



Main menu of RIGAMO V4.x ("System Configuration")



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1. Features

1.1. General

- Unified Windows® software for **measurement data acquisition** from RITTER products
- Support for multi-core processors
- Windows® software for data acquisition of gas volume and flow rate from up to 18 RITTER Gas Meters to a PC USB port
- Graphical and tabular display of measurement data in real-time
- **Normalization of measurement data** by compensation of
 - ✓ temperature
 - ✓ pressure
 - ✓ humidity
- Storage of measurement data in both SD memory card of *Signal Input Module* »SIM« and PC
- Data Acquisition even during failure of mains power supply (see par. 5.2 "Data Acquisition during Failure of Mains Power Supply")
- Export of stored data to Microsoft Excel® spreadsheet (Excel® 2003 or higher)
- No support of bi-directional recognition of the measuring drum rotation with Pulse Generator V4.01
- Maximum data transmission frequency: 125 Hz
- **The *Signal Interface Module* »SIM« required for data acquisition is not approved for use in ex-proof areas!**

1.2. Measurement of Gas Volume

- Data acquisition of gas volume and flow rate from up to 18 RITTER gas meters
- Measurement of gas temperature for recalculation to norm temperature (normalization)
Please note: With the current version of the »SIM« only one temperature sensor can be connected to one »SIM« unit.
- Measurement of atmospheric pressure for recalculation to norm pressure (normalization)
- Compensation of humidity
- Automatic correction of measurement data based on the individual calibration curve (see par. 11 "Automatic Dynamic Correction of the Measurement Error (Milli-Gascounter only)

1.3. Operation with Biogas Batch Fermentation System »BBFS«

- Temperature Control of Heating Oven
- Speed Control of stirring units of fermentation bottle incl. interval mode
- Real-time status of CO₂ absorption for up to 18 CO₂ absorption bottles (with optional accessory »CO₂ Absorption System« of the Biogas Batch Fermentation System »BBFS«):
 - Display of current CO₂ absorption capacity for each absorption bottle
 - Display of remaining CO₂ absorption for each absorption bottle
 - Alarm function for each absorption bottle if the CO₂ absorption capacity falls below a freely selectable level

1.4. Gas Analysis with RITTER »MultiGas« Sensors (in preparation)

2. System Requirements

- Gas Meter with built-in pulse generator
- *Signal Input Module »SIM«*
- Operating system Windows® 7 / 8 / 10 / 11¹
Please note:
The RIGAMO installation directory must be accessible to the user with the required access rights.
- Microsoft Excel® 2003 or newer for data export to Excel®
- Recommended processor performance: ≥ 2 GHz
- Random access memory (RAM): ≥ 4 GB
- 1 available USB port
- Monitor: ≥ 17"
- Monitor setting: Optimised for resolution of 1280x 1024 pixel or higher
- Mouse / mouse pointer

¹ Rigamo is not compatible with Microsoft computers running with an ARM processor. The software company providing the USB driver used by Rigamo didn't launch an updated driver so far (June 2025).

3. Components / Scope of Supply



Figure 1



Figure 2

1. Signal Interface Module »SIM«
2. USB memory card with:
 - RIGAMO software V4.x
 - Documentation incl. this manual which can be also downloaded here:
<https://www.ritter.de/en/download/rigamo-manual/>

3. Temperature sensor
Figure 1: Sensor with adapter for Drum-type Gas Meters »TG«
Figure 2: Sensor with adapter for MilliGascounters »MGC«

Please note:

- With the current version of the »SIM« only one temperature sensor can be connected to a single »SIM« unit. If several gas meters are connected to one »SIM« unit, the temperature compensation ("normalization") performed by the RIGAMO software will only consider the gas temperature from the temperature sensor of the connected gas meter.

In this case, it is recommended to install the temperature sensor in the gas meter that can be used as a reference temperature for all connected gas meters. If this is not possible, an additional »SIM« unit must be installed for each gas meter, each connected to the first »master« »SIM« unit.

- **The temperature sensor is not approved for use in ex-proof areas!**

4. Power supply unit 12 V DC / 230 V AC
5. 2 x USB cables for connection of »SIM« to computer:
 - 1 x USB "A" plug → USB "B" plug, length 0.5 m
 - 1 x USB "B" socket → USB "B" plug, length 5 m

4. Handling after Receipt

- a) Please read these setup instructions thoroughly to ensure a long and trouble-free operation.
- b) Unpack all parts of the consignment carefully.

5. Signal Interface Module »SIM«



5.1. Features

- a) **The *Signal Interface Module »SIM«* is not approved for use in ex-proof area!**
- b) The *Signal Interface Module »SIM«* is the **key unit for the data transfer** from and to:
- All RITTER Gas Meters
(Drum-type Gas Meter »TG« / Bellows-type Gas Meter »BG« / MilliGascounter »MGC«)
 - PC with data acquisition software »RIGAMO V 4.x«
 - Biogas Batch Fermentation System »BBFS«:
 - Temperature control of heating oven
 - Speed control / interval mode for stirring units of fermentation bottles
 - Management of CO₂ absorption from biogas (optional accessory)
 - Temperature sensor **for recalculation of the actual gas temperature to norm temperature 273.15 K** ("normalization")
Type: PT 1000
Measurement range: 0 ~ 80°C, measurement accuracy ~ ±0.1°C

Please note:

- **The temperature sensor is not approved for installation in an ex-proof area!**
- With the current version of the »SIM« only one temperature sensor can be connected to a single »SIM« unit. If several gas meters are connected to one »SIM« unit, the temperature compensation ("normalization") performed by the RIGAMO software will only consider the gas temperature from the temperature sensor of the connected gas meter.

In this case, it is recommended to install the temperature sensor in the gas meter that can be used as a reference temperature for all connected gas meters. If this is not possible, an additional »SIM« unit must be installed for each gas meter, each connected to the first "master" »SIM« unit.

c) The *Signal Interface Module »SIM«* contains:

- An **absolute pressure sensor for recalculation of the atmospheric air pressure to norm pressure** 1013.25 mbar ("normalization").
Measurement range: 950 ~1050 hPa abs., measurement accuracy~ ±1 hPa
- An integrated SD memory card (16 GB) for permanent, captive storage of the measurement data, independent of the storage of the measurement data on the computer.
 - Minimum storage interval of measurement data to computer: 1 min
 - Storage interval of measurement data to SD memory card: 4 min

5.2. Data Acquisition during Failure of Mains Power Supply

If the power supply of *Signal Interface Module »SIM«* is buffered by an "Uninterruptible Power Supply" (UPS) unit, the data storage on the »SIM« continues even if the mains power supply fails and independently of the computer.

5.3. Description of Ports



- (1) Bus port for interconnection with additional optional »SIM« units
- (2) Bus port for interconnection with additional optional »SIM« units
- (3) USB port to computer with software »RIGAMO 4.x«
- (4) Socket for power supply unit 12 V DC / 230 V AC
- (5) Socket for temperature sensor
- (6) Ports for data acquisition from gas meter(s)

(Picture shows 3-channel »SIM« for connection of 3 gas meters)

5.4. Available Configurations

The *Signal Interface Module »SIM«* is available for data acquisition from up to 18 RITTER Gas Meters. For operation of the »SIM« the data acquisition software RIGAMO V4.x is mandatory. Furthermore, the gas meter must be equipped with the option "Pulse Generator". Each gas meter is connected to the »SIM« through an individual input port. Available port numbers:

Type	Number of Ports
SIM-1Ch	1
SIM-3Ch	3
SIM-6Ch	6
SIM-9Ch	9
SIM-12Ch	12
SIM-15Ch	15
SIM-18Ch	18



SIM-1CH



SIM-9CH



SIM-18CH

6. Installation of the Software and Hardware

6.1. General

The software is provided on a USB memory card.
Alternatively, it can be downloaded from our Website:
<https://www.ritter.de/en/download/rigamo-software-v-4/>

Please note:

RIGAMO must be installed with administrator access rights. The designated access rights for the directory

[installation drive]:\Rigamo

must not be changed. Otherwise, it may not be possible to save measuring data. Furthermore, this directory and its subdirectories must have "read and write" rights for all users.

6.2. Content of the USB card

- ✓ ReadMe BEFORE Installation.txt .. Installation sequence
- ✓ Software files All necessary files for running the software
- ✓ Rigamo-Manual-V4.x.pdf..... This manual
- ✓ Calibration data file(s) In directory "Calibration Data": [serial-no].cal (for MGC MilliGascounter only)

6.3. Setup and recommended Installation Sequence

Do **not** connect the *Signal Interface Module »SIM«* to the PC prior to installation of the software »RIGAMO«.

6.3.1. Installation of the Software »RIGAMO«

It's recommended to install Rigamo in the directory "C:\Rigamo", as the default directory path for measurement data is a subdirectory of this directory: "C:\Rigamo\Results\Port[x]". This default path can be changed individually. However, the directory path for measurement data must be changed accordingly. Please refer to par. 7.4.8 "Target Directory and File Name of Measurement Data".

- a) **Create** on drive C: a **new directory "C:\Rigamo"**
- b) Make sure that this directory has admin rights.
- c) Copy all files from the USB memory card located in the directory "RIGAMO_Software" **into the new directory "C:\Rigamo"**.
- d) Install the appropriate driver for your operating system:
 - 32-bit system:
 \Drivers\USBXpressInstaller_x86.exe
 - 64-bit system: \Drivers\USBXpressInstaller_x64.exe



These drivers are located in the directory "C:\RIGAMO\Drivers"

6.3.2. Connection of Signal Interface Module »SIM« to Computer

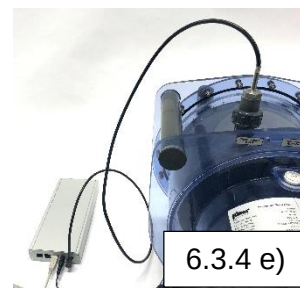
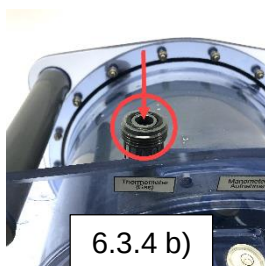
- a) **Connect** port (3) of the »SIM« marked "PC" via the provided USB cable to the PC (see par. 5.3 "Description of Ports").
- b) **Connect** port (4) of the »SIM« marked "POWER" via the provided power supply unit to mains.
- c) **Connect** the Cinch plug of the temperature sensor to port (5) of the »SIM« marked "TEMP".
- d) **Restart** the PC.

6.3.3. Connection of Gas Meter(s) to Signal Interface Module »SIM«

Connect the gas meter(s) with the provided connection cable(s) to the »SIM« ports shown in par. 5.3 (6) "Ports for data acquisition from gas meter(s)". Please ensure that the assignment of the gas meters to the respective ports is identical to the assignment of the channel numbers within the software.

6.3.4. Installation of the Temperature Probe to a Drum-type Gas Meter »TG«**The Temperature Probe is not approved for use in ex-proof area!**

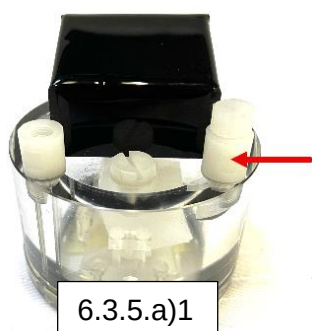
- a) Unscrew the cap nut from the port "Thermometer (Gas)" of the gas meter.
- b) Insert the **sensor** (2) into the port ...
- c) ... and screw the cap nut on hand tight.
- d) Insert the **cinch** plug (1) into the corresponding port of the »SIM« according to par. 5.3 (5) "Socket for temperature sensor".
- e) Photo 6.3.4 e) shows the completed configuration.



6.3.5. Installation of the Temperature Probe to a MilliGascounter »MGC«

The Temperature Probe is not approved for use in ex-proof areas!

- Unscrew the complete screw plug of the gas outlet opening using the special spanner supplied, including its base, which is screwed into the housing of the MilliGascounter. This screw plug is marked with the red arrow in the photo below.
- Screw the Temperature Sensor unit (2) into the gas outlet port; don't use a tool, screw on the unit firmly but hand-tight only so that the O-ring seals this connection. In direction of rotation the unit may have a final position which different to the shown position.
- Insert the Cinch plug (1) into the respective port of the »SIM« according to par. 5.3 (5) "Socket for temperature sensor".
- If required, connect port (3) of the Temperature Sensor unit to a connecting tube or any further device such as a gas sampling bag.



