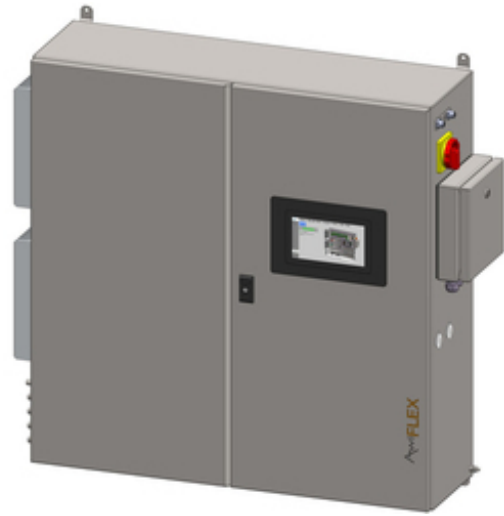


PART B: OPERATION OF THE GAS
ANALYSIS SYSTEM
AWIFLEX XL
AWITE
BIOENERGIE



Original Instruction Manual
(Version 10.0)

Contact and Imprint

Please find the latest information online at www.awite.com . For any questions, comments or suggestions, please send an email to info@awite.com .

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1 Preface



PLEASE READ THE INSTRUCTION MANUAL AND SAFETY INSTRUCTIONS CAREFULLY BEFORE INSTALLATION AND OPERATION!

This Instruction Manual provides you with information to assist you in using the gas analysis system. The Instruction Manual is part of the product and has to be kept throughout the service life of the product. When subsequently passing on the gas analysis system to a third party, the customer has to provide the Instruction Manual along with it. The new owner of the system has to be trained in the regulations referred to. If you receive an amendment to the Instruction Manual at a later stage, this amendment is also part of the Instruction Manual.

The device may only be used in a technically perfect condition and for its intended use, with awareness of safety aspects and possible hazards and in full adherence with the Instruction Manual. Please operate and service your gas analysis system based on the information in this Instruction Manual.

The Instruction Manual for the Awite - Gas Analysis System consists of two parts:

Part A: Product Description, Installation and Operation

Part B: Operation

2 Identification

This Instruction Manual is intended for Awite Bioenergie GmbH gas analysis systems of the respective series specified on the cover sheet. The type plate on the right hand side panel of the device indicates the device type, the required voltage supply and the rated output.

The manufacturer's address is:

Awite Bioenergie GmbH
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3 Safety instructions Part B

Errors can occur where the unit sets to STOP (dangerous atmosphere inside) for safety reasons. If the gas analysis system is stopped and the error still persists, the cause of error has to be eliminated and acknowledged before the gas analysis system is activated again. The stop state may only be released once the operator of the plant has verified that the safety risk (gas leakage, explosive atmosphere) no longer exists.

A pressure between 100 mbar and 2 bar may only reach the gas analysis system in the rare event of a fault. When the device detects high pressure, it will STOP with the following error message:

'System state not safe / high pressure'

After resetting the fault, make sure to check the device for leaks.

Monitoring can be disabled by manual operation. As a result, too much oxygen may enter the process, for example in the case of the optional air injection / oxygen dosage (AwiDESULF), which may eventually lead to an explosive atmosphere. The gas analysis system should therefore be operated in automatic mode. The system operator himself is responsible for all manually effected settings, specifically for adhering to the upper oxygen limit..

Please also refer to the safety instructions in Part A!

4 Operation of the Gas Analysis System

The gas analysis systems are available in the AwiECO, AwiFLEX and AwiFLEX XL versions. The scope of operation depends on the design and the options of the analysis system. In the following chapter you will find a special description of the operation of the analysis system AwiFLEX XL with its options.

4.1 Measurement Process

The gas analysis systems actively suck in biogas from the extraction point, even over greater distances. The sensors are flushed with fresh air between the measuring intervals which prolongs the life of the sensors considerably. Prior to every measurement, the analysis gas is sucked in via a bypass line and the line is filled with fresh measuring gas. The time for the sucking in of the analysis gas in the bypass is variable and is set in the course of the initial operation of the system.

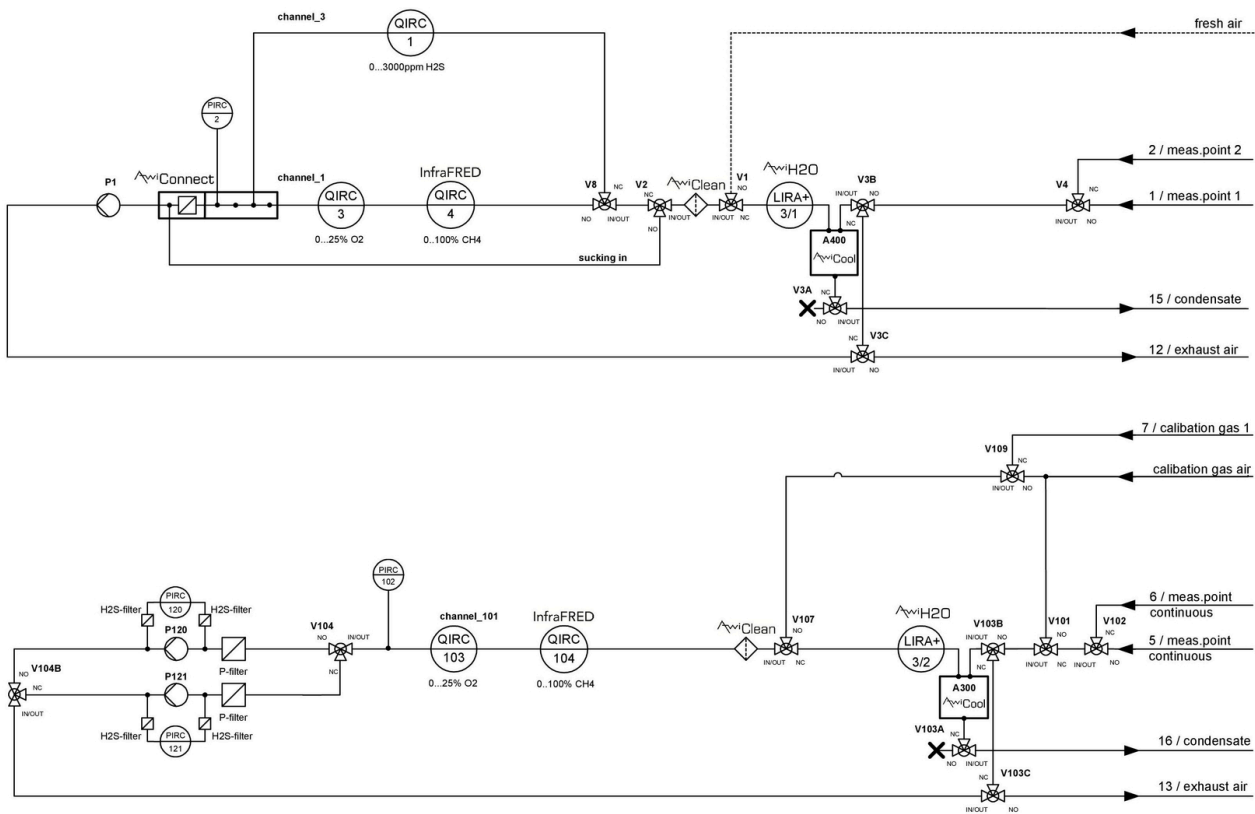


Figure 1: Gas flow plan AwiFLEX XL (exemplary presentation)

4.1.1 Interval Measurement (discontinuous)

A measuring cycle consists of the following steps, which are repeated at each measuring point:

1. **Suction** of the sample, bypassing the sensors
2. **Measurement:** Sample gas is led via the sensors of the first measuring channel
3. **Flushing:** Cooler is flushed with air in order to remove any condensate. Air is led over the measuring channel in order to flush the sensors.
4. The next measuring channel is selected and the process continues with step 2 - if there is no further channel, then step 5 is continued with.
5. The next measuring point is selected and the process continues with step 1. If there are no more measuring points (the last measuring point is air) the process continues with step 6.
6. **Pause:** Device pauses.

You can change the intervals for the suction process (Chapter 4.4.2) yourself via the touch panel . Depending on the configuration of the gas analysis system, different intermediate steps are also possible (e.g. removal of condensate, measurement of pressure etc.). For gas analysis systems with gas accumulating bag, the bag will be emptied before step 5.

4.1.2 Continuous measurement (continuous)

Continuously operating gas analysis systems serve to continuously measure certain gas components. Methane, carbon dioxide or oxygen can be measured continuously, for example.

In contrast to the measurement process with discontinuous measurement (Chapter 4.1.1), the measuring cycle is reduced to the following step:

- **Measurement** (e.g. "Measurement channel CH₄")

For gas components which are analyzed using electrochemical sensors (e.g. hydrogen sulphide), a continuous measurement is not possible. The measuring cycle for these gas components corresponds to the discontinuous measurement (Chapter 4.1.1). Using separate pumps for a continuous and discontinuous measurement guarantees an uninterrupted analysis of the continually measured components. The relative pressure sensors in front of the pumps serve to monitor the pumps.

4.2 Operation

Before turning on the system please ensure that the hand valves at the gas extraction points are open. To turn on the gas analysis system, set the main switch at the right hand side of the stainless steel casing to the "On" position. The system will now start up. After approx. one minute, the system will be ready. The integrated panel PC with touch-screen allows one to read off the measured values and the operating modes directly and configure the gas analysis system. The individual menus can be selected by means of tabs on the touch-screen (Fig. 2). Touch the tabs slightly for 1 to 2 seconds with your fingertip or with a special touch-screen pen in order to do this. Please refer to Chapter 4.7.4 for information on shutting down the system.

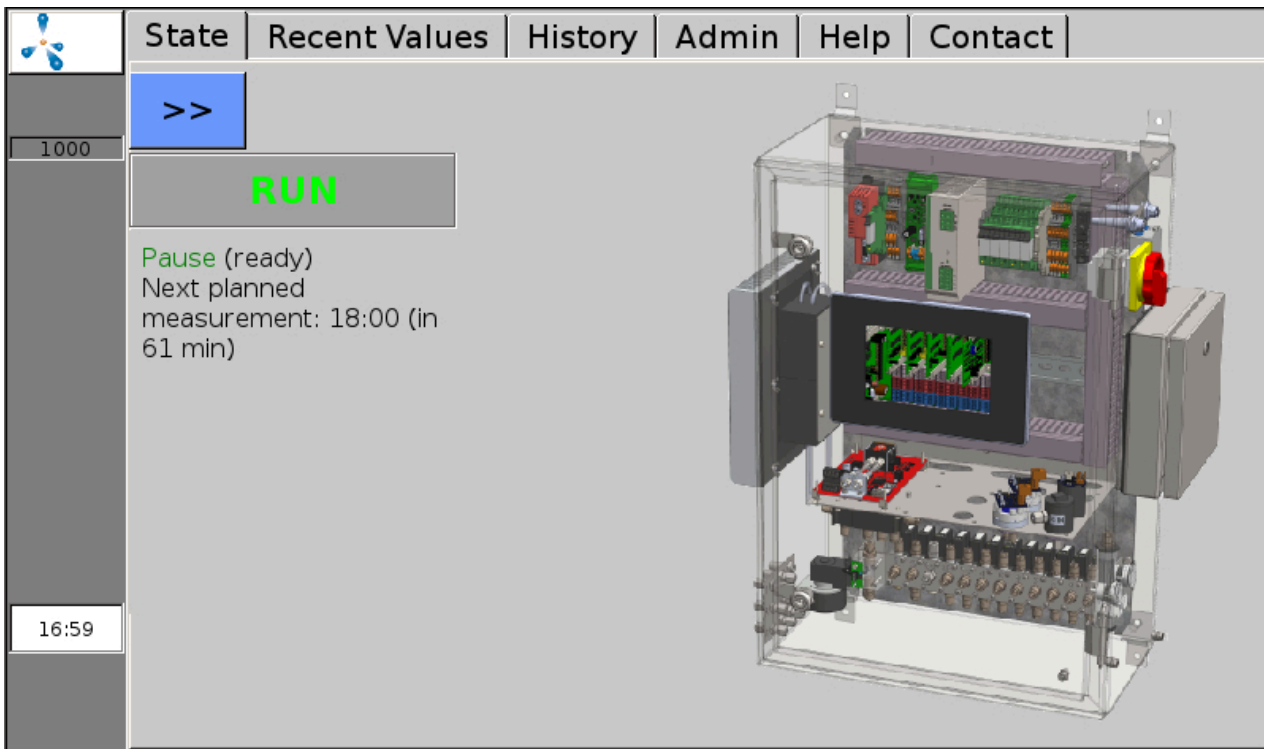


Figure 2: The tabs in the upper section of the screen allow for accessing all menu functions

