coherent light from a laser is fundamentally different from broadband non-coherent radiation sources. Typical radiative broadband sources illuminate and thus excite several transitions of gases, other than target gases, and thus require tailored chemometry to provide selectivity. However, in the case of lasers,

the illumination is often selected so that it excites only a single molecular transition and thus inherently provides high selectivity and sensitivity. The sensitivity is dependent on the transition strength and light source intensity.

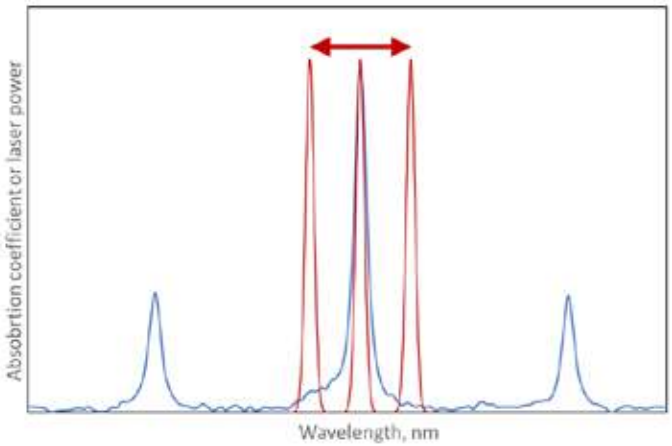

Figure 90. Wavelength modulation principle: The laser line (red) is scanned sequentially over the absorption (blue) feature of the sample gas, which generates sequential absorption of the laser light producing the photoacoustic signal.

The lasers are either wavelength or amplitude modulated. The best modulation method is selected by the application and the laser type. The wavelength modulation principle is illustrated in Figure 90. A narrowband laser is periodically scanned over the absorption feature to generate so-called harmonic signals. The harmonic signals are measured at multiples of the fundamental modulation frequency, and the resulting signal levels are proportional to the gas concentration. The wavelength modulation absorption spectroscopy (WMAS) eliminates background signals produced by the amplitude modulation. Wavelength modulation is limited to continuous-wave (CW) lasers with adequate continuous mode-hop free tuning range. Alternative modulation method is the direct amplitude modulation. It generates a background signal at the modulation frequency that originates, for example, from window and cell absorbance. The background signal is compensated algorithmically using the background calibration.

The actual power and tuning range depend strongly on the operational principle of the laser. DFB lasers generally have very good tuning characteristics and reasonably high power, but the downside is that usually only one or two gas components can be measured simultaneously with a single laser because of the limited tuning range. On the other hand, EC-QCLs and OPOs provide much broader overall tuning range, but they are often operated in amplitude modulation, and thus are limited in their modulation possibilities and on their inherent line widths. They also require more complex chemometry for sufficient selectivity. Optimal laser source is always selected for each application depending on the requirements.

A.4.2. GASERA ONE DFB

GASERA ONE DFB uses a DFB-type laser as the light source, providing high optical power and thus high sensitivity. However, the wavelength tuning capability is limited, so in practice GASERA ONE

DFB units can measure both single and dual gas components. The optimal laser component is selected based on the application gas matrix.

The DFB is an acronym for distributed feedback. DFB lasers have an internal Bragg grating structure that allows lasing only in a very narrow wavelength band. Therefore, DFB lasers produce high-quality narrow line shapes, and their wavelengths can be precisely controlled with chip temperature and drive current. Several types of lasers, such as laser diodes or quantum cascade lasers, can be structured as a DFB laser.

DFB lasers are controlled by their temperature and the driving current. In GASERA ONE DFB, these are optimized to maximum performance with the desired wavelength defined by the application. The wavelength can be tuned using the laser temperature controlled by a thermo-electric cooler integrated with the laser chip. The wavelength is matched to the desired absorption line by tuning the temperature. Then the temperature is kept unchanged to maintain a steady wavelength. The driving current influences the laser power and the wavelength.

GASERA ONE DFB comes with an automated wavelength calibration. A known molecular transition within the tuning range of the laser and close to the target transition is used to provide a highly reliable wavelength reference. This wavelength reference enables long-term measurement stability that could not be otherwise possible because of the slow and natural drift in laser wavelength.

Coupling of laser light into the photoacoustic cell is typically straightforward due to the short path length requirement. The characteristics of a typical laser beam are very close to being ideal with regards to its spatial distribution. The laser beam travels typically only once directly through the cell, where it is absorbed by the sample gas.

A.4.3. GASERA ONE EC-QCL

GASERA ONE EC-QCL takes advantage of the EC-QCL technology, providing the widest wavelength tuning capability of all lasers. EC-QCL-type lasers also produce high optical power with very narrow line width; thus a real spectrum can be measured with high signal to noise ratio. When spectra is analyzed by advanced chemometric algorithms, simultaneous measurement of multiple gas components — even up to tens of gases — with precise selectivity is possible. GASERA ONE EC-QCL can be equipped with single or dual EC-QCL sources.

EC-QCL stands for external cavity quantum cascade laser. The quantum cascade laser is integrated with an external cavity, having a grating for narrowing the line width and tuning the wavelength. EC-QCLs must be temperature-stabilized.

GASERA ONE EC-QCL measures the spectrum with high resolution, meaning that the spectrum has thousands of channels. These channels are grouped as channel groups to help in handling and presenting of data.

www.GASERA.fi