6.3.6. Preparations prior to starting the Software

- Disable all automatic update functions permanently including Windows updates** to prevent a potential shutdown and restart of the computer. **This would terminate the data acquisition.**
- Deactivate all energy-saving settings** because these functions deactivate the USB ports of the PC. **This would terminate the data acquisition.**
- It is recommended to deactivate any anti-virus scanning software as it may conflict with the data acquisition.

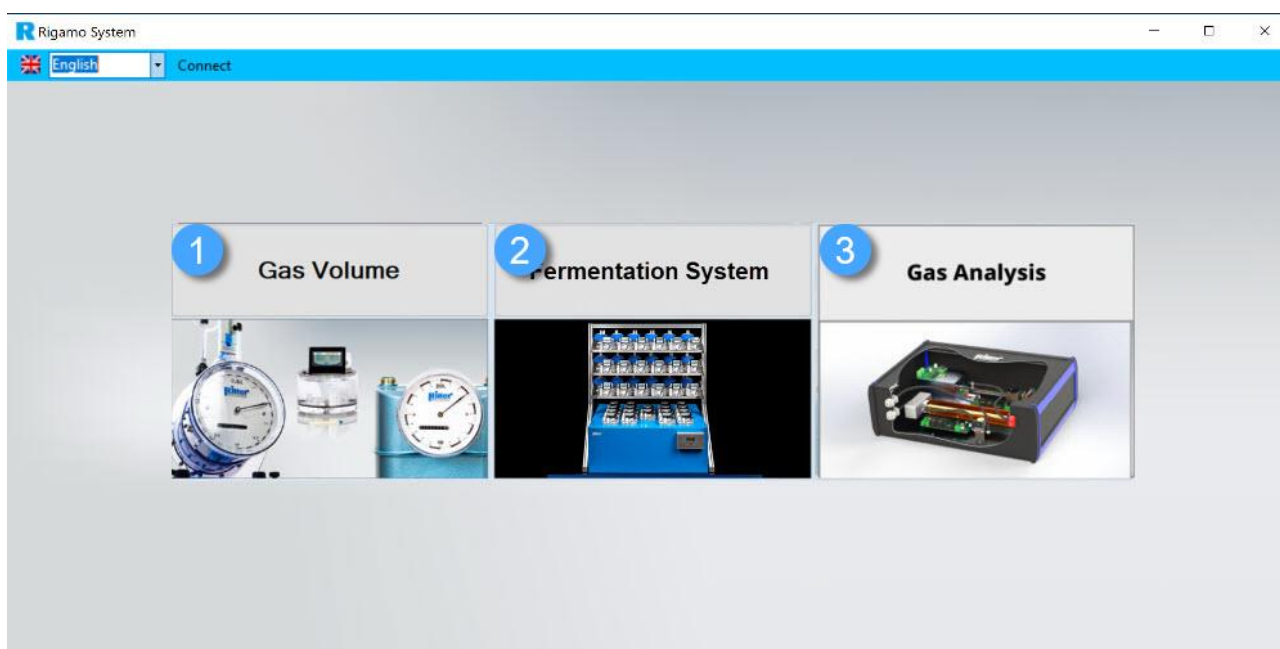
6.4. Starting the Software

The software is started with the file "RIGAMO-V4-[x].exe" in the directory "C:\RIGAMO\".

If no *Signal Interface Module »SIM«* is connected to the computer, the error message "Error finding SIM device" will be displayed, see the following par. 6.4.1.

To open the software without any data acquisition or control functions, press Ctrl+R.

After starting the program, the window "System" appears:



(1) Measurement of gas volume

Data acquisition of gas volume and flow rate from up to 18 RITTER Gas Meters.
See description in par. 7 "Application "Gas Volume"".

(2) Biogas Batch Fermentation System

See description in par. 16 "Application "Fermentation System"".

(3) Gas Analysis

Simultaneous data acquisition with RITTER »MultiGas« Sensors of up to 4 gases plus pressure plus humidity with one sensor unit (in preparation).

The desired application can be started by clicking on the respective menu items.

6.4.1. Connection of the Signal Interface Module »SIM«

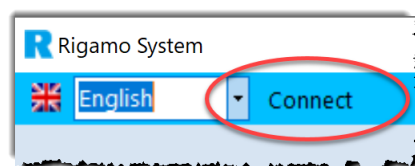
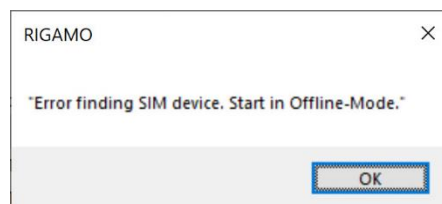
When starting the software, the connected SIM device is automatically detected. If no device is detected the following message is displayed:

In this case please check:

- ✓ Is the »SIM« connected to the power supply (power supply unit 24V»BBFS« or Fermentation System »BBFS«)?
- ✓ SIM connected to the USB port of the PC?

If the device still cannot be connected, please contact your authorized RITTER distributor or RITTER → mailbox@ritter.de

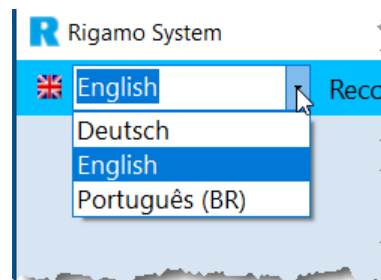
If for any reason a previously connected »SIM« becomes disconnected, it can be re-connected by clicking the button "Connect" (see screenshot on the right).



6.4.2. Selection of Language

The software is pre-set to "English". The desired language can be selected by clicking the pull-down menu (see screenshot on the right).

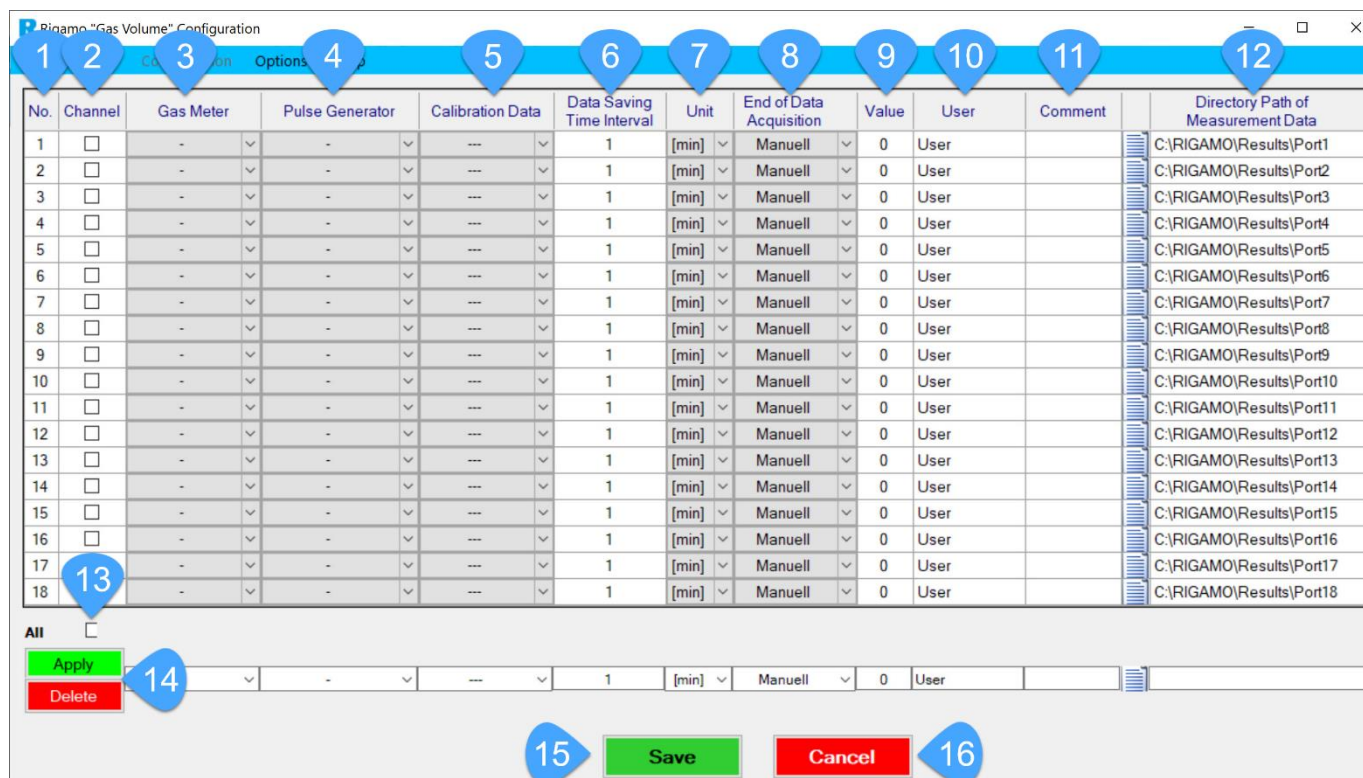
The selected language is saved and used for the following starts of the software until another language is selected.



7. Application “Gas Volume”

7.1. Configuration and Settings

After starting the application, the following *Configuration window* is displayed. All settings necessary for the data acquisition can be configured in this window.



No.	Channel	Gas Meter	Pulse Generator	Calibration Data	Data Saving Time Interval	Unit	End of Data Acquisition	Value	User	Comment	Directory Path of Measurement Data
1	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port1
2	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port2
3	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port3
4	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port4
5	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port5
6	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port6
7	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port7
8	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port8
9	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port9
10	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port10
11	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port11
12	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port12
13	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port13
14	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port14
15	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port15
16	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port16
17	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port17
18	☐	-	-	---	1	[min]	Manuell	0	User		C:\RIGAMO\Results\Port18

All ☐

Apply

Delete

Save

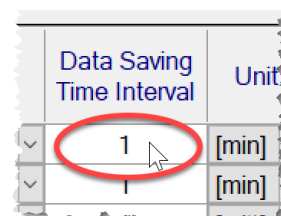
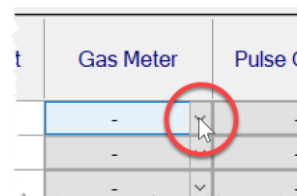
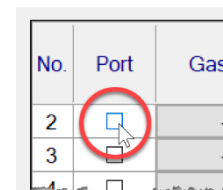
Cancel

- (1) Consecutive number of input ports / channels
- (2) Checkboxes for selection / deselection of single channels (needed for “master line” (14) only)
- (3) Assignment of Gas Meter type to each port
- (4) Selection of Pulse Generator type for each Gas Meter
- (5) Selection of calibration data file for each Gas Meter (MilliGascounter only)
- (6) Input of time interval value for saving of measurement data to the PC
- (7) Selection of time interval unit for saving of measurement data
- (8) Selection of mode for termination of data acquisition
- (9) Input of value for termination of data acquisition (if applicable for selected mode)
- (10) Optional input of user/identifier for a test run (person in charge, laboratory, department etc.)
- (11) Optional input of description or comment for a test run
- (12) Directory path for measurement data
- (13) Checkbox for selection / deselection of all ports
- (14) Master line for simultaneous input / deletion of parameters in selected channels
- (15) Saves entered parameters and closes the *Configuration window*
- (16) Closes the *Configuration window* without saving entered parameters

7.1.1. Field Types

There are three different field types:

- “Checkbox”: This field can be used for selecting ports or data files for subsequent actions such as starting/stopping data acquisition, erasing of parameters, printing of data files etc..
- “List field”: Clicking on the field displays a list of selectable items (e.g. selecting a gas meter type).
- “Input field”: After selecting the field, values can be entered.



7.1.2. General procedure for the configuration of channels

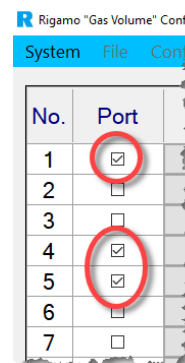
a) Configuration of a single port

- Selecting the checkbox is not necessary (see right side)
- Select / enter the data within the line of the respective port according to par. 7.4 “Assignment of Gas Meter Parameters to Ports at the *Signal Interface Module »SIM«*”



b) Simultaneous configuration of multiple channels with identical data

- Select the checkboxes of required ports (see example right side). If many ports are necessary, the checkbox “All” can be selected according to (c) and any unrequired ports can be deselected afterwards.
- Selection / input of data within the “master line” below of the Configuration Table (see below graphic) according to par. 7.4 “Assignment of Gas Meter Parameters to Ports at the *Signal Interface Module »SIM«*”
- Once the desired data has been entered in the “master line”, this data can be applied to all selected channels with the **Apply** button.