4.3 Menu Navigation

The dark grey bar on the left side of the screen indicates the status of the gas analysis system and is visible in all menus (exception: some sub-menus under the "Admin" tab (Chapter 4.7)). A pulsating methane molecule, the Awite logo, indicates that the system is operating. During the measurement process, a green field "Meas." is displayed. In case of an error, a red (or yellow or orange) button is displayed (Chapter 7.2). You also find the serial number of the system on this bar. At the bottom of the column, the current time is indicated.

The following chapters sequentially describe the various tabs in the menu of the gas analysis system.

4.4 Status Tab

Is accessed via the "Status" tab. The current operation status with the following additional information is displayed:

4.4.1 Pause

The screen displays the time until the next scheduled measurement.

4.4.2 Suction

Analysis gas is sucked in via the bypass (e.g. from the fermenter). The display shows the remaining time of suction (Fig. 3). The number of the measuring point where measurement is currently taking place is displayed as well. The measuring gas is not yet channeled over the sensors in the course of this process, but past them through the bypass. By tapping on >>, the display of the status message is maximized to fill the whole width of the screen.

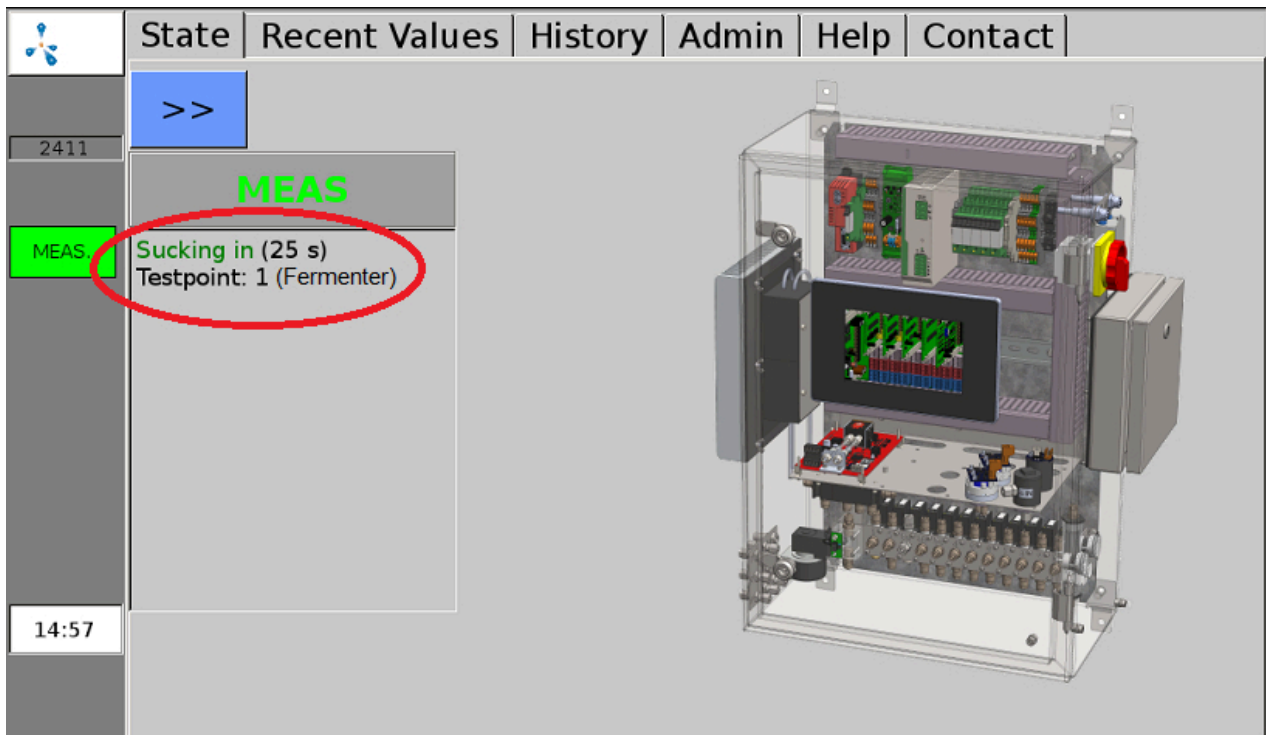


Figure 3: Display in the Status Window during suction prior to the Measurement

4.4.3 Measurement

After the analysis gas has been sucked in long enough in the bypass (variable setting) the measurement can take place. Now the measuring gas is channelled over the sensors. If the gas analysis system has different measuring channels, there is an intermediate flushing with air prior to the switch-over. The remaining time for the measurement of the current channel is displayed. The number of the measuring point as well as the number of the measured channel is shown.

4.4.4 Flushing

The remaining time during which the current channel will be flushed with air is indicated. The number of the measuring point as well as the number of the channel being flushed are shown.

4.4.5 Stop

The gas analysis system is at Stop, the pump is switched off. If a serious fault occurs, the gas analysis system will be automatically stopped. 'System state not safe' is displayed in the status, and additionally above the fault list in the error window, as well as the cause 'Pressure too high' or 'Explosive atmosphere'. You can find more information on the fault in the fault list (Chapter 7.2.1), You can find more information on Undo Stop in (Chapter 4.10.3).

4.5 Current Values Tab

The 'Current Values' (Fig. 4) offers the Values, Settings and Extended Settings sub-menus. Under "Values" (Fig. 4) a table containing the current (last measured) measuring values is displayed. The different parameters are listed underneath each other, while the measuring points are displayed in the columns.


	State	Recent Values	History	Admin	Help	Contact
	Values	Settings	Extended Settings			
1000		Meas. point 1	Meas. point 2	Meas. point 3		
	CH4 (% Vol.)	54.3(10:03)	56.2(10:05)	56.4(10:12)		
	O2 (% Vol.)	0.48(10:03)	0.32(10:05)	0.05(10:12)		
	CO2 (% Vol.)	43.7(10:03)	44.5(10:05)	44.8(10:12)		
	H2 (ppm)	162(10:04)	81(10:07)	37(10:14)		
	H2S hi (ppm)	447(10:04)	180(10:10)	99(09:59)		

Figure 4: "Current Values" tab, display of the values last measured

The "Settings" (Fig. 4) sub-menu allows you to choose which measured values should be displayed in the table under "Values" (Fig. 4) . For each measuring point you can mark the measured values to be displayed by setting a check mark beside them. You can also set the colour to use for highlighting the measured values in the table. The "Extended Settings" (Fig. 4) sub-menu allows for choosing whether the measured values displayed in the "Values" (Fig. 4) sub-menu are to be displayed with or without a time stamp.

4.6 History Tab

Under "History" (Fig. 5) you can choose between the Graph, Table, Settings and Events sub-menus. In the "Graph" sub-menu (Fig. 5) the measured values of the individual sensors of each measuring point can be displayed over a longer period of time (up to 9 days). The left ordinate axis (y1) is divided into percentages (for displaying the measured values of the methane, oxygen or carbon dioxide concentrations), the right ordinate axis (y2) is scaled to ppm (parts per million) for hydrogen sulphide or hydrogen. If you select a point on the curve by tapping the screen with a finger or touch-screen pen, the corresponding date and time are displayed.

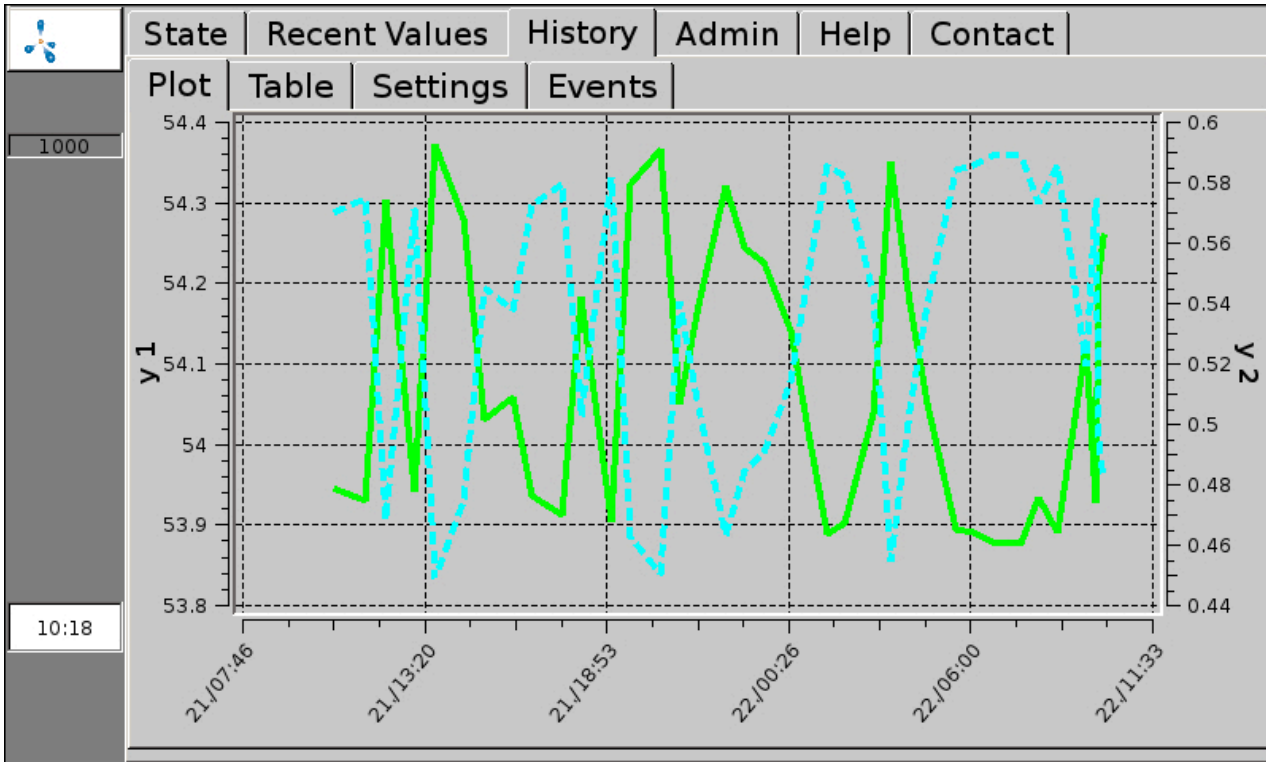


Figure 5: Tab "History", sub-menu "Graph", displays the measuring value history as a graph

The sub-menu "Table" (Fig. 6) displays the measured values in table format. In one column the histories of a measurement at a specific measuring point are displayed (for up to 9 days). You can scroll up and down in the table using the arrow keys. By clicking the single arrows < and >, you can jump up or down 3 rows. The double arrows << and >> move the display by 7 rows. The arrow >>| brings you back to the top of the table, i.e. the most recent measured values.

State		Recent Values		History		Admin		Help		Contact	
Plot		Table		Settings		Events					
1000				1		2					
22.09.2017		Meas. point 1 / CH4 (% Vol.)		Meas. point 1 / O2 (% Vol.)							
10:03		54.3		0.48							
09:54		54.2		0.49							
09:47		53.9		0.57							
09:31		54.1		0.52							
08:38		53.9		0.59							
10:19											

Figure 6: Tab "History", sub-menu "Table" displays the measuring value history in the form of a table

The sub-menu "Settings" (Fig. 5) allows for influencing the display mode of the measuring values in the sub-menus "Graph" (Fig. 5) and "Table" (Fig. 6). If only part of the sensors are to be displayed, the respective selections in the sub-menus for the individual measuring points can be made by setting check marks. Here you can also change the colour (for the display in the table and the graph) as well as the line type and line width (display in the graph). Under History > Settings > , the following settings can also be made. The date input in the top line (format: Month/Day/Year) defines up to which date the measured values are to be displayed. The "time span" determines for how many days prior to the chosen date the values are to be shown (maximum of 9 days). For continuously operating gas analysis systems, the storage interval can be pre-defined by Awite based on customer requirements. Due to the large amount of data, the number of loaded table rows should be limited in the field 'Max. Number of Rows'. This reduces the charging time even with very short measuring intervals. Depending on the configuration of the device and user level, the sub-menu "Events" (Fig. 5) shows different event archives (e.g. archive of error messages) depending on the configuration of the device and the user level.

4.7 Tab 'Admin' - Settings

Not all systems offer all sub-menus. Only fields highlighted in blue are active. The currently set user level is displayed in the right field (Fig. 7). You can find more information the user level in the (Chapter 4.7.3)

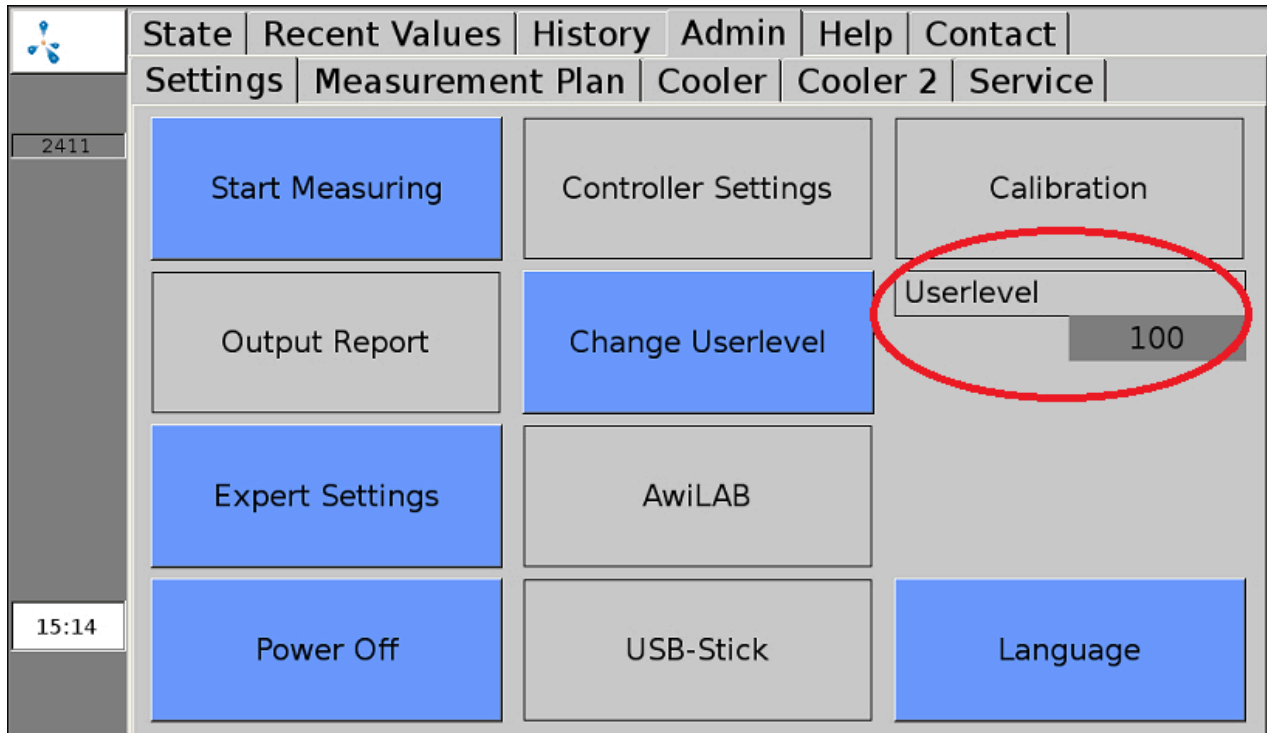


Figure 7: 'Admin' tab with sub-menus

4.7.1 Start Measurement

The „Start Measuring“ sub-menu allows you to manually trigger an immediate measurement in addition to the chosen measurement interval. Pop-up menu list the measuring points to be measured, which can be confirmed by choosing “Yes” or “No“.. The measured values are found in the „Recent Values“ (Chapter 4.5) and „Historie“ (Chapter 4.6) tabs. The display of the test gas measuring poin sub-menu must be checked off for this to work.

For continuously measuring gas analysis systems (Chapter 4.1.2) ‘Start Measurement’ is not possible as the measurement is carried out continuously. Measurements of these measuring points can be enabled or aborted from user level 300 (Admin > User Level - Einter „300“ (Chapter 4.7.3)) under the tab ‘Experte Settings’ (Chapter 4.7.7).

4.7.2 Controller Settings

The microbiological desulphurisation process is controlled by a combination of PI controller and fuzzy control. The control of the air supply is based on the measured values for oxygen and hydrogen sulphide in the biogas. The setting options for the control can be found under the tab

Admin > Controller Settings (Fig. 8). Depending on the configuration, the parameters for one or more points of air supply can be set separately from one another. On principle, however, the control of the air supply should be set to automatic operation. The controller is displayed in green (Fig. 8). The controllers may only be operated manually if instructed to do so by Awite or with the necessary background knowledge.

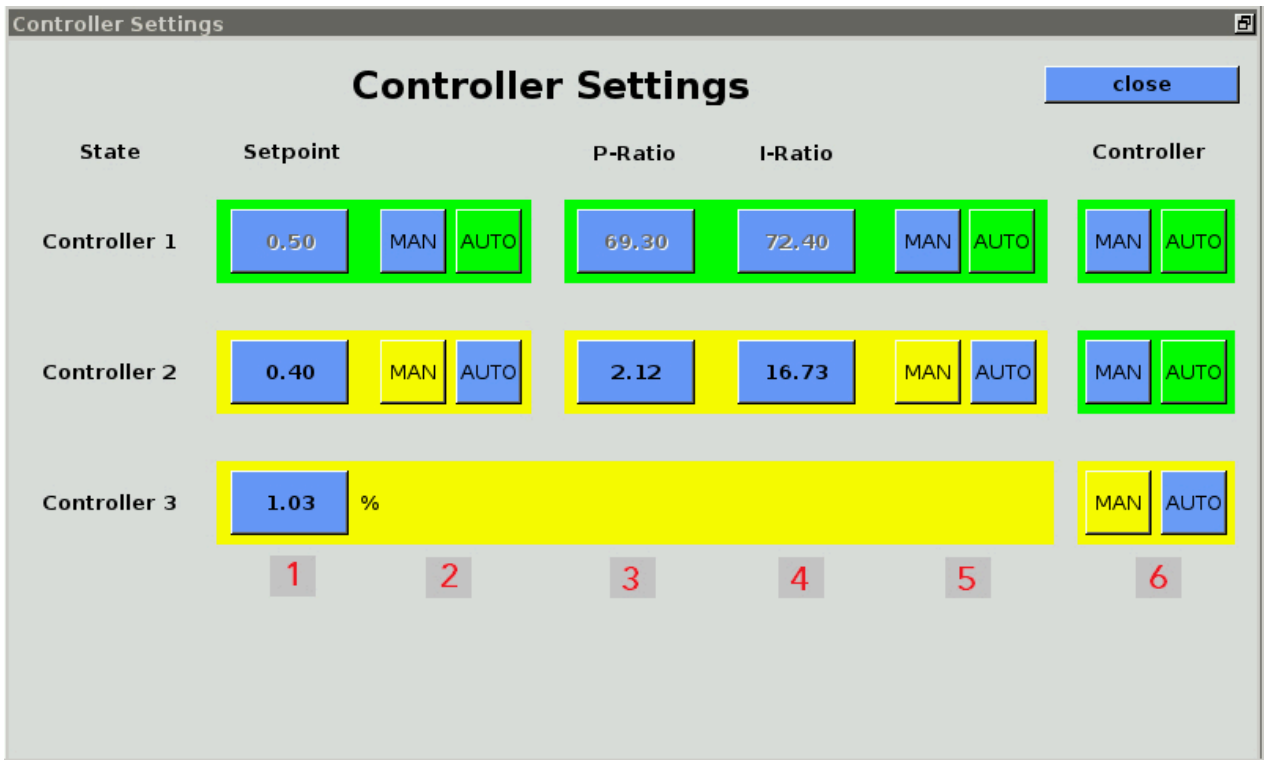


Figure 8: Admin > Controller Settings

By clicking the MAN buttons, the controllers can be fully or partly switched to manual operation. Manual controllers are displayed in yellow. By clicking AUTO, the control is reset to automatic operation. For manual operation, the controller has to be switched to User level 1000 (Admin > User Level - Enter "1000" (Chapter 4.7.3)).

The following controller configurations are possible:

By clicking on **MAN (2)**, the controller is switched to manual and the button for the set point is activated. Clicking the **numeric value (1)** allows you to predefine a set point value for the oxygen content in the biogas at the measuring point of the controller in a pop-up window. For microbiological reasons, the set point value must never be set higher than 1%. For explosion protection reasons, only values between 0 and 2.4% can be entered. Clicking on **AUTO (2)** reactivates the fuzzy control.

By clicking on **MAN (5)**, the PI controller is switched to manual and the buttons for the P-ratio and I-ratio are activated. By clicking on the **numerical values (3+4)**, a ratio can be pre-set in a pop-up window. Clicking on **AUTO (5)** reactivates the fuzzy control.

By clicking on **MAN (6)**, the fuzzy control and the PI control are deactivated. Now a value between 0 and 100% can be entered. This sets the opening time of the valve at the selected point of air supply as part of the maximum possible switching time (Manual Control of the Air Supply AwiDESULF). Clicking on **AUTO (6)** reactivates the automatic control. The limits can only be altered within the specified sensor measuring ranges. Wrong inputs can lead to alarms being released constantly or not at all. The control variable is the oxygen and hydrogen sulphide content in the measuring gas.