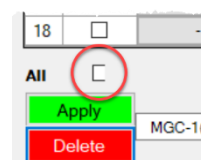


Please note: Calibration data files cannot be applied this way as this would cause measurement errors.



c) Simultaneous assignment of identical data to all ports

- Select the checkbox “All” (see right side)
- Continue as described in (b)



7.1.3. Removing Data / Reverting to factory settings

- Select the checkbox(es) of the required port(s) (or "All" for all ports)
- Remove data in selected port(s) by clicking the **Delete** button
- Previously entered data will be removed and reset to default installation values

7.1.4. Finalizing the Settings / Saving Configuration Data

After all parameters have been entered, the configuration window must be closed with the **Save** button in order to save the entered data. The data will remain saved even when terminating RIGAMO.

When closing the configuration window with the **Cancel** button, all entered data since opening the window will be lost. Previously entered data will remain stored.

7.2. Mandatory Settings prior to Start of Data Acquisition

- a) Selection of gas meter type(s) and assignment to port(s) at the *Signal Interface Module »SIM«* (par. 7.4.1 "Assignment of Gas Meter Type")
- b) Selection of pulse generator (par. 7.4.2 "Assignment of Pulse Generator Type")
- c) MilliGascounters only: Assignment of calibration data (correction factors) to the gas meter(s) (par. 11.3 "Activation of Individual Calibration Data")
- d) **Ticking the checkbox(es) "Show Graph" to display the desired diagram graph(s)** (par. 8.4.3 "Show / Hide of Graphs ")
- e) Monitor settings: Set the size of text and elements (scaling) to "100%". If it is set to higher values, the size of characters within the tables will be too large.

7.3. Optional Settings prior to Start of Data Acquisition

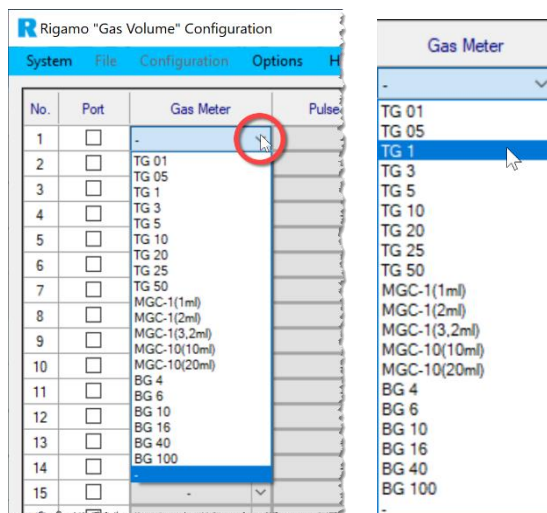
- a) Input of comments regarding the data acquisition to be started (par. 7.4.7 "Comments")
- b) Selection of an individual file name and file path for saving of the measurement data (7.4.8 "Target Directory and File Name of Measurement Data").
- c) Setting the units of the diagram axes for display of gas volume and flow rate (par. 8.2 "Diagram Settings")

7.4. Assignment of Gas Meter Parameters to Ports at the *Signal Interface Module »SIM«*

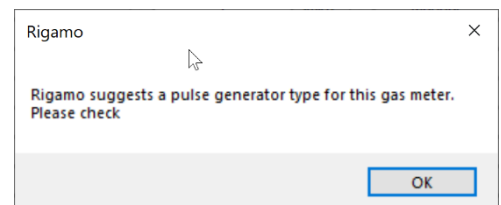
Prior to the data acquisition, the gas meter parameters must be assigned to the respective ports of the *Signal Interface Module »SIM«* where the gas meters are connected to. This can be accomplished in the *Configuration window* as described in general in par. 7.1 "Configuration and Settings".

7.4.1. Assignment of Gas Meter Type

- Open the pull-down menu in the column "Gas Meter" of the respective port (it's not necessary to select the checkbox of this port)
- Select the respective gas meter type which is connected to this port, e.g. »TG1«

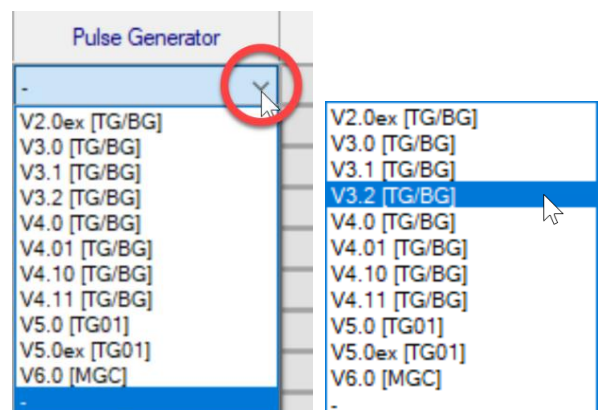


- RIGAMO automatically suggests a suitable Pulse Generator for the selected gas meter type. Please check and select a different type if necessary.



7.4.2. Assignment of Pulse Generator Type

- Open the pull-down menu "Pulse Generator" of the respective port
- Select the pulse generator type of the previously selected gas meter. The pulse generator type of the respective meter is stated at the meter label on top of the counter mechanism casing.

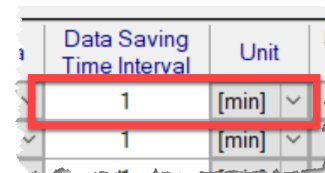


7.4.3. Calibration Data

Please refer to par. 11.3 "Activation of Individual Calibration Data". For general information please regarding the topic "Automatic Dynamic Correction of the Measurement Error" refer to par. 11.1 "General".

7.4.4. Sampling Time Interval

After start of measurement all pulses are detected for the measurement of gas volume. The sampling time interval specifies the time after which a single measurement value (= totaled gas volume and current gas flow rate) is logged from the continuous data stream created by the pulse generator and saved. These logged measurement data are the basis for generating the diagram graphs for volume and flow rate.



The time unit can be set to minutes [min] or hours [h]. The smallest sampling time interval is 1 minute. When setting a short sampling time interval, the available data storage space must be considered for long-term measurements.

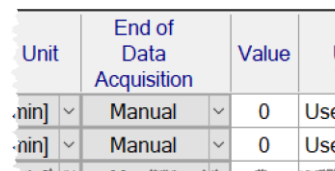
Please note:

- The sampling time interval acts like an indirect averaging of the measurement graph.
- With a long sampling time interval, the time for displaying the next data value may become very long.
- If no pulse is detected during the selected sampling time interval, no data will be saved to the data file at the end of the sampling time interval. Furthermore, there will be no repetitive saving of the last detected pulse.

7.4.5. End of Data Acquisition (Pre-Selection):

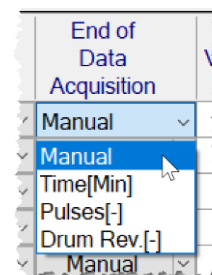
Regardless of the termination mode, the data acquisition can be started and stopped at each port individually.

There are four options available for termination of data acquisition:



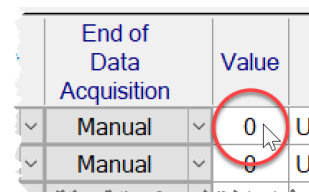
- Manually ⇒ By a click on the button "Start/Stop" at any time at any port.

Please note: If the manual mode is selected for termination of data acquisition but no manual termination occurs, the data acquisition will continue and data will be saved until the storage medium is out of space.



- Time (min)
⇒ After the pre-selected value of time.
- Number of Pulses
⇒ After the selected number of pulses.
- Number of drum revolutions (»TG« Drum-type Gas Meters only)
⇒ After the selected number of drum revolutions

The value for the termination options "Time", "Number of Pulses", and "Number of drum revolutions" can be entered into the corresponding field as shown on the right side.



7.4.6. Identifier for Measurement Data File Name

Optional input of a user-defined identifier for the measurement data file name (person in charge, laboratory, department etc.).

Please note:

- a) This identifier forms the first part of the measurement data file name. The default value for this identifier is "User". If the identifier is deleted and no other is entered, the file name will start with an underline "_". Please also refer to par. 7.4.8.4 "Standard Data File Name".
- b) According to the Windows specification for file names the following special characters are not allowed and will be erased after input:

\\ / > < * ? " | :

7.4.7. Comments

Optional input of a describing text regarding the measurement, parameters etc. This text will be shown in the headers of the respective measurement data file [xxx.txt].

7.4.8. Target Directory and File Name of Measurement Data

Please note:

The target directory for saving of measurement data ...

[installation drive]:\RIGAMO\Results\

... must be accessible to the user with the required access rights. Otherwise, it may not be possible to save the measurement data.

All measurement data, gas meter parameters, and optionally entered test parameters are automatically saved in real time. The default target directory and data file name are stated below but can be changed individually.

The measurement data is stored at the following locations at the following time intervals:

- At the storage medium of the computer:
According to the sampling time interval set in *Configuration* menu (par. 7.4.4 "Sampling Time Interval")
- At the SD card in the *Signal Interface Module »SIM«*:
Every 4 minutes.
(Therefore, blocks of 4 minutes are restored when restoring data from the SD card. Please refer to par. 12.2.1 "Option "Yes" = Recovery and continue data acquisition

7.4.8.1. Standard Target Directory (Default Setting)

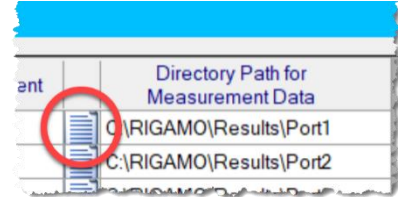
The default directory is C:\RIGAMO\Results\Port[1-24]

7.4.8.2. Custom Target Directory

A custom directory for subsequent data acquisition can be set as follows:

(For simultaneous assignment of one target directory to several or to all ports please refer to par. 7.1.2 b) "Simultaneous configuration of multiple channels with identical data")

- Select the directory icon of the respective port to open the file explorer window of your operating system (see illustration on the right).
- Select the desired path.
- Click on button **Choose Directory** (or similar, depending on your operation system) in the bottom right corner of the file explorer window.



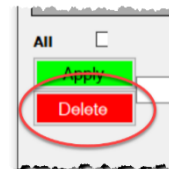
A custom directory will remain valid (even when RIGAMO is closed and restarted) until changed by the user or set to installation default (see following par. 7.4.8.3).

7.4.8.3. Set Target Directories to Installation Default

Previously selected custom directories can be reset to the installation default C:\Rigamo\Results\Port[n] as follows:

- Select the respective port(s) or "All" for all ports
- Click on **Delete** :

Please note: By clicking on **Delete** the settings of the respective port(s) will be deleted as well.



7.4.8.4. Standard Data File Name

The default data file name is:

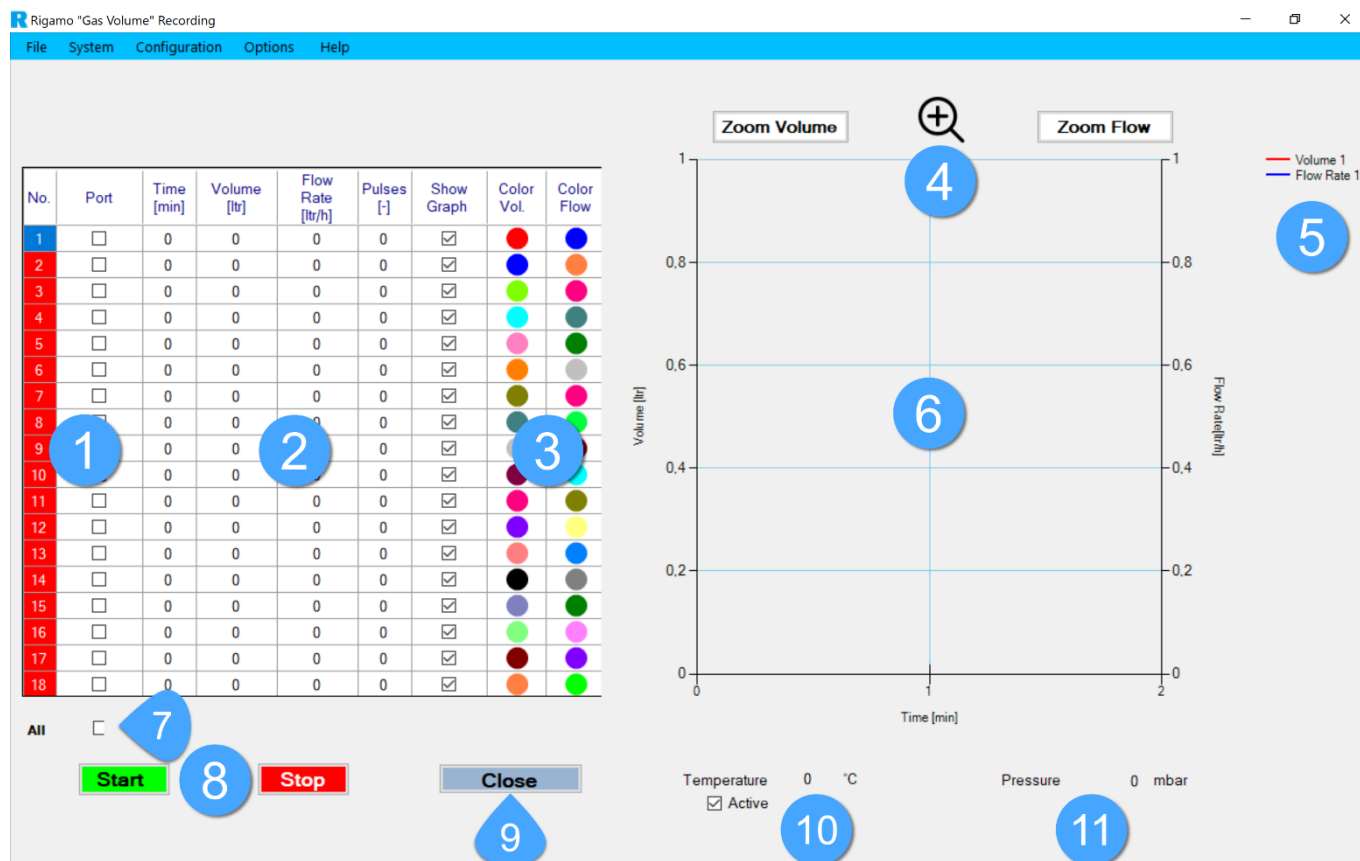
[User]_[Port No.]_[Meter Type]_[yymmdd]_[hhmmss].txt

Date and time of the measurement start will be used for creating the data file name.

For defining a user-defined identifier (instead of "User") please refer to par. 7.4.6 "Identifier for Measurement Data File Name".

8. Display of Data

8.1. Recording Window



Structure of the *Recording window*:

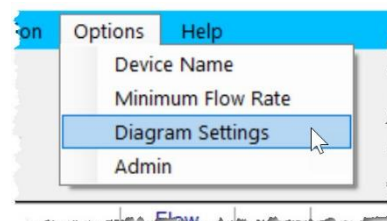
- Area 1: Display of port status
 - ⇒ Blue: No function
 - ⇒ Grey: Ports are not available at connected »SIM« unit. More available ports may be displayed than are actually available on the connected »SIM«. Please check the number of physical available ports on the connected »SIM«.
 - ⇒ Red: Inactive
 - ⇒ Green: Active, data acquisition started
- Area 2: Tabular display of data for respective ports in real time
- Area 3: Checkboxes for displaying or hiding of graphs
- Area 4: Magnification tools for diagram area
- Area 5: Legend for graphs (gas volume and flow rate)
- Area 6: Diagram area for gas volume and flow rate
 - left y axis ⇒ gas volume
 - right y axis ⇒ flow rate
- Area 7: Selection / deselection of all ports
- Area 8: Start / Stop of data acquisition

- Area 9: Closes the *Recording window*
- Area 10: Indication of gas temperature
Activation / deactivation of temperature normalisation
- Area 11: Indication of atmospheric pressure
Activation / deactivation of pressure normalisation

8.2. Diagram Settings

The diagram settings can be changed in the menu "Options" which is available in the windows "Recording" and "Configuration".

For the display of recorded graphs for volume and flow rate the following diagram settings can be selected in the above-mentioned menu "Options".

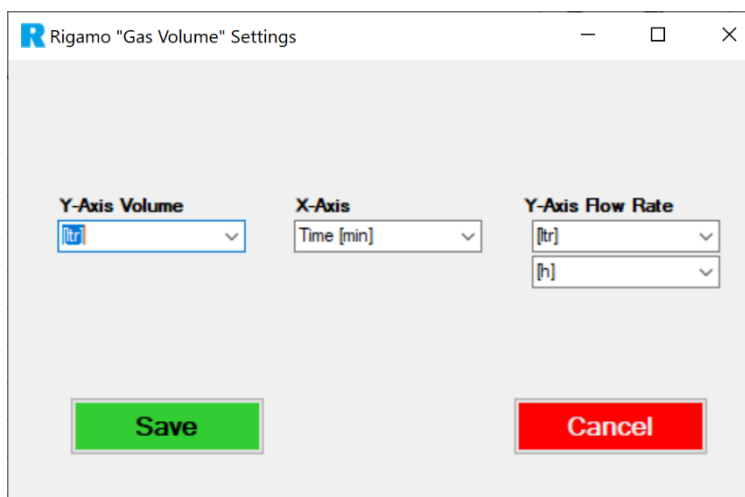


Please note: The diagram settings cannot be changed after the start of data acquisition.

8.2.1. X-Axis

8.2.1.1. Selectable Units

- Pulses [-]
- Time [s]
- Time [min]
- Time [h]
- Time [d]



8.2.2. Y-Axis 1 (Volume)

8.2.2.1. Selectable Units

- Milliliter [ml]
- Liter [l]
- Cubic meter [m³]
- Cubic foot [ft³]

8.2.3. Y-Axis 2 (Flow Rate)

8.2.3.1. Selectable Units

Volume		per	Time
Time	[s]	Milli liter	[ml]
Time	[min]	Liter	[l]
Time	[h]	Cubic meter	[m³]
Time	[d]	Cubic foot	[ft³]

For the display of flow rate all combinations of volume and time are possible.

8.2.3.2. Limitation of Flow Rate (MilliGascounters only)

If the maximum flow rate range of the MilliGascounter is exceeded far beyond its limit, the flow rate graph in the diagram will be limited to 3 ltr/h.

For further information please refer to par. 11.4 "Limitation of the Maximum Flow Rate".

8.3. Tabular Display of Data

Please set in Windows <Control Panel><Display> the scaling option of your monitor for the size of text and elements to "100%". If it is set to a larger value, the display of the data within the display boxes will be too large.

The data is updated every second regardless of the sampling time interval set in the window *Gas Volume Configuration*. Please note, however, that the update may not be displayed in the following cases:

- The sampling time interval set in the menu *Gas Volume Configuration* has not elapsed.
- No further impulse has been recorded yet.

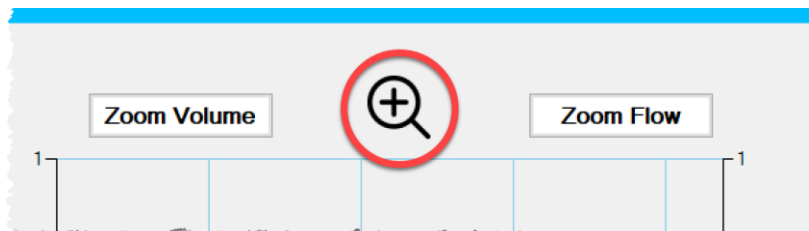
8.4. Graphical Display of Data

8.4.1. Updating of Graphs in Diagram

The graphs are updated according to the Sampling Time Interval set in the *Configuration window*.

8.4.2. Magnification of the diagram area

The diagramm area can be set to full screen with the magnification icon: The data table

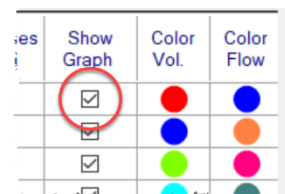


will be hidden while the diagramm area is enlarged. A repeated click on the magnification icon will show the previous view of both the data table and the diagramm area.

8.4.3. Show / Hide of Graphs in Diagram

The graph pairs for volume and flow rate can be displayed for each channel individually. To display the graphs, the checkbox(es) of the respective channel(s) must be selected in the column "Show Graph" of the window *Recording* (see screenshot on the right side).

☒ shows graph(s) ☐ hides graph(s)



With the standard installation setting, the display of all channels is pre-selected.

8.5. Deletion of Graphs

After restarting data acquisition from any channel, the previous graphs for volume and volume flow of this channel are automatically deleted from the diagram.

9. Data Acquisition

9.1. Conflict with “Microsoft .NET Framework”

In order to avoid a conflict with “Microsoft .NET Framework” the following precautions are recommended:

- **Deactivate ALL automatic update functions including Windows updates** during data acquisition as these function may shut down the computer and/or disconnect the USB port.
- **Deactivate ALL energy-saving settings** as these functions may deactivate the USB ports of the PC which would terminate the data acquisition.
- If a conflict is caused by one of the a.-m. functions, an **error message** is displayed by the **“Microsoft .NET Framework”**.

Furthermore, it is recommended ...

- ... to **deactivate any anti-virus scanning software** as it might conflict with the data acquisition.
- ... to **disconnect the computer from a company or university network** as such networks might overrule the a.-m. settings at the local computer.

9.2. Preparation

a) Before starting the data acquisition, the following steps **must** be completed:

- Selection of gas meter type and assignment to the ports on the *Signal Interface Module »SIM«*
⇒ menu <Configuration> (par. 7.4.1 “Assignment of Gas Meter Type”).
- Selection of pulse generator
⇒ menu <Configuration> (par. 7.4.2 “Assignment of Pulse Generator Type”)
- Setting the required graphs to “Show”
⇒ menu <Recording> (par. 8.4.3 “Show / Hide of Graphs ”)

b) **Optionally** the following settings can be made before starting the data acquisition:

- Input of a user-defined identifier in the data file name
⇒ menu <Configuration> (par. 7.4.6 “Identifier for Measurement Data File Name”)
- Selection of an user-defined target directory for saving of measurement data
⇒ menu <Configuration> (par. 7.4.8.2 “Custom Target Directory”)
- Setting the units of the diagram axes for the display of gas volume and flow rate
⇒ menu <Recording><Options> (par. 8.2 “Diagram Settings”)

9.3. Start of Data Acquisition

The data acquisition can be started (and stopped) at any port or combination of ports up to the number of ports of the connected *Signal Interface Module »SIM«*.

Available ports are marked in red, not available ports are marked in grey. More available ports may be displayed than are actually available on the connected »SIM«. Please check the number of available ports of the connected »SIM«.

No.	Port
1	☐
2	☐
3	☐
4	☐
5	☐
6	☐
7	☐
8	☐
9	☐
10	☐
11	☐
12	☐

1. Please make sure that all mandatory settings are completed according to par. 9.2 "Preparation".
2. To select port(s) for data acquisition, the checkbox(es) of the respective port(s) must be selected ⇒ ☒

This can be done either for **single ports**, a **group of ports** or for **all ports** by selecting "All" ⇒



No.	Port	Tim [min]
1	☒	0
2	☒	0
3	☐	0
4	☐	0
5	☒	0
6	☒	0
7	☐	0
8	☒	0
9	☒	0
10	☐	0

3. In order to start the data acquisition, please click **Start**.

The status indicators of the selected port(s) will change from red to green and the data acquisition starts at those ports. The screen shot at the right side shows the running data acquisition from the ports no. 1, 4 and 5.

The measurement data will be saved automatically to the directory set in the menu <Configuration> (please refer also to par. 7.4.8 "Target Directory and File Name of Measurement Data").

No.	Port
1	☒
2	☐
3	☐
4	☒
5	☒
6	☐
7	☐

Please note: If the “Manual” mode is selected for termination of the data acquisition but no manual termination takes place, data recording and saving of the data will continue until the capacity limit of the storage medium is reached.

9.4. Saving of Measurement Data

When starting the data acquisition, data files are generated according to the number of ports on which the data acquisition is started. The file names correspond to the names as set in the window *Configuration* (see also: par. 7.4.8 “Target Directory and File Name of Measurement Data”). These data files are text files with the file name extension “.txt”.

Furthermore, the marker “_TMP” is added to the file names at start-up:
→ [FileName]_TMP.txt.

When the data acquisition is finished as planned and set in the *Configuration window* → “End of Data Acquisition”, the marker “_TMP” is deleted.

If the data acquisition is unexpectedly stopped, e.g. due to failure of the PC and / or the mains power supply, the marker “_TMP” remains until the next start of the RIGAMO software.

In this case, the data file and measurement data can be recovered according to par. 12 “Data Recovery”

9.5. During Data Acquisition

9.5.1. Opening of Data Files

Data files are saved to the directory C:\RIGAMO\Results. For opening and/or processing during data acquisition a data file should be copied into any different directory first. A data file should not be opened in the original Rigamo directory in order to avoid a writing/reading conflict.