For more information about the combined package for microbiological desulphurisation, see (Combi Package Microbiological Desulphurisation AwiDESULF)

4.7.3 User Level

In the "User level" sub-menu, the user level for the gas analysis system can be entered. The higher the user level, the higher the access rights. Click the tab Admin > User Level in order to enter the user level and enter the corresponding code in the pop-up window. The following user levels are relevant for the extended operation:

User Level	Designation	Code
User Level '100'	Standard user	100
User Level '300'	Advanced user	300
User Level '1000'	Expert	1000

User levels with even more access rights are particularly relevant for the service personnel.

4.7.4 Power Off

By clicking Admin > "Power Off", the gas analysis system can be stopped or switched off. Confirm both the "Do you really want to cancel?" and the "Do you also want to switch off the device?" pop-up menus with "Yes". After a few seconds, several rows containing white letters are displayed. Now the main switch can be set to 'off'. If the main switch is left as is, the gas analysis system will re-start by itself immediately after the shutdown is complete.

4.7.5 USB stick

see Chapter 5.2

4.7.6 Language

By clicking on Admin - Language opens a window which contains the available visualization languages. After choosing the desired language, confirm your entry with "Yes" to restart the visualization server.

4.7.7 Expert Settings

This setting particularly concerns the service personnel. In normal operating mode, accessing the expert settings is not necessary.

4.8 Tab 'Admin' - Measurement Plan

The sub-menu "Measurement Plan" (Fig. 9) displays the measuring intervals of the single measuring points in an organized view. If a measuring interval is longer than 60 minutes, no empty green field is shown in the corresponding hour column. If there are multiple measurements per hour, the number of the measurements is displayed in the green field.

MeasPoint	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Meas. point 1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Meas. point 2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Meas. point Air	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Figure 9: Admin > Measurement Plan (display with number of measurements and without channels)

1: By clicking on "New measuring interval for all" (Fig. 9), the desired measuring interval (in minutes) can be entered into the pop-up menu. If a value is specified for the measuring interval that is above or below the allowed values, the entered value for the minimum or maximum allowed value is overwritten automatically. No settings are necessary here in the case of continuously operating gas analysis systems.

2: Switch-over option for the display of the number or times of the measurements in the hours columns.

3: Switch-over option for the display of the measuring points with or without the associated channels in the measurement plan table.

4: When clicking on the measuring points or a channel (display with channels) on the left hand side, the measuring intervals for the respective measurement point or channel can be set individually.

4.9 Tab "Admin" - Cooler

The sub-menu "Cooler" (Fig. 10) shows the temperature values and states of both the cooler and the casing. "Setpoint" (Fig. 10) is the setpoint value temperature of the cooler, "Current value" (Fig. 10) shows the current cooler temperature. The subsequent status bar shows the current state of the cooler and whether it lies in the allowed range (green bar), deviates from it (yellow bar) or strongly deviates from it (red bar). The system calculates this status from the temperature of both the cooler and the casing and the power consumption of the cooler. Additionally, the casing temperature is displayed, with this also being in the form of a bar that indicates whether the current value is within the permitted range.

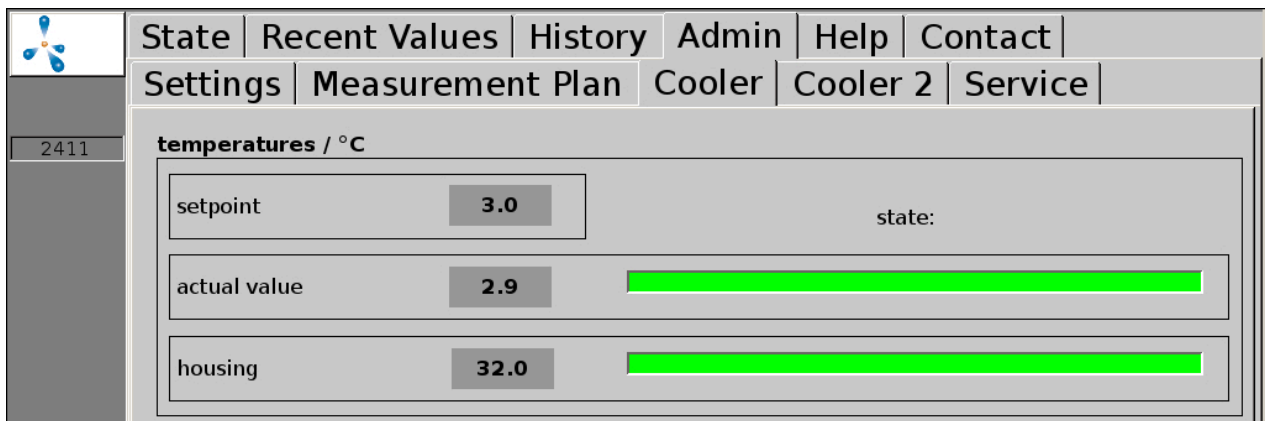


Figure 10: Admin > Cooler

4.10 Tab 'Admin' - Service

Settings for service or maintenance can be made from the 'Service' sub-menu.

4.10.1 Set Date and Time

Procedure:

1. **Admin > User Level > Enter "1000"** (Chapter 4.7.3)
2. **Admin > Service > Enter Date/Time**
After this, the device needs to be restarted using the "Power Off" option (Chapter 4.7.4).

4.10.2 IP address - Change Network Settings

Procedure:

1. **Admin > User Level > Enter "1000" (Chapter 4.7.3)**
2. **Admin > Service > Network**

The current network settings are displayed here. The settings can be changed by clicking on 'Settings'. In order to apply the changes to the system configuration, a restart of the gas analysis system is necessary. After closing the network menu, the user is asked if the restart should be done now or later.

4.10.3 Cancel Stop

CAUTION

Errors can occur where the unit sets to STOP (dangerous atmosphere inside) for safety reasons. If the gas analysis system is stopped and the error still persists, the cause of error has to be eliminated and acknowledged before the gas analysis system is activated again. The stop state may only be released once the operator of the plant has verified that the safety risk (gas leakage, explosive atmosphere) no longer exists.

Procedure:

1. **Admin > User Level > Enter "1000" (Chapter 4.7.3)**
2. **Admin > Service > Cancel Stop**

4.10.4 Performing Air Adjustment

By means of a so-called air adjustment or air correction (calibration with fresh air), the zero points of the sensors can be aligned. In this case the oxygen sensor is adjusted to 21% in ambient air.

The air adjustment should be carried out in the event of:

- a newly installed oxygen sensor
- if an older oxygen sensor shows less than 21% when measuring air

Procedure:

1. **Admin > Start Measurement**
Under "Start Measuring" (Chapter 4.7.1) initiate a measurement of all measuring points. Please wait until the measurement, including measurement of the air, is fully completed.
2. **Admin > User Level > Enter "1000" (Chapter 4.7.3)**
3. **Admin > Service > Air adjustment**
Please confirm "Perform air adjustment?" with "Yes". Also confirm the following sub-points. After successful adjustment, a message is displayed indicating that all sensors have been set.

To check the air adjustment, please carry out step 1. After the measurement, the oxygen concentration at the air measuring point should be between 20.8% and 21.1%.

4.10.5 Calibration Touchscreen

Procedure:

1. **Admin > Service > Calibration Touch**

4.11 Tab 'Help'

In this area you will find help on how to operate the gas analysis system. By touching the respective tab, you receive information on the desired subject.

4.12 Tab 'Contact'

Here you will find the contact information for Awite Bioenergie GmbH.

5 Data transfer and remote access

There are various possibilities for data transmission. If the connection to the process control is done via a bus connection (e.g. Ethernet, Profibus DP, serial interface), you will find further information in the Operating instructions 'Bus connection and interfaces' supplied with the device.

Remote access via PV-Browser or VNC Viewer is possible with the option AwiRemote.

5.1 AwiRemote

By means of the AwiRemote option, the gas analysis system automatically establishes a secure connection to the Awi remote maintenance server for purposes of remote maintenance and remote control as soon as there is a functioning Internet access. The gas analysis system must be connected via Ethernet to the customer's Internet router for this. The device then opens a reverse SSH tunnel to awiremote.com via the outgoing port number 10000. The port 10000 must be set as enabled. Both the functionality of the Internet access as well as incurred costs for Internet services and data transfer are within the responsibility of the customer. Awi assumes no liability nor any costs for this.

Minimum speed for internet access:

- PV browser: 56 kBit/s (ISDN)
- VNC viewer: 256 kBit/s

5.1.1 Remote access via PV browser

The software for remote access via PVB can be downloaded and installed from the following website:
www.pvbrowser.de

1. After starting the PV browser, the following address is entered into the address bar:
awiremote.com:Port number. The port number after ":" is made up of **40000 + serial number**. The serial number can be found on the display or on the label on the right external side of the device. For this, you add 40000 plus the serial number.. Example: Serial number **1910** > Port number = **41910**
2. The "Name" field is left blank in the display window. Only the password has to be entered:
The password is provided by the project manager / service technician or in case of loss under info@awite.com
3. Press LOGIN

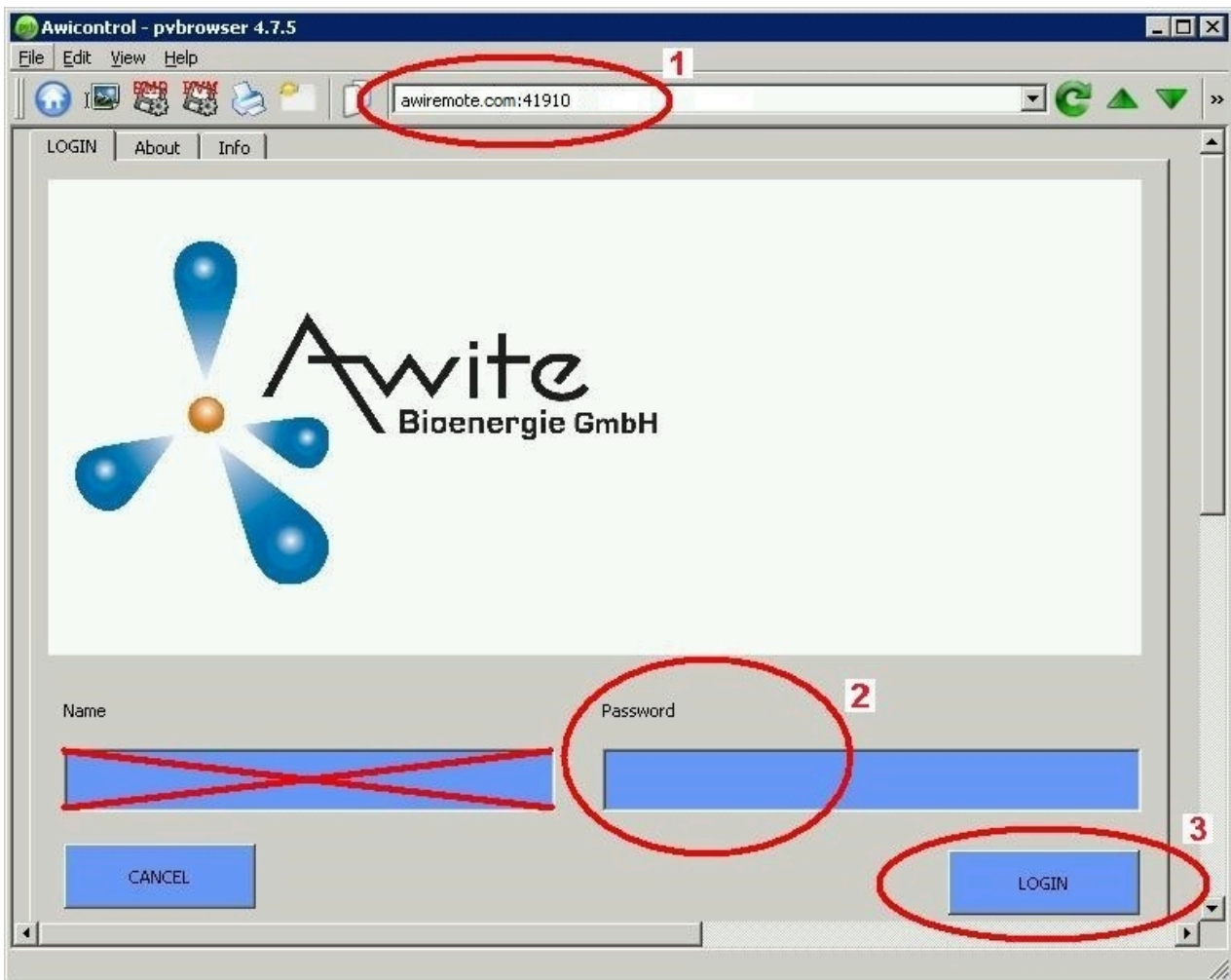


Figure 11: Input window PV browser

Under Windows, please run the PV browser with the option "run as administrator". If no connection is possible, please check or follow these points:

- Is the gas analysis system connected to a working Internet connection?
- Does the PC have a working Internet connection?
- Are all entries correct and complete?
- The PC as well as the gas analysis system should be restarted if necessary!

5.1.2 Remote access via smartphone or tablet

As a software for remote access via smartphone or tablet, Awite recommends the VNC viewer for Android and Apple iOS operating systems. These applications can be downloaded from Google Play Store, from the Apple App Store, or from Windows Marketplace, respectively.

Procedure:

1. After starting VNC Viewer, the following address is entered into the address bar:
awiremote.com:Port number. The port number after ":" is made up of **30000 + Serial number**. The serial number can be found on the display or on the label on the right external side of the device. For this, you add 30000 plus the serial number. Example: Serial number **1910** > Port number = **31910**
2. Enter Name: The name may be freely chosen. Example: Gas analysis
3. Initiate the connection with Connect
4. Enter password: The password is provided by the project manager / service technician or in case of loss under info@awite.com. If the "Save Password" option is checked, the password required later only needs to be entered once.

If no connection is possible, please check or follow these points:

- Is the gas analysis system connected to a working Internet connection?
- Does the smartphone/tablet have a working Internet connection?
- Has the right application been installed?
- Are all entries correct and complete?
- The PC as well as the gas analysis system should be restarted if necessary!

Note:

Only one user may dial in. If there is already a connection to a further user, no further connection can be established. One can dial in only after that connection was terminated.

5.1.2.1 Procedure with VNC Viewer (Google and Apple)

1. After starting VNC Viewer, the following address is entered into the address bar:
awiremote.com:Port number. The port number after ":" is made up of **30000 + Serial number**. The serial number can be found on the display or on the label on the right external side of the device. For this, you add 30000 plus the serial number. Example: Serial number **1910** > Port number = **31910**
2. Enter Name: The name may be freely chosen. Example: Gas analysis
3. Initiate the connection with "Connect"
4. Enter password: The password is provided by the project manager / service technician or in case of loss under info@awite.com. If the "Save Password" option is checked, the password required later only needs to be entered once.

5.2 Download - Update via USB-Stick

Procedure:

1. **Admin > Settings > USB stick**
2. **Connect USB stick**
(insert into the appropriate slot on the right hand side of the device)

“Download” button:

Use this to transfer the recorded data of the gas analysis onto the stick. The copying process is started by clicking the “Download” button and is shown by the left-facing arrow (for copying direction) turning green and an animation. Please wait until the process is completed before you remove the USB stick. The copied data on the USB stick can be opened and evaluated with the program “AwiView”. Please find more information on the AwiView programme online at www.awite.com .

“Update” button:

Thus, a software update can be transferred to the gas analysis using a prepared USB stick. The copying process is started by clicking the “Update” button and is shown by the left-facing arrow (for copying direction) turning green, and an animation. Please wait until the process is completed before you remove the USB stick. After this, the device needs to be restarted using the “Power Off” option ().

5.3 Alarm Limits

On exceeding or falling below adjustable threshold values, alarm limits serve to trigger an automatic reaction (e.g. switching of a relay). Gas analysis systems that allow the adjusting of an upper or lower alarm limit for certain measuring values have the setting options for the corresponding sensor under **Admin > Expert settings**. By clicking on the respective alarm limit (e.g. “Upper limit H₂S Measuring point 2” or “Lower limit CH₄ BHKW measuring point”) you can enter the desired alarm limit in the pop-up menu.

The status of whether an alarm limit has been reached can be read under ‘Current values’ (Chapter 4.5) and ‘History’ (Chapter 4.6) . A status code (Fig. 12) with the following meaning is displayed for the measured value:

- !A0 > no alarm limit reached
- !A1 > alarm limit main alarm reached
- !A2 > alarm limit pre-alarm reached

Example (Fig. 12) Alarm limits at all measuring points:

- Pre-alarm when O₂ > 0.25%
- Main alarm when O₂ > 0.5%



 2411 	State	Recent Values	History	Admin	Help	Contact	
	Values	Settings	Extended Settings				
		Meas. point 1	Meas. point 2	Meas. point 3			
	CH4 (% Vol.)	53.9(08:40)	56.1(08:47)	56.4(08:54)			
	O2 (% Vol.)	0.57(08:40)!A1	0.36(08:47)!A2	0.05(08:54)!A0			
	CO2 (% Vol.)	43.3(08:40)	44.4(08:47)	44.8(08:54)			
H2 (ppm)	147(08:42)	82(08:49)	40(08:56)				
H2S hi (ppm)	429(08:44)	128(08:52)	69(08:57)				

Figure 12: Status Alarm Limits

6 Information security and data protection

6.1 Protection against loss of data

Loss of data

Device-specific settings, user-specific settings, calibration data, message history and measured value history are stored on the device. These may be lost if the memory card is defective.

Backup

The data can be backed up by the user via download.

Recovery

Data backed up by the user or data at the time of the last device maintenance can be made available for upload by Awite if required.

6.2 Protection against misuse

6.2.1 General protection principles

Embedded Linux

Awite process analysis systems are operated with an Awite-specific embedded Linux which only contains necessary open source software modules. There are no desktop users and no desktop software packages installed. The Linux is based on Yocto Project/OpenEmbedded. Usually, no antivirus software is necessary or installed on such systems, as is the case here.

Software modification

The only way to modify the firmware on the device is via USB stick or with SSH/SCP login (network port 22). Virus protection also exists due to the different Linux binary data format and the different CPU architecture (ARM 7) compared to a normal PC. Other malware could be installed intentionally after logging in as 'root' via network port 22 (SSH) in the local network. Awite does not provide the root password and remote access via the Internet is specially secured.

6.2.2 Access control on site

Communication directly on the device is only possible via the touchscreen user interface. Important settings are protected by a password (user level).

6.2.3 Local network access protection

With knowledge of the root password and unrestricted access in the local network, the system could in principle be manipulated and other systems in the network could potentially be accessed from this system.

The operator is responsible for protecting the local network. Depending on the network environment, access could be restricted using a managed network switch, for example.

6.2.4 Internet access protection

When connected to a network with an Internet connection, the device creates a secure tunnel to the remote maintenance server `awitemote.awite.de`. This is a semi-open reverse SSH tunnel. The device connects to the server after authentication. The respective device can only be accessed via the server using device-specific network ports.

SSH port

Access via SSH (port 22) represents a potential threat. This access is therefore blocked on the server side, except via the SSH tunnel from the Awite Langenbach site network.

Other ports

Otherwise, only a few required ports are enabled for access via the SSH tunnel (PV browser 5051 and 5053, VNC 5900 and 5901). The corresponding services only allow limited intervention options via the user interface. Access is protected with device-specific passwords. Further authentication, as is the case for local access, is required for important settings.

7 Error Messages

The following chapter is designed to help you find the cause for occurring errors and to provide you with the information required to solve these problems.

7.1 Errors for Touch Panel or during Transmission of Measured Values

If the touch panel and/or the transmission of measured values to external devices are faulty, use the following checklist to start your troubleshooting:

Table 1: Errors for Touch Panel - Transmission of Measured Values

Error appearance	Troubleshooting
No display on the touch panel and no transmission of measured values to external gas analysis systems	<ol style="list-style-type: none"> 1. Check power supply of the gas analysis system 2. Check fuses 3. Check the LEDs on the AwiProtect module (Fig. 13). The module is built into the upper left in the gas analysis device (see also part A of the Instruction Manual). There are 3 LEDs in the component. The colour may indicate the reason for the fault. <p>Green: Normal operation</p> <p>Yellow: Overvoltage (triggered if the voltage at the power-supply unit is > 27.5V, reason: overvoltage has damaged power-supply unit, counter measure: contact Awite)</p> <p>Red: Overcurrent (triggered when current is > 5/10 A, reason: faulty components in the device have caused a short circuit, counter measure: contact Awite)</p>
No display on the touch panel, but output signals exist	<ol style="list-style-type: none"> 1. Check whether the data cable and the power supply for the touch panel are properly connected 2. Display module faulty
Despite display of measured values on the gas analysis system, no signal output	<ol style="list-style-type: none"> 1. Check connectors and cable connection to external devices

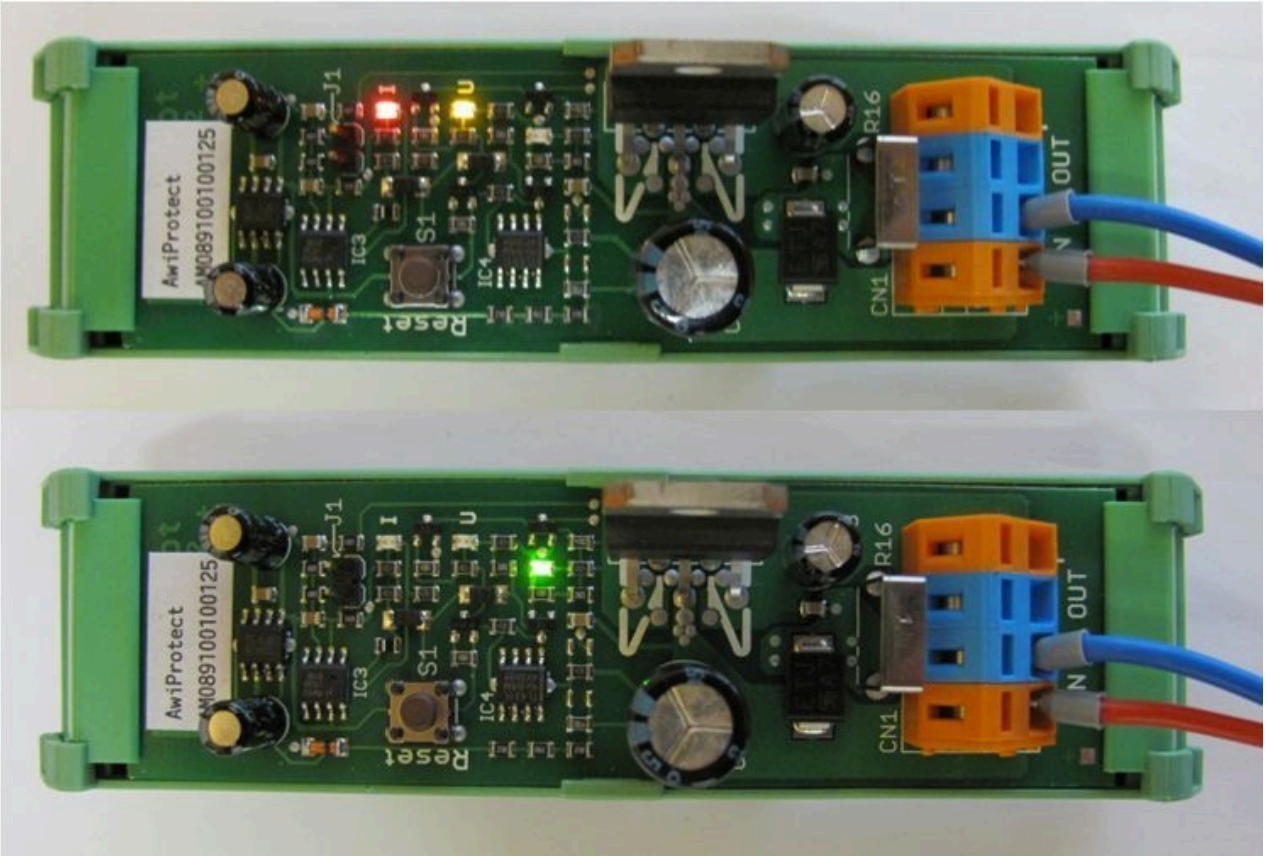


Figure 13: AwiProtect module with LEDs showing the current operational status

7.2 System Error Messages

In the event of system errors, these are displayed via error messages. There are three types of errors, which are displayed by a button on the left hand side of the screen.

- Current and not acknowledged errors (red button)
- Current and acknowledged errors (orange button)
- Non-current and not acknowledged errors (yellow button)

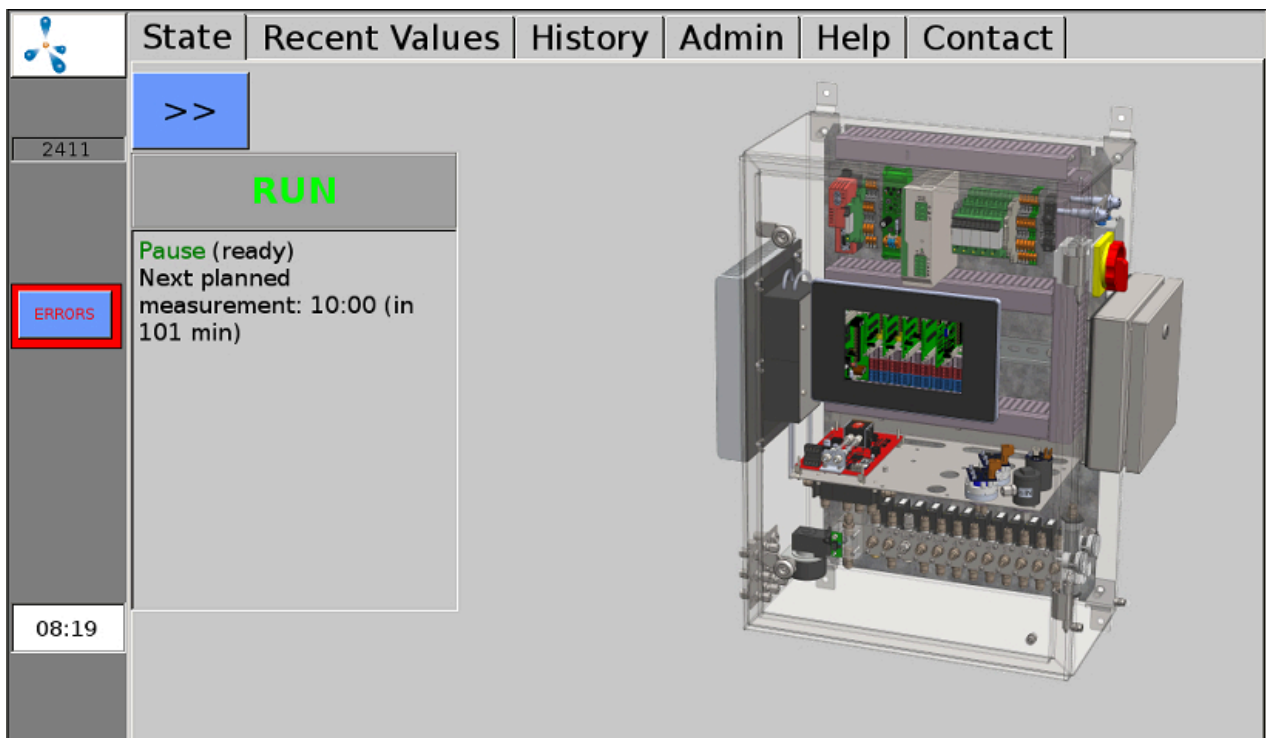


Figure 14: Current and not acknowledged errors (red button) are displayed on the left edge of the screen

When you click the button, the error window is displayed. You can call up detailed errors by clicking the underlined name. By clicking on the word "Confirm", individual errors can be confirmed, with 'All confirm' all errors can be confirmed. Click "Close" to close the error window.

If the system fails to recognize the successful outcome of the troubleshooting process, it is additionally necessary to "delete" the error after acknowledging it.

If errors don't get acknowledged for a longer period of time, a prompt to do so will be shown repeatedly on the display. Some errors are still displayed after they are acknowledged if they are still unresolved.

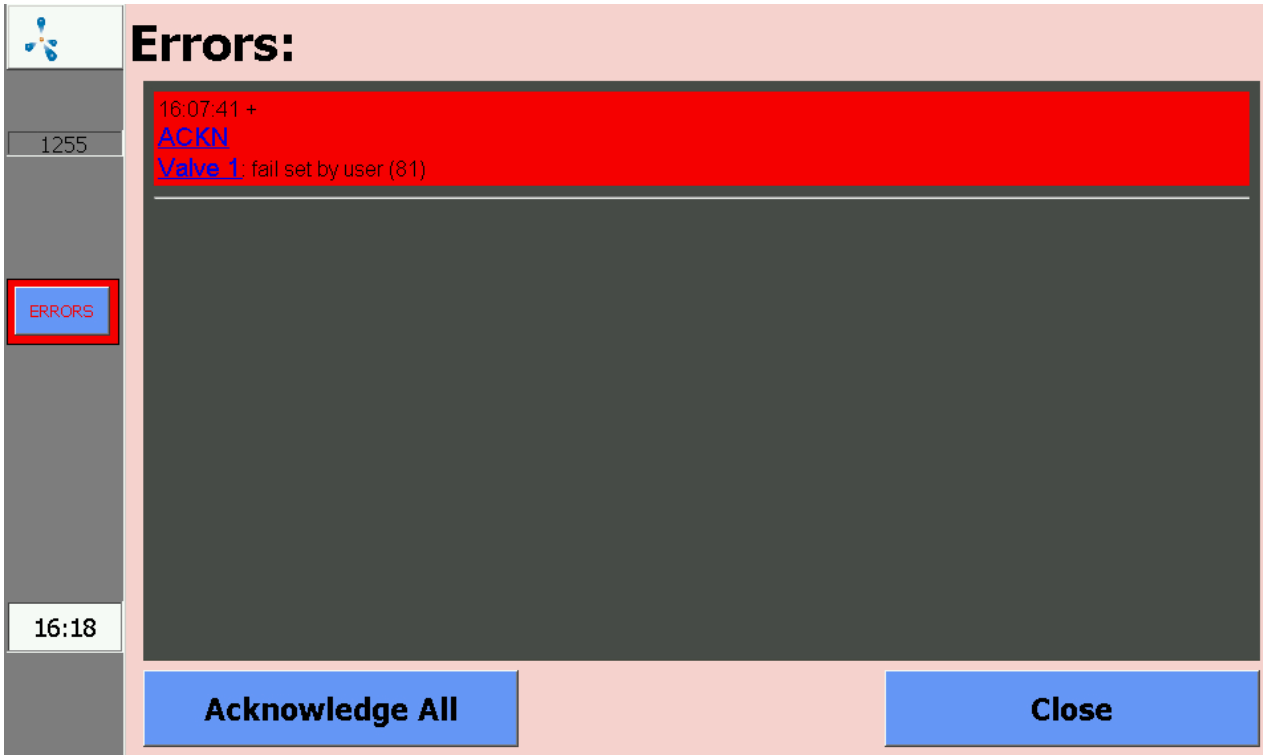


Figure 15: Error window displays a list of the errors that occurred

7.2.1 List of the possible system error messages

Table 2: List of the possible system error messages with a short description of the error, possible causes and notes for determining or resolving the error

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
1	9999	Signal too high	Sensor has reached maximum signal	Sensor provides signal that is too high or indicates an error	Measured value is higher than measuring range of the sensor
7	-9995	General error (7)	General error	Corresponding object does not function properly or indicates an error	Please contact service
13	-9989	Timeout: Emptying took too long (13)	Timeout: Emptying takes too long	Pump faulty or leakage in the system	Check pump for proper functioning and system for leakage
14	-9988	Timeout: Filling took too long (14)	Timeout: Filling takes too long	Request for connecting something was not followed	Repeat procedure

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
17	-9985	Switched off due to overload of another sensor (17)		One of the sensors connected in series (most of the time channel 1: CH4, CO2, O2) has an overload detection. Therefore the other sensors were switched off.	Switch gas analysis off and on or contact service
18	-9984	Not measured because of filter test failure (18)	Measurement deactivated to protect the sensors	Internal or external filter is used up	Exchange filter
19	-9983	No measurement values yet (19)	No measurement has taken place yet	<ul style="list-style-type: none"> - No measuring interval set - Validity expired 	Check when measurement is planned for, set measuring interval
20	-9982	Sensor gives no signal! (20)	No measurement signal	<ol style="list-style-type: none"> 1. Sensor faulty 2. Cable faulty 3. No connection to internal PLC (LEDs don't flash on I/O module) 	<p>To 1. and 2.: Check contacts (loose pin contact, corrosion ...)</p> <p>To 3.: LEDs on I/O module don't flash > Please contact service</p>
32	-9970	Serial interface: Error during opening (32)	Serial interface could not be opened	Communication with internal or external bus component failed	Most of the time hardware problem, therefore check cable connections of the respective components
33	-9969	Serial interface: Communication error (33)	Serial interface: Communication error	Communication with internal or external bus component failed	Most of the time hardware problem, therefore check cable connections of the respective components
35	-9967	No feedback from peripherals (35)	No feedback from the peripherals	<p>Object</p> <ul style="list-style-type: none"> - not in operation - not available - Assembly faulty 	Please contact service
36	-9966	State is not safe: stopped (36)	State is not safe, gas analysis system was stopped	<ol style="list-style-type: none"> 1. Faulty hardware 2. Critical error 	Please contact the service