9.5.2. Display

During the data acquisition the currently measured values are displayed both graphically in the diagram and in the table for each active port .

If required, during data acquisition ...

- ... the graphs of any ports can be hidden or shown (see par. 8.4.3 “Show / Hide of Graphs ”),
- ... the list of parameters in the menu “Configuration” can be monitored but not changed.

9.5.3. Updating of Data

Each pulse of the gas meter’s Pulse Generator is detected by the software. The corresponding values of volume and flow rate are updated in the window *Recording* as follows:

- In the data table: After a pulse has been detected
- In the diagram: After approx. 10 sec

9.5.4. Detection of Gas Flow Interruption

For calculation of the flow rate, the elapsed time between the last two pulses is measured. To avoid an infinite loop in the software when the gas flow is interrupted or after the end of the gas flow, the volume flow is set to zero after a certain time. The duration is dependent on the minimum flow rate and pulse generator of the respective meter.

To change the minimum flow rate please refer to par. 14.2 "Minimum Flow Rate".

9.5.5. Limitation of maximum flow rate (MilliGascounters only)

If the maximum flow rate range of the MilliGascounter is exceeded far beyond its limit, the **maximum flow rate is limited to 3 ltr/h**.

For further information please refer to par. 11.4 "Limitation of the Maximum Flow Rate"

9.5.6. Opening and Processing of Data Files

Data files are saved to the directory C:\RIGAMO\Results. (Please refer also to par. 7.4.8 "Target Directory and File Name of Measurement Data".) For opening and/or processing during data acquisition a data file should be copied into any different directory first. A data file should not be opened in the original Rigamo directory in order to avoid a writing/reading conflict.

9.6. End of Data Acquisition

According to the "End of the Measurement" mode, which was selected in the menu "Configuration", the data acquisition will be terminated either manually or automatically after the selected ...

- ... time
- ... number of pulses
- ... number of drum revolutions (only with Drum-type Gas Meters type »TG«)

Regardless of the termination mode data acquisition can be started and stopped for each port or a group of ports individually.

Manual termination

1. To select the port(s) for termination of the data acquisition, the checkbox(es) of the respective port(s) must be selected ⇒ ☒ This can be done either for **single ports**, a **group of ports** or for **all ports** by selecting the checkbox "All" ⇒ **Please make sure, that the checkboxes of only those channels are marked which shall be terminated.**



2. In order to terminate the data acquisition of the selected port(s), please click **Stop** ⇒



The status indicator of the selected port(s) will change from green to red. **The data acquisition of the other port(s) remain(s) active.**

The measurement data will be saved automatically to the directory which was set in the *Configuration window* for the respective port(s). Please refer to par. 7.4.8 "Target Directory and File Name of Measurement Data" as well.

Please note: If the manual mode is selected for termination of the data acquisition but no manual termination occurs, the data acquisition continues and data will be saved until the storage medium is full.

10. Processing of Data

10.1. Averaging of Data

The following calculation modes apply for averaging of the recorded data:

10.1.1. General Averaging

In general, a **moving average** applies to the recorded data **over the last 10 recorded measurement data sets**. The resulting average value is displayed in both the data table and diagram.

Please note when using drum-type gas meters:

According to the physical measuring principle with drum-type gas meters, the individual chambers of the measuring drum are opened and closed cyclically. The active chamber **must be closed before** the following chamber opens.

This compulsory measurement on the one hand is the reason for the high measuring precision of drum-type gas meters. On the other hand, the opening and closing of the measurement chambers creates a marginal pressure increase within the chamber. The surface tension of packing liquid causes an additional pressure increase when a chamber **emerges from the liquid (water: highest, oil: less, CalRix: lowest surface tension)**. The resulting pressure increase creates a small reduction in the rotational speed of the measuring drum which – almost invisible to the eyes in most cases – is recorded very precisely by the software. Thus, a slightly wavelike graph of the flow rate shows the real flow through the measuring drum.

10.1.2. Averaging with Changes of the Gas Flow

When the current **gas flow value varies by more than 50%** from the last average value, the averaging starts from the beginning without consideration of the previous values.

10.1.3. Averaging with Interruptions of the Gas Flow

When the **gas flow is interrupted**, the flow rate value is set to zero according par. 9.5.4 "Detection of Gas Flow Interruption" without any further averaging. When the gas flow starts again, the averaging starts from the very beginning without consideration of the values before and during the downtime.

10.2. Normalisation of Volume

RITTER gas meters are volumetric gas meters and measure the current gas volume at the current gas temperature and gas pressure. The »RIGAMO« software converts the measured current volume into the standard volume of the gas at standard conditions:

Norm temperature = 273.15 Kelvin (= 0°C)
Norm pressure = 1,013.25 mbar

The formula for converting the **current volume** into **standard volume** is as follows:

$$V_N = V_i \times \frac{P_a}{P_N} \times \frac{T_N}{T_i}$$

where V_N = Norm volume in [ltr]
 V_i = Displayed volume in [ltr]
 p_N = Norm pressure in [mbar absolut]
 p_a = Current gas pressure in [mbar absolut]
 T_N = Norm temperature in [Kelvin]
 T_i = Current temperature in [Kelvin]

The temperature sensor is installed in the gas meter, the pressure sensor for measuring the atmospheric pressure in the "Signal Interface Module" (SIM).

10.3. Humidity Correction

The volume correction due to the humidity of the gas is carried out according to VDI4630 using the Magnus formula:

$$p_w = 6,11231 \cdot e^{\left(\frac{17,5043 \cdot T}{241,2 + T}\right)}$$

p_w Vapour pressure of water as a function of the temperature of the surrounding space [hPa] (example: p_w at 38°C = 66 hPa)

T Gas temperature

10.4. Correction of the Volume based on the Calibration Curve (MilliGascounter only)

The measurement error in MilliGascounters, which is dependent on the flow rate, is corrected by an algorithm with the calibration factors determined by the individual calibration. (For details see the following par. 11.)

11. Automatic Dynamic Correction of the Measurement Error (MilliGascounter only)

11.1. General

Because of the physical measurement principal, the measurement error is dependent on the flow rate. The error is approx. +3% at min. flow rate and -3% at max. flow rate. The RIGAMO software therefore provides an algorithm, which automatically corrects the current measurement data of gas volume and flow rate based on the calibration data. The remaining error is approximately $\pm 1\%$ across the full flow rate range.

The calibration data of the MGC are the basis for the correction algorithm. When a new MilliGascounter is delivered, the calibration data file(s) are included in the USB memory card → directory "RIGAMO_Software\Calibration Data". With subsequently delivered calibration data file(s) please refer to par. 11.2.2 "Procedure with subsequently delivered Calibration Data File(s)".

Please note:

- The **display unit of the MilliGascounter** includes a calibration factor which corrects the deviation of the measurement data from the real value at the standard flow rate of 500 ml/h (0.5 ltr/h).
- In contrast, the **software RIGAMO** corrects the measurement data at the respective current flow rate. As a result, the volume values shown on the display and by RIGAMO may differ if the MilliGascounter is operated for a longer period of time with a flow rate that deviates significantly from the standard flow rate.
- **If no individual calibration data file was selected and designated to a Milli-Gascounter, no correction of the measurement data will be performed.**

11.2. Installation of Individual Calibration Data File(s)

For activating individual calibration data, the respective file(s) containing calibration data must be available to the software (file type: "[serial-no].cal").

Please make sure that the access rights for the respective directories are available according to par. 6 "Installation of the Software and Hardware" and par. 6.1 "General".

11.2.1. Procedure with a new Rigamo Installation

When RIGAMO is delivered, the directory

\RIGAMO_Software\Calibration Data

on the USB memory card contains the respective calibration data file(s). Please copy this / these file(s) into the directory

[installation drive]:\Rigamo\Calibration Data.

Thus, the calibration data are available for the software for the automatic dynamic correction of the measurement error.

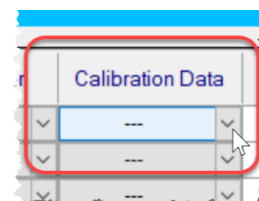
11.2.2. Procedure with subsequently delivered Calibration Data File(s)

When MilliGascounters plus calibration data files are subsequently delivered to an existing RIGAMO installation, please copy these files into the directory

[installation drive]:\Rigamo\Calibration Data.

11.3. Activation of Individual Calibration Data

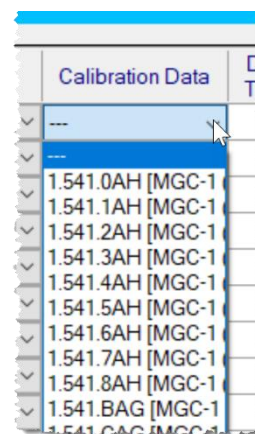
- a) Select the pull-down “Calibration Data” of the respective port (selecting the checkbox of that port is not necessary). **Simultaneous assigning of calibration data to multiple ports is not possible.**



- b) A list of MilliGascounter serial numbers of all calibration data file(s) previously saved to the directory C:\RIGAMO\Calibration Data will be displayed. Select the serial number of the respective gas meter.

Make sure that the correct serial no. is assigned to the respective port / gas meter! Otherwise, measurement errors will occur.

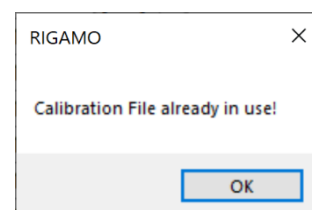
- c) Repeat the steps (b) and (c) for all connected gas meters. As an example, the result is shown in the screen shot below.



No.	Port	Gas Meter	Pulse Generator	Calibration Data	D	T
1	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.0AH [M...		
2	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.1AH [M...		
3	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.2AH [M...		
4	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.3AH [M...		
5	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.4AH [M...		
6	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.5AH [M...		
7	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.6AH [M...		
8	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.7AH [M...		
9	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.8AH [M...		
10	☒	MGC-1(3,2ml)	V6.0 [MGC]	1.541.9AH [M...		

Remark: The checkboxes of the port numbers are selected in this screenshot due to previously assigned MilliGascounter and Pulse Generator types to these ports by using the “Apply” function. For more information please refer to par. 7.1.2 b) “Simultaneous configuration of multiple channels with identical data”

If a serial no. is selected erroneously a second time, an error message will be displayed as shown in the screen shot on the right side.



The calibration data are now activated and will be used for automatic correction of the measurement data of the connected gas meter(s) across the full flow rate range.

11.4. Limitation of the Maximum Flow Rate

If the maximum flow rate range of the MilliGascounter is exceeded far beyond its limit, the algorithm for the correction of flow rate may generate incorrect (even negative) values. To prevent this, the **maximum flow rate is limited to 3 ltr/h.**

In this case, both the flow rate graph in the diagram and the data in the data table will be limited to this value. The measurement data file contains the same limited value.

12. Data Recovery

12.1. General

The *Signal Interface Module »SIM«* contains an integrated SD memory card (16 GB) for permanent, captive storage of the measurement data, independent of the storage of the measurement data on the computer.

Regardless of the sampling time interval set in the *Configuration window*, the **storage interval of measurement data to the SD memory card is 4 minutes**.

If the computer or its power supply fails, the measurement data continues to be stored continuously on the »SIM«. However, for this purpose the »SIM« must have its own power supply. This is the case if the »SIM« is either connected to the RITTER Biogas Batch Fermentation System »BBFS« or is buffered by an "uninterruptible power supply" (UPS).

If the software and/or the computer have been shut down, the software automatically recognises active data acquisition by the »SIM« when the software is restarted. In this case, the data recovery can be performed according to the following par. 12.2 "Automatic Data Recovery".

12.2. Automatic Data Recovery

When starting the data acquisition, a data file is generated with the file name as set in the *Configuration window*. (See also par. 9.4 "Saving of Measurement Data")

Furthermore, the marker "**_TMP**" is added to the file names at start-up:
→ [FileName]**_TMP**.txt

When restarting the software after a shutdown of the PC, the file name(s) with the marker "**_TMP**" is/are recognized and the following message is displayed:

The data acquisition to computer was terminated while the data acquisition to SIM was continued. Recovery of saved data from SIM to computer?

Yes = Recovery and continue data acquisition

No = Recovery and stop of data acquisition

Quit = No recovery and stop of data acquisition

12.2.1. Option "Yes" = Recovery and continue data acquisition

- a) All data files in all ports with the marker "**_TMP**" are converted into files named »[FileName_FirstStartTime]**_REC**.txt«. ("**REC**" = Recorded)

These files contain the original data from start of measurement until the shut-down of the software and/or the computer. These files remain available permanently for possible review.

- b) New files are generated with the file name »[FileName_FirstStartTime].txt«

These files contain the recovered data from start of measurement until the re-start of the software. Please note: **The interval of measurement data recovered from the SD memory card is 4 minutes**.

- c) Upon resumption of the data acquisition new files are generated with the file name »[FileName_NewStartTime]_TMP.txt«

These files contain the measurement data after the restart of measurement with the data saving interval set in the *Configuration window*. When this new data acquisition is finished as set in the *Configuration* menu → “End of Data Acquisition”, the marker “_TMP” is deleted.

12.2.2. Option “No” = Recovery and stop of data acquisition

Same procedure as with option “Yes” but without new data files according to 12.2.1 c).

12.2.3. Option “Quit” = No recovery and stop of data acquisition

The data file(s) generated with the start of the measurement → [FileName]_TMP.txt remain unchanged.

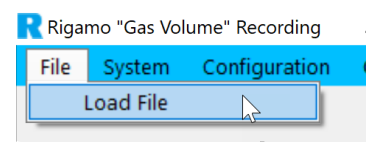
12.3. Manual Data Recovery

13. Display and Processing of stored Data Files

Once data acquisition is complete, the saved files can be opened within Rigamo for ...

- ... graphical and tabular display of measurement data
- ... export to Microsoft Excel® (version 2003 or higher)

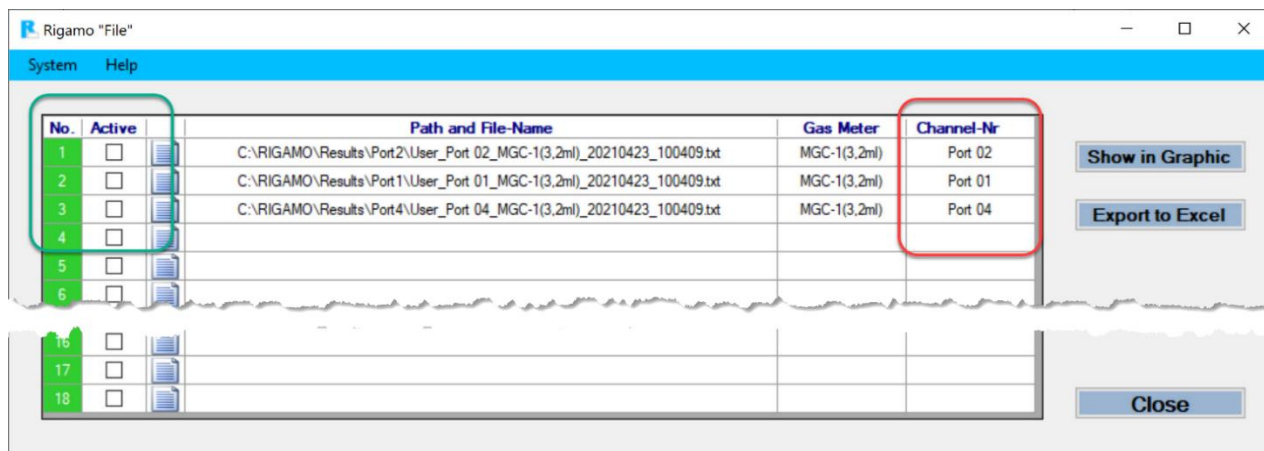
For this purpose, open in the menu “Gas Volume” Recording the menu <File><Load File>.



To open data files, please click on the “Directory” icon as marked below in green. The file explorer window of your operating system will be opened. Select the requested files in the respective directory/directories.

no.	Active	Path and File-Name	Gas Meas.	Channel-N.
1	☐			
2	☐			
3	☐			
4	☐			
15	☐			
16	☐			
17	☐			
18	☐			

The selected files are displayed:

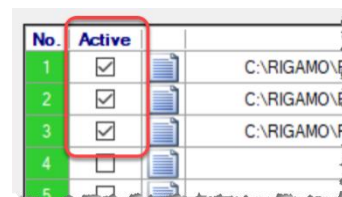


Please note: When working in offline mode, the numbers (in the green marked area) define **file numbers** and **not port numbers**. The reason is that the port numbers of the previous data acquisition (marked above in red) may not necessarily correspond to the sequence and number of selected data files.

13.1. Tabular and Graphical Display

For display of stored data, select the checkboxes of the respective files (multiple selection possible) and click to "Show in Graphic" (see screenshot above).

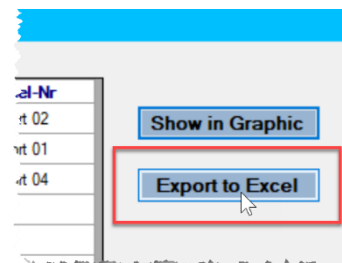
- The numerical data table will display the last recorded data set of the respective data file.
- The diagram will show the pair of graphs (volume and flow rate) of the respective data file(s). Make sure that for displaying the graphs, the respective file (port) number(s) are set to "Show" in the *Recording window*.



13.2. Export of Data

For export of stored data, Microsoft Excel® 2003 (or a later version) must be installed.

- Select the data files as described in par. 13 "Display and Processing of stored Data Files". In particular, do not forget to tick the checkbox(es) of the chosen files.
- Clicking on "Export to Excel" opens Microsoft Excel® and exports the data of the selected files into a new Excel spreadsheet.
- The file explorer of your operating system will be opened for selecting the target directory and file name. Standard pre-set:
C:\RIGAMO\Results\Export_to_Excel_[Date].xlsx
- After selecting the target directory, Microsoft Excel® is opened and the data from the selected file(s) is exported to a new Excel spreadsheet.



When exporting several files at the same time, the data of each data file (parameters plus measurement data) are exported into a separate table of the spreadsheet.

Export example of 4 data files:

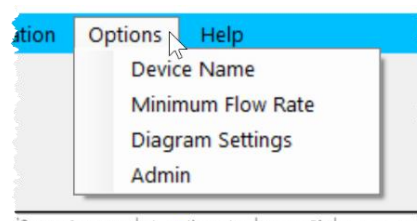
A	B	C	D	E	F	G	H	I	J	K	L	M
1 User	User											
2 File	C:\Programme\Rigamo V2.12 Beta\Result\Port 16\User_Port16_MGC-1_090211_105125.txt											
3 Start Date	11.02.2009											
4 Start Time	10:51:26											
5 Gas Meter	MGC-1											
6 Pulse Generator	V6.0 (MGC)											
7 Port	Port16											
8 Smoothing Factor (1-10)	5											
9 Sampling Time Interval	1											
	Serial No.=16											
	Calibration Parameters:											
	a=-0,010700											
	b=-0,011400											
	c=0,957700											
	d											
10 Comment												
11 End of Measurement	Manual											
12 Date	Time	Runtime [h]	Volume [ltr]	Flow Rate [ltr/h]	Pulse [-]							
13 11.02.2009	10:51:30	0,0000	0,0032	-	1							
14 11.02.2009	10:51:37	0,0020	0,0067	18,067	2							
15 11.02.2009	10:51:47	0,0048	0,0102	16,620	3							
16 11.02.2009	10:51:57	0,0076	0,0136	15,800	4							
17 11.02.2009	10:52:08	0,0104	0,0171	15,292	5							
18 11.02.2009	10:52:17	0,0131	0,0206	14,942	6							
19 11.02.2009	10:52:27	0,0159	0,0240	13,989	7							
20 11.02.2009	10:52:37	0,0187	0,0275	13,595	8							
21 11.02.2009	10:52:48	0,0214	0,0309	13,389	9							
22 11.02.2009	10:52:58	0,0243	0,0344	13,237	10							
23 11.02.2009	10:53:07	0,0270	0,0378	13,122	11							
24 11.02.2009	10:53:17	0,0298	0,0413	12,945	12							
25 11.02.2009	10:53:27	0,0326	0,0447	12,786	13							
26 11.02.2009	10:53:38	0,0353	0,0482	12,653	14							
27 11.02.2009	10:53:48	0,0382	0,0516	12,534	15							
28 11.02.2009	10:53:57	0,0409	0,0551	12,424	16							

14. Options

The menu "Options" provides settings for each of the following parameters.

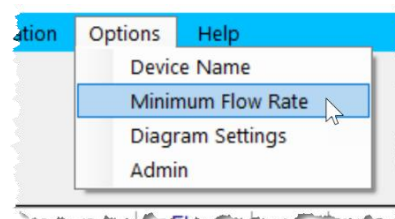
14.1. Device Name

This feature will be made available in an upcoming version of this software.



14.2. Minimum Flow Rate

For calculation of the flow rate, the elapsed time between the last two pulses is measured. To avoid an infinite loop in the software after the gas flow has stopped, the flow rate is set to zero after a specific time. This is dependent on both the minimum flow rate and the pulse generator of the respective meter. Generally, the flow rate value is set to zero after 1.5 x of the time interval between two pulses at minimum flow rate has elapsed.



After this time has elapsed the flow rate value is set to zero without any averaging. When the gas flow starts again, the averaging starts from the beginning without consideration of the values before and during the downtime.

If required, this time frame can be adapted to the respective conditions of the measurement by changing the value of the minimum flow rate in this menu.

The time is inversely proportional to the minimum flow rate:

⇒ Doubling the minimal flow rate value halves of the time frame.

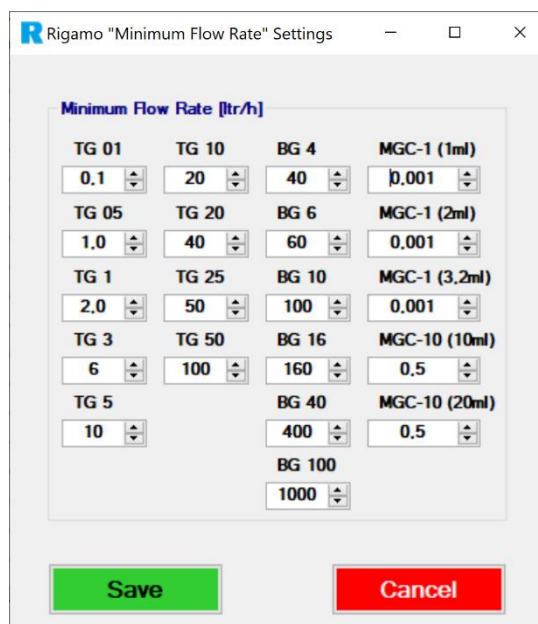


Table of default values for the time after which the volume flow is set to zero:

TG/BG types [seconds]:

Gas Meter	Standard Minimum Flow Rate [Ltr/h]	Pulse Generator				
		V2.0ex	V3.x	V4.01	V4.11	V5.0
TG 01	0.1	144	36	18	14	144
TG 05	1	54	14	7	5	54
TG 1	2	54	14	7	5	54
TG 3	6	45	11	6	5	45
TG 5	10	45	11	6	5	45
TG 10	20	45	11	6	5	45
TG 20	40	45	11	6	5	45
TG 25	50	45	11	6	5	45
TG 50	100	45	11	6	5	45
BG 4	40	23	6	3	2	23
BG 6	60	30	8	4	3	30
BG 10	100	45	11	6	5	45
BG 16	160	56	14	7	6	56
BG 40	400	23	6	3	2	23
BG 100	1000	9	2	1	1	9

MGC type:

Gas Meter	Standard Minimum Flow Rate [Ltr/h]	[Minutes]
MGC-1 (3.2 ml)	0.001	192

14.3. Diagram Settings

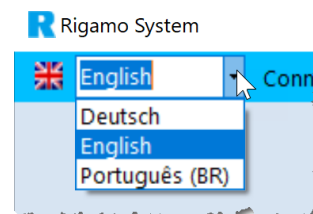
The diagram settings are described in par. 8.2 “Diagram Settings”.

14.4. Language

Software offers multilingual settings for languages with Latin characters. The required language can be selected after the start of the software in the menu of the *System window*.

The software is currently available in the following languages:

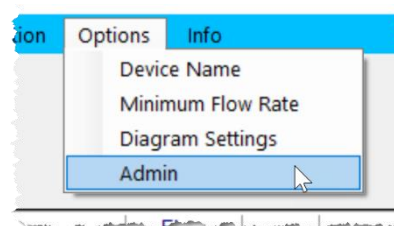
- English
- German
- Portuguese (Brazil)



Once you have selected a different language, it will be displayed immediately.

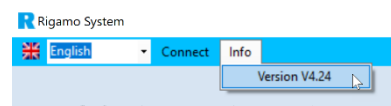
14.5. Admin

Password-protected area for software modification by the RITTER Company.