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
38	-9964	Reading log-file failed (38)	Error when reading log file	Problems with memory card	Please contact service
39	-9963	Writing log file failed (39)	Error when writing to log file	Memory card full	Please contact service
41	-9961	Filter test failed (41)	Filter test failed	Internal or external filter is ready for used up	Exchange filter
42	-9960	Calibration file not found (42)	Calibration file not found	Damaged calibration file	Please contact service
43	-9959	Too few calibration points defined (43)	Too few calibration points defined	Configuration error	Please contact service
46	-9956	No flow (46)	No flow could be detected at the respective measuring point	<ol style="list-style-type: none"> 1. Measuring pipe clogged 2. Extraction point dirty 3. Manual valve at the extraction point is closed 	Check measuring pipe from extraction point to gas analysis system for any blockage
47	-9955	Bus: Timeout (47)	Communication error bus	Communication with internal or external bus component failed	Please contact service
48	-9954	Bus: Set Comm. (48)	Communication error bus	Communication with internal or external bus component failed	Please contact service
49	-9953	Bus: CRC Error (49)	Communication error bus	Communication with internal or external bus component failed	Please contact service
50	-9952	Bus: opening failed (50)	Communication error bus	Communication with internal or external bus component failed	Please contact service
51	-9951	Bus: Connecting failed (51)	Communication error bus	Communication with internal or external bus component failed	Please contact service

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
52	-9950	Bus: Socket failure (52)	Communication error bus	Communication with internal or external bus component failed	Please contact service
53	-9949	Calibration failed (53)	Calibration failed	Problems with optional automatic calibration	Please contact service
54	-9948	Calibration partly failed (54)	Calibration partly failed	Problems with optional automatic calibration	Please contact service
55	-9947	Calibration: Calibration: deviation too high - Sensor defective? (55)	Calibration: Deviation too high	Problems with optional automatic calibration	Please contact service
56	-9946	Sensor defective or dangerous atmosphere! (56)	Sensor defective. A hazardous atmosphere is unlikely, but cannot be completely ruled out.	-explosive atmosphere at installation location or in the interior of the device -pumps faulty -exhaust air line blocked -sensor faulty	Explosive atmosphere detected: <ul style="list-style-type: none"> - avoid sparks - no switching operations - Ventilation - eliminate leakage Check pump (trigger measurement > pump must start up) Check exhaust line for any blockage Check sensor values
57	-9945	Caution! Possibly Explosive Atmosphere! (57)	Explosion Hazard! - One or more sensors have detected a hazardous atmosphere. It is likely that there is an explosive atmosphere inside the device.	See error 56	See error 56

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
58	-9944	Sensor defective (58)	Sensor faulty	Measured value could not be accepted in the scheduled time Sensor reacts too slowly	Sensor used up > replace sensor
60	-9942	Timeout: No measurement values yet (60)	Timeout: Time span since last measurement is too long	Error only with analogue outlet, measured value too old and therefore no longer valid	Please contact the service
62	-9940	not released (62)	Not released	Controller or process not released	Check motor protection switch desulphurisation
63	-9939	stopped (63)	Stopped	Gas analysis system was stopped due to error message	See chapter "Stop"
64	-9938	switched off (64)	Switched off	Control is switched off	Activate the controller.
65	-9937	stopped, switched off or not released (65)	Not released, stopped, not active or not switched on	Motor protection switch desulphurisation	Check desulphurisation
66	-9936	Gas analysis system was stopped due to failure of a component (66)	Only used with special devices.	e.g. water sensor responded	Please contact service
68	-9934	no data file (68)	Data file not found		Please contact service
70	-9932	Bus: Writing failed (70)	Communication error bus	Communication with internal or external bus component failed	Please contact service
71	-9931	Bus: Reading failed (71)	Communication error bus	Communication with internal or external bus component failed	Please contact service
72	-9930	Out of memory (72)	Out of memory	Memory full	Restart the gas analysis system

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
75	-9927	not ready (75)	Not all prerequisites are met yet	Gas analysis system cannot run yet as certain prerequisites are not met: <ul style="list-style-type: none"> - Other gas analysis system not switched on - tank empty - switch incorrectly set 	See causes
84	-9918	Fail criteria reached (84)	Object cooler: The temperature of the cooler is too high or too low in relation to the ambient temperature	Object cooler: <ol style="list-style-type: none"> 1. Device was switched off 2. Problems with the cooler (not able to reach setpoint temperature any more) 	Object cooler: <ol style="list-style-type: none"> 1. Wait until the temperature has been adjusted (1 hour) 2. Service required
			Object casing temperature: Temperature of the casing too high or too low	Object casing temperature: <ol style="list-style-type: none"> 1. Installation location too hot or too cold 2. Device has not been running for long 	Object casing temperature: <ol style="list-style-type: none"> 1. Check installation location 2. wait
			Object pressure too high: Pressure too high discontinuous system / pressure too high continuous system	Object pressure too high: <ol style="list-style-type: none"> 1. Incorrect pressure regulation setting 2. Pressure regulation defective 	Object pressure too high: <ol style="list-style-type: none"> 1. Correct the setting on the pressure regulator 2. Disconnect gas supply pipe / Ensure safe pressure control
			Object pressure too low: Pressure too low discontinuous system / pressure too low continuous system	Object pressure too low <ol style="list-style-type: none"> 1. Underpressure at measuring point too high 2. Supply of analysis gas to the gas analysis system obstructed/ interrupted 	Object pressure too low <ol style="list-style-type: none"> 1. Check pressure at process pipe 2. Check gas supply pipe

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
85	-9917	OK criterion not reached (85)	End criterion with error on failure to reach: Error, as not reached	Above or below threshold value	
90	-9912	Pressure too high (90)	Pressure too high	Input pressure too high	Check input pressure
91	-9911	Pressure too low (91)	Pressure too low	Input pressure too low	Clean measuring pipe or exchange filter
92	-9910	Pressure problem (92)	Pressure problem		Please contact service
93	-9909	used up (93)	used up (e.g. filter)	Filter used up	Exchange filter
98	-9904	Write error (98)	File could not be written	1. microSD full 2. Data corruption on microSD	Please contact the service
99	-9903	Watchdog write error (99)	Communication error with counterpart	1. Faulty component 2. Communication with counterpart failed	Please contact service
100	-9902	could not be opened (100)	File could not be opened	1. microSD full 2. Data corruption on microSD	Please contact service
101	-9901	write error with secondary file (101)	A secondary file (e.g. backup copy) of the archive could not be created. Saving of data might have been aborted.	1. microSD full 2. Data corruption on microSD	1. a) Restart the device (during restart some files are deleted) b) Delete log files (Service personnel) 2. Please contact service
103	-9899	Range exceeded (103)	Measuring ranges have been exceeded	Set alarm thresholds were exceeded or sensor gives a signal that is too high or too low	Please contact service

Error Messages

No. GA	No. BUS	Error Text	Short description	Possible causes	Troubleshooting or Handling
104	-9898	Pump is defective or outlet is blocked (104)	Pump faulty or outlet blocked	<ol style="list-style-type: none"> 1. Pump faulty 2. Exhaust line blocked 3. Exhaust line frozen up 	Check exhaust line for any blockage and exchange pump if necessary
105	-9897	Drift is too high (105)	Sensor drift is too high	The sensor in question is possibly depleted. This error occurs during calibration.	Please contact the service.

7.3 Error multi-gas sensor InfraFRED

The multi-gas sensor InfraFRED has LEDs (Fig. 16) that show the current status ("Tab. 3: List Status Conditions Multi-Gas Sensor InfraFRED") of the sensor. Errors can be transmitted as well here.

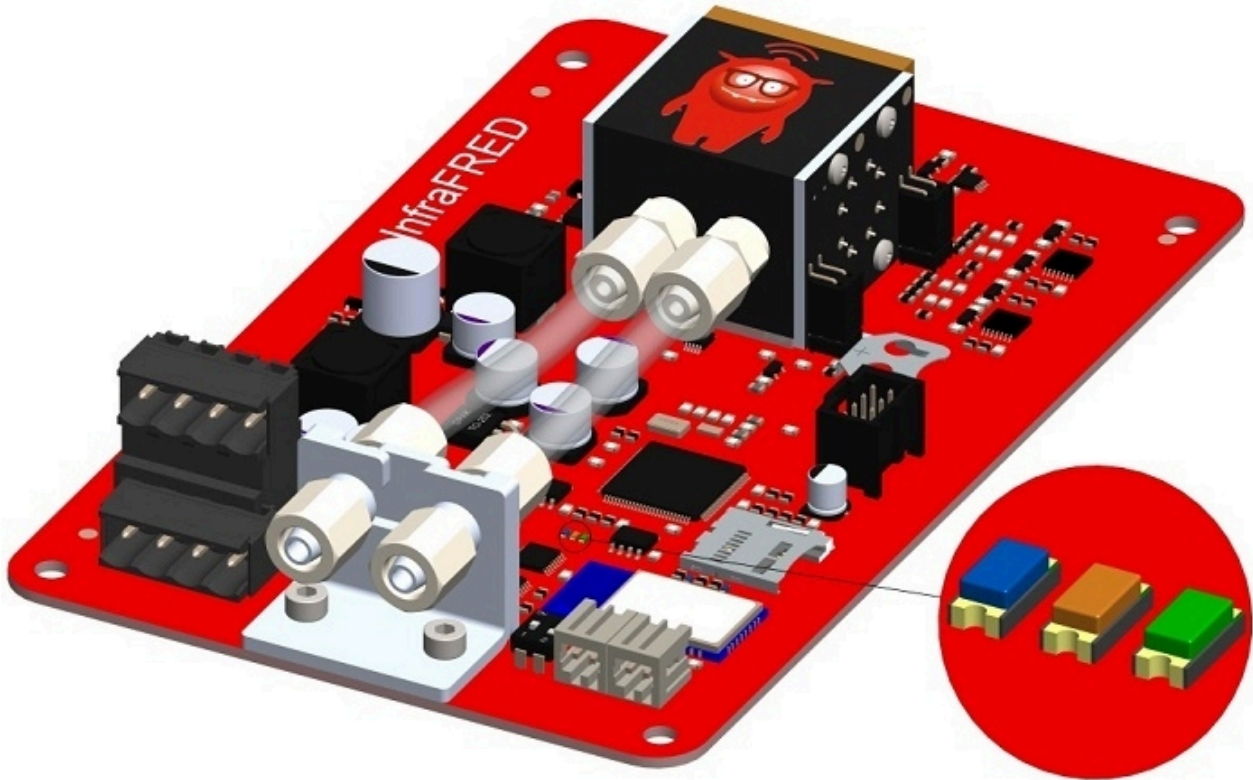


Figure 16: Status LEDs Multi-Gas Sensor InfraFRED

Table 3: List Status Conditions Multi-Gas Sensor InfraFRED

State	LED blue	LED orange	LED green
normal operation, warm-up phase not yet completed	flashes alternately with orange LED (5 Hz)	flashes alternately with blue LED (5 Hz)	off
normal operation, warm-up phase completed (approx. 15 min after switching on)	flashes alternately with orange LED (5 Hz)	flashes alternately with blue LED (5 Hz)	on
Error thermostatzation measuring cell (= sensor at STOP)	on	off	off
Error IR emitter (= sensor at STOP)	off	on	on
Other errors	on	on	off

8 Options

Awite gas analysis systems are modularly built and can be equipped with many options. Below you will find information about the options available especially for your gas analysis system.

8.1 Combi Package Microbiological Desulphurisation AwiDESULF

Below, you will find a description of the AwiDESULF combi-package microbiological desulphurisation option, i.e. controlled air or oxygen supply for desulphurisation with the option of a separate setting for different plant components or fermenters.

8.1.1 Setup AwiDESULF:

See Part A of the Instruction Manual.

8.1.2 Mode of Operation AwiDESULF

The Awite gas analysis system can be used with this option for the microbiological desulphurisation of biogas. Controlled amounts of air or pure oxygen are blown into the gas storage or the gas space in the fermenter of the biogas system. In the gas spaces, bacteria oxidize sulphide into elementary sulphur with the help of oxygen and hydrogen. The controlled variable is the oxygen and hydrogen sulphide content in the respective system part. Through this controlled process, the currently produced gas amount is taken into account and the underdosing or overdosing of oxygen with the corresponding negative impact is avoided.

8.1.3 Automatic Control of the Air Supply using PI Controller and Fuzzy Control

The amount of air to be supplied depends on the oxygen and hydrogen sulphide content in the biogas. For this reason, the gas analysis system needs to be fitted with an oxygen sensor. If the air is fed into several containers, it is recommended to fit each fermenter with a measuring point. The air supply for each tank is individually controlled this way. The control is effected through one or more PI controller outputs along with a fuzzy control (Chapter 4.7.2).

8.1.4 Manual Control of the Air Supply AwiDESULF

WARNING

Monitoring can be disabled by manual operation. As a result, too much oxygen may enter the process, for example in the case of the optional air injection / oxygen dosage (AwiDESULF), which may eventually lead to an explosive atmosphere. The gas analysis system should therefore be operated in automatic mode. The system operator himself is responsible for all manually effected settings, specifically for adhering to the upper oxygen limit..

In certain operational modes it is preferable to use the manual control of air supply rather than the automatic control.

- Example 1:
Startup operation of a biogas plant, when the CHP is only running from time to time and the measured values of the CHP measuring point are used for controlling the air supply
- Example 2:
Faulty oxygen sensor.

When using manual control, 0.5 to 1% of the biogas amount should be fed in as air. The following table shows the air throughput. In the event of deviating counter pressures, please contact Awite about the air throughput.

Table 4: Air flow rate in the event of 25 mbar of counterpressure (opening pressure of the check valve) and a power frequency of 50 or 60 Hz.

Compressor type	Counterpressure	Throughput at 50 Hz	Throughput at 60 Hz
AwiDESULF 100	25 mbar	6.9 m ³ /h	6.9 m ³ /h

Table 5: Air flow rate in the event of 25 mbar of counterpressure (opening pressure of the check valve) and a power frequency of 50 or 60 Hz.

Compressor type	Counterpressure	Throughput at 50 Hz	Throughput at 60 Hz
AwiDESULF 200	25 mbar	12 m ³ /h	12 m ³ /h

Table 6: Air flow rate in the event of 25 mbar of counterpressure (opening pressure of the check valve) and a power frequency of 50 or 60 Hz.

Compressor type	Counterpressure	Throughput at 50 Hz	Throughput at 60 Hz
AwiDESULF 200 UL	25 mbar	13.8 m ³ /h	13.8 m ³ /h

Table 7: Air flow rate in the event of 25 mbar of counterpressure (opening pressure of the check valve) and a power frequency of 50 or 60 Hz.

Compressor type	Counterpressure	Throughput at 50 Hz	Throughput at 60 Hz
AwiDESULF 300	25 mbar	37 m ³ /h	45 m ³ /h

Table 8: Air flow rate in the event of 25 mbar of counterpressure (opening pressure of the check valve) and a power frequency of 50 or 60 Hz.

Compressor type	Counterpressure	Throughput at 50 Hz	Throughput at 60 Hz
AwiDESULF 500	25 mbar	58.5 m ³ /h	71 m ³ /h

Table 9: Air flow rate in the event of 25 mbar of counterpressure (opening pressure of the check valve) and a power frequency of 50 or 60 Hz.

Compressor type	Counterpressure	Throughput at 50 Hz	Throughput at 60 Hz
AwiDESULF 1000	25 mbar	117 m ³ /h	142 m ³ /h

The air or oxygen supply amount can be varied continuously. The appropriate settings can be made under **Admin > Controller** .

Click on the **"Man"** button at the right-hand side of the screen for this. By choosing the number field now displayed, a value between 1 and 100% can be entered.

100% means: The valve to the point of supply is opened 100% of the maximum possible switching time. The maximum switching time of a valve is based on the number of points of supply that exist on the system. The **basic interval of 100 seconds** is split among the points of supply (= valves), because only one point of supply at a time receives air from the compressor.

Systems with one point of supply only have a maximum opening time of 100 seconds per valve. With two points of air supply, the maximum opening time per valve is reduced to 50 seconds, with three points to 33 seconds, etc.

Example:

For example, if 33% of the maximum allowed air amount is to be distributed evenly to the three points of a system with three points of supply, the setting must be as follows:

Controller 1: 33%, controller 2: 33%, controller 3: 33%.

In this example, each valve switches every 100 seconds for approximately 11 seconds

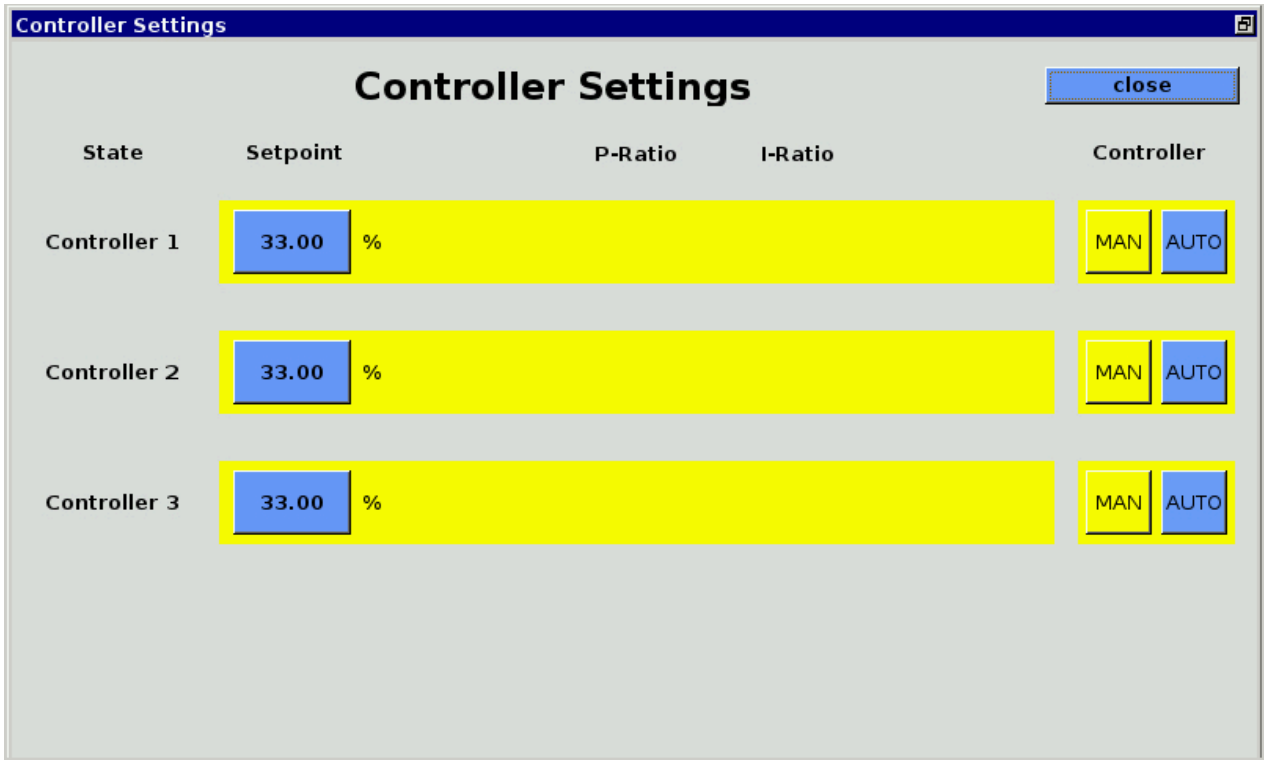


Figure 17: Admin > Controller, manual control of air supply

8.2 Flow meter AwiFLOW

The thermal mass flowmeter AwiFLOW transfers the uncorrected measured values for the current temperature **Temp** (in °C) and the current flow rate **F uncomp** (in m³/h) to the gas analysis system. These values are evaluated and corrected in the gas analysis system. From the temperature **Temp** (in °C) the absolute humidity **H₂O** (in vol%) is assumed. The uncorrected flow rate **F uncomp** (in m³/h) is converted to the standard conditions for dry biogas (reference conditions 0°C / 1013 mbar) **F_{dry}** (in Nm³/h). A measured CH₄ value and the assumed absolute humidity serve as the basis for the calculation. The adjusted volume **V_{dry}** (in m³) is derived from the integration of the adjusted flow.

It is also possible to calculate and display the energy flow P_{sn} (in KW), an energy meter E_{sn} (KWh) and the average calorific value H_{sn} (KWh/m³).

All values refer to the Awite standard reference states according to standard DIN 51857:1995:

- Calorific value (100% CH₄): 11.06 kWh/m³
- Reference pressure gas volume: 1013 mbar
- Reference temperature gas volume: 0°C
- Reference temperature combustion: 25°C

Further reference states and measurements are possible on request.

The volume and the energy meter can be reset as follows:

Procedure:

1. **Admin > User Level > Enter "300"** (Chapter 4.7.3)
2. **Admin > Expert settings > reset all counters**

8.3 Automatic calibration

For automatic calibration, the gas analysis system is firmly connected to the calibration gases using its own calibration gas connectors, or the calibration gases are only connected to the gas analysis system during the calibration process. With the user level "300", Admin > User Level - Enter "300" (Chapter 4.7.3) basic settings can be made. From user level 1000, Admin > User Level - Enter "1000" (Chapter 4.7.3) on, you can specify extended settings.

8.3.1 Fixed Calibration Gas Connection

The gas analysis system is equipped with separate measuring points for the calibration gases. It is recommended to use this option if calibration is to take place frequently.

8.3.1.1 Media

Admin > Calibration > Media

Under the "Media" tab (Fig. 18) all test gas mixtures required for calibration are displayed. When new calibration gases are used, the exact concentrations of the components have to be entered into the gas analysis system by clicking on the blue fields. Please note the actual values stated on the analysis certificate on the neck of the corresponding gas cylinder (not the ones on the labels on the cylinders). Use only test gases with certificates.


		State	Recent Values	History	Admin	Help	Contact
Calibration							Close
2411	Media	State	History	Setup			
Media		Actual values					
Calibration gas air							
Methan	0	Enter value					
Carbon dioxide	0						
Hydrogen	0						
Hydrogen sulphide	0	7	8	9			
Oxygen	20.95	4	5	6			
Calibration gas 1							
Methan	55.32	1	2	3			
Carbon dioxide	44.58						
Hydrogen sulphide	988	0					
Oxygen	0						
Calibration gas 2							
08:58							

Figure 18: Admin > Calibration > Media, pop-up window for entering a gas concentration

8.3.1.2 Status

Admin > Calibration > Status

Under the 'Status' Tab (Fig. 19) the individual sensors as well as the respective gases used for calibration