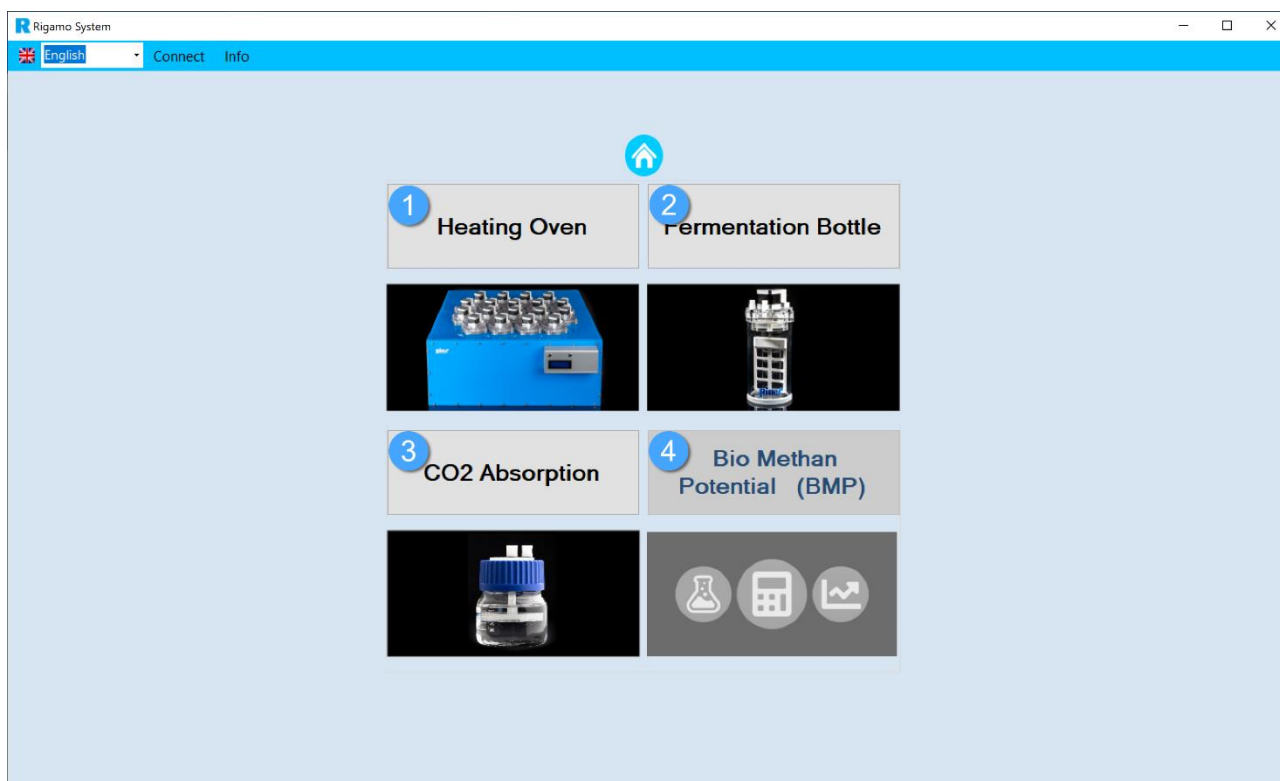
15. Info

The menu “Info” shows the version number of the installed RIGAMO software.



16. Application “Fermentation System”

16.1. Menu



(1) Heating Oven

- Setting and display of Heating Oven temperature

(2) Fermentation Bottle

- Setting the speed of stirring devices
- Setting the interval operation: Stirring time / break time

(3) CO₂ absorption

- Calculation, display, and storage of remaining CO₂ absorption capacity values - individually for each of up to 18 absorption bottles
- Set a custom value for the remaining CO₂ absorption capacity alarm function

(4) Bio Methane Potential

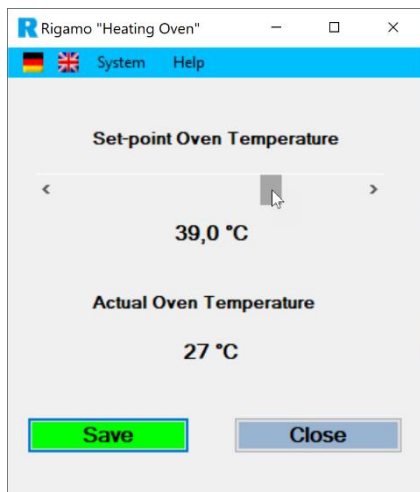
- Calculation of Bio Methane Potential (“BMP”) for up to 18 substrates / samples (in preparation)

To return to the main window *System* please click on the “Home” button:



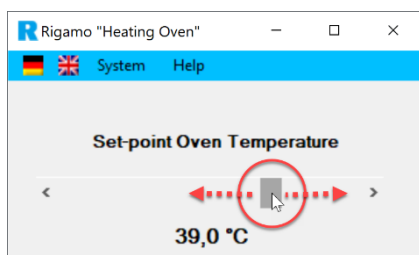
16.2. Setting and display of Heating Oven temperature

When this application is started, the following window is displayed:

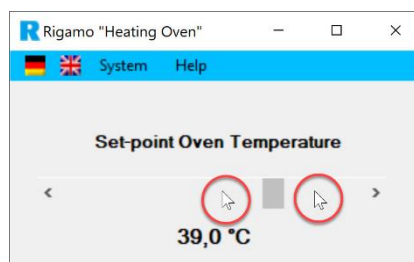
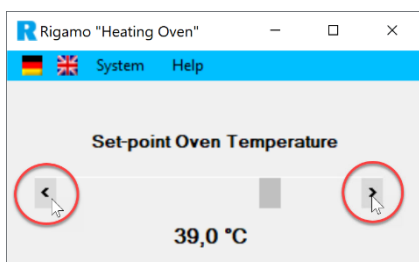


Temperature setting:

- a) Quick adjustment: Click and hold the mouse button to move the slider sideways to the required temperature:



- b) Adjustment in intervals of 1°C:



Clicking on the arrows or into the areas on the left and right of the slider decreases / increases the temperature by 1°C. If you click on one of these points and hold down the mouse button, the temperature will be continuously lowered or raised.

The **current temperature** will be displayed in **this window** as well as at the **display unit shown at the front of the Heating Oven**.

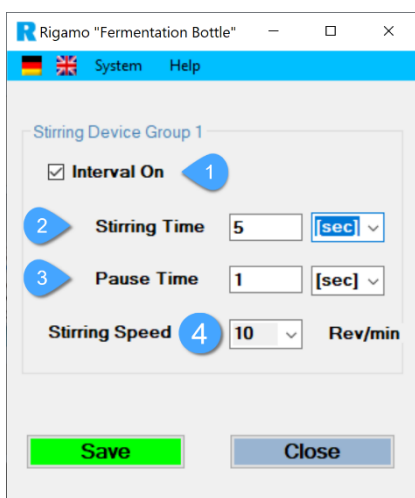
Please note: If the *Signal Interface Module »SIM«* is connected to the Heating Oven **and** to the computer, the manual setting of the oven temperature at the display unit of the oven is disabled. With this configuration the temperature adjustment is only possible through »RIGAMO«.

When changing the temperature value, the oven will immediately start / stop heating accordingly. However, the entered values will only be saved by clicking on **Save**.

A click on **Close** will shut-down the heating oven.

16.3. Control of the Fermentation Bottle Stirring unit

When this application is started, the following window is displayed:



- (1) Switching interval stirring of stirring blades on/off
- (2) Setting of stirring time [sec / min / h]
- (3) Setting of pause time [sec / min / h]
- (4) Setting of stirring speed in predetermined discrete values

When entering a value into one of the input fields, this value will be immediately applied. However, the entered values will only be saved by clicking to click **Save**.

A click on **Close** will shut-down the stirring unit.

16.4. CO₂ Absorption

16.4.1. General

RITTER has developed a CO₂ absorption bottle which **reliably absorbs more than 99% of CO₂ from biogas. Guaranteed! Without any indicator liquid for absorption limit!** This absorption bottle combined with the RITTER »Biogas Batch Fermentation System« provides the ideal solution for professional biogas research.



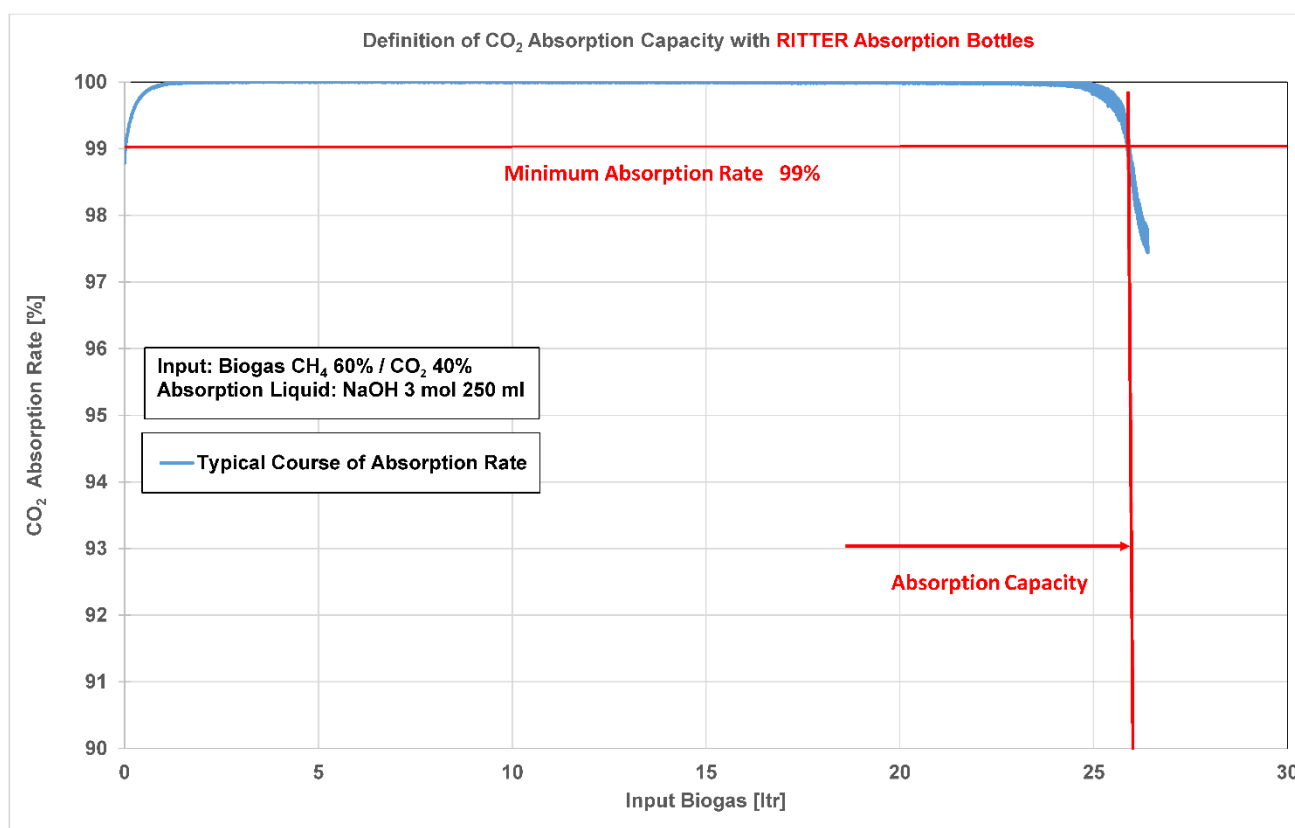
For more technical information, see the data sheet of the CO₂ absorption bottle.

16.4.2. Absorption Capacity

Definition:

The absorption capacity is that volume of CO₂ which is absorbed until the absorption rate is decreased from 100% at start of absorption process to 99%.

In other words: When the limit of absorption capacity is reached, the gas at the ab-



sorption bottle outlet contains 1% of CO₂.

Table of absorption capacities at various flow rates and CO₂ concentrations: ¹⁾

	Biogas Input	Flow Rate [ml/h]							
		0	50	100	200	300	500	750	1000
CO ₂ absorption capacity approx. [ltr] ²⁾	40% CO ₂ 60% CH ₄	17.0	13.4	12.1	8.8	7.9	7.8	7.7	7.6
	60% CO ₂ 40% CH ₄	17.0	13.5	11.8	8.9	8.5	8.3	8.0	8.1
Max. volume of methane approx. [ltr] ³⁾	40% CO ₂ 60% CH ₄	25.5	20.1	18.2	13.2	11.9	11.7	11.6	11.4
	60% CO ₂ 40% CH ₄	11.3	9.0	7.9	5.9	5.7	5.5	5.3	5.4

¹⁾ This table will be updated with additional CO₂ concentration values when new data becomes available.
For determination of CO₂ concentration values the RITTER »MultiGas« Sensors are recommended. With the RITTER »MultiGas« Sensor *duo IR2*, the concentration values for both Methane and CO₂ can be determined simultaneously.
For further information, please refer to <https://www.ritter.de/en/products/multigas-sensors/>
If no determination of the CO₂ concentration value is possible, it is recommended to use the smallest CO₂ concentration value stated in the above table.

²⁾ Per bottle filling 250 ml, absorption solution KOH 3 mol

³⁾ After the CO₂ was absorbed from the biogas, the MilliGascounter displays the volume of the pure methane. The CO₂ absorption capacity limit is reached when the MilliGascounter indicates the values the stated in the table above.

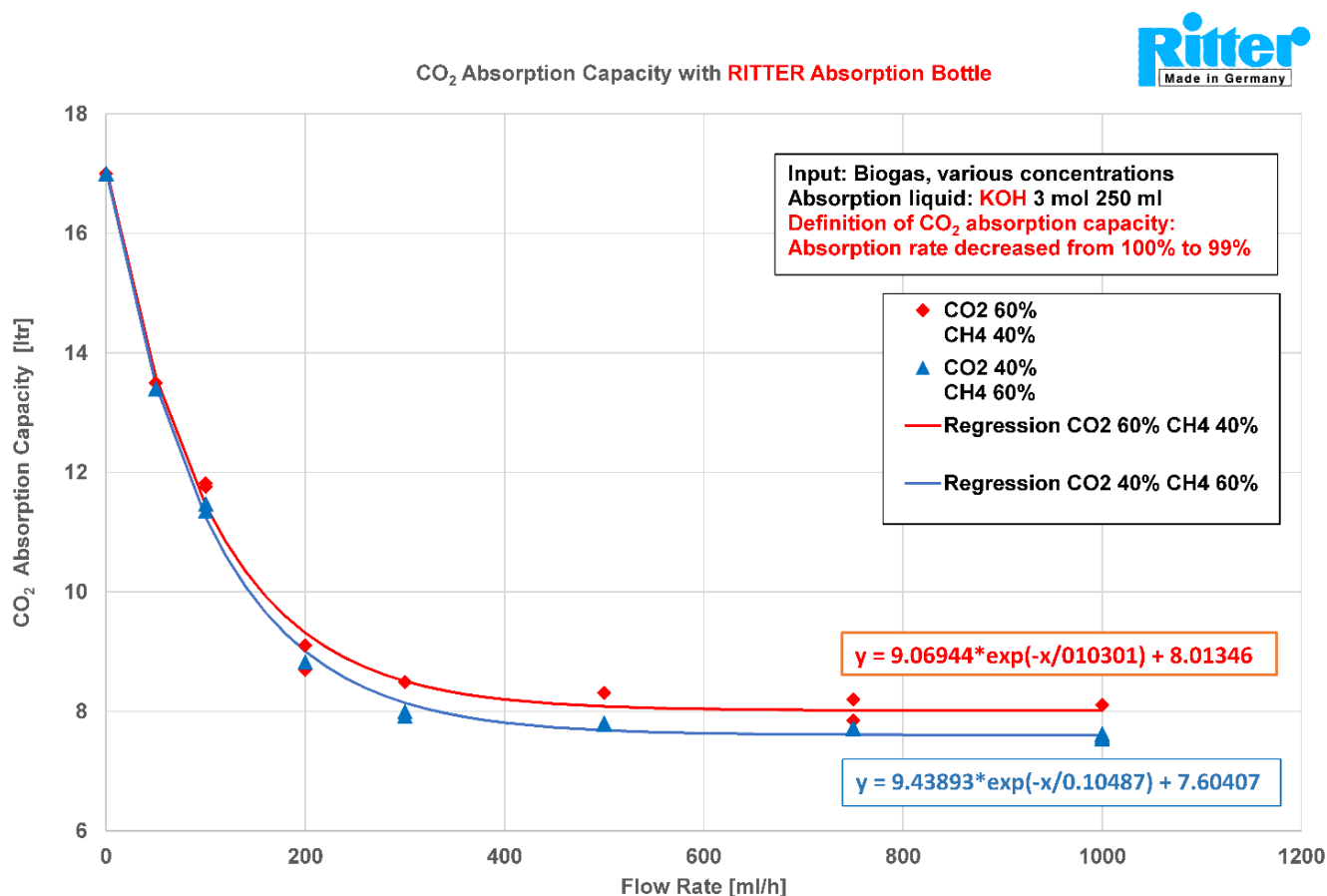
Please note: The values for the max. volume of methane stated at a specific flow rate were obtained at a **constant** flow rate of biogas. However, with biogas fermentation processes the flow rate varies in general significantly during a fermentation test run. To get a more meaningful value for the remaining CO₂ absorption capacity the use of the data acquisition software »RIGAMO« is highly recommended.

16.4.3. Dynamic Calculation of the Absorption Capacity

The table above shows that the absorption capacity with the RITTER absorption bottle ...

- ... does not vary much with different concentrations of CO₂,
- ... varies significantly with increasing flow rates because of the decreasing time the CO₂ is in contact with the absorption liquid. However, due to the unique RITTER dip pipe design this contact time is far longer than with usual surface absorption bottles.

The following diagram shows the CO₂ absorption capacity as a function of the flow rate:



The software »RIGAMO« calculates the remaining CO₂ absorption capacity according to the current flow rate at any time during the fermentation process **for each of up to 18 absorption bottles individually**.

Algorithms for calculation of the remaining CO₂ absorption capacity:

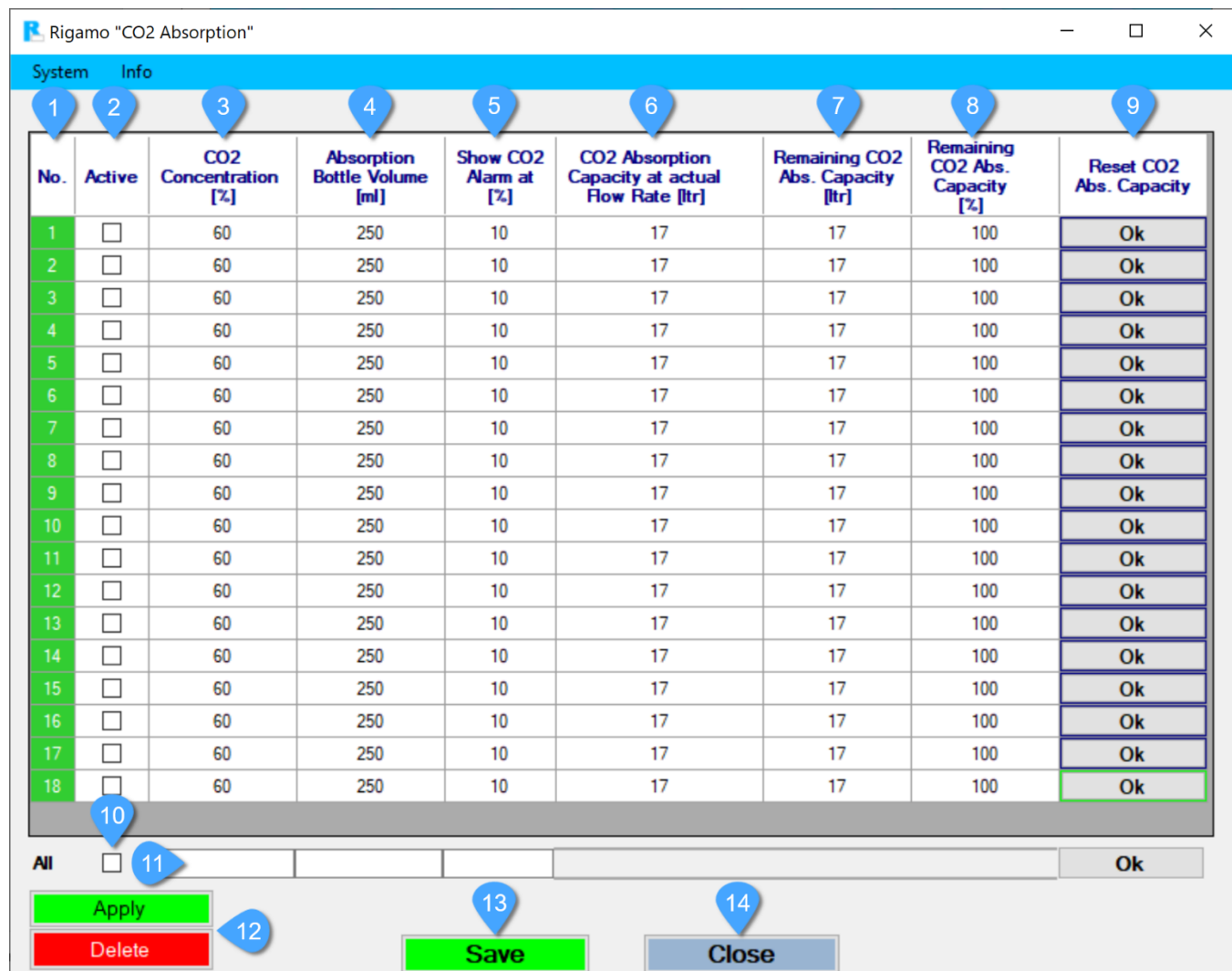
- CO₂ concentrations < 60%: $y = 9.43893 \cdot \exp(-x/0.10487) + 7.60407$
- CO₂ concentrations ≥ 60%: $y = 9.06944 \cdot \exp(-x/010301) + 8.01346$

Whereas ... $y \triangleq$ CO₂ absorption capacity [ltr]

$x \triangleq$ Flow rate [ml/h]

16.4.4. Calculation of the Absorption Capacity

When this application is started, the following window is displayed:



No.	Active	CO2 Concentration [%]	Absorption Bottle Volume [ml]	Show CO2 Alarm at [%]	CO2 Absorption Capacity at actual Flow Rate [ltr]	Remaining CO2 Abs. Capacity [ltr]	Remaining CO2 Abs. Capacity [%]	Reset CO2 Abs. Capacity
1	☐	60	250	10	17	17	100	Ok
2	☐	60	250	10	17	17	100	Ok
3	☐	60	250	10	17	17	100	Ok
4	☐	60	250	10	17	17	100	Ok
5	☐	60	250	10	17	17	100	Ok
6	☐	60	250	10	17	17	100	Ok
7	☐	60	250	10	17	17	100	Ok
8	☐	60	250	10	17	17	100	Ok
9	☐	60	250	10	17	17	100	Ok
10	☐	60	250	10	17	17	100	Ok
11	☐	60	250	10	17	17	100	Ok
12	☐	60	250	10	17	17	100	Ok
13	☐	60	250	10	17	17	100	Ok
14	☐	60	250	10	17	17	100	Ok
15	☐	60	250	10	17	17	100	Ok
16	☐	60	250	10	17	17	100	Ok
17	☐	60	250	10	17	17	100	Ok
18	☐	60	250	10	17	17	100	Ok

All ☐ Ok

Apply Delete Save Close

- (1) Consecutive number of CO₂ absorption bottles
- (2) Checkboxes for selection / deselection of single channels (needed for "master line" (11) only)
- (3) CO₂ concentration in biogas
- (4) Volume of RITTER CO₂ absorption bottle
- (5) Value of CO₂ concentration at which an alarm is displayed (Standard value: 10%, can be changed individually)
- (6) Display of the CO₂ absorption capacity at the current flow rate
- (7) Current remaining CO₂ absorption capacity in [ltr]
- (8) Current remaining CO₂ absorption capacity in [%]
- (9) Resets CO₂ absorption capacity to default (= maximum) values of 17 ltr / 100% after refilling of CO₂ absorption bottle(s) with new absorption liquid

- (10) Checkbox for selection / deselection of all absorption bottles
- (11) Master line for simultaneous input / deletion of parameters from selected absorption bottles
- (12) Applies entered values in master line to selected absorption bottles
- (13) Saves entered parameters
- (14) Closes Configuration window without saving entered parameters

16.5. Bio Methane Potential (BMP)

This feature will be made available in an upcoming version of this software.

17. Termination of RIGAMO

The program will be closed with the “Close window” button in the top right corner of the application.



Please note that all data acquisition will be stopped when closing the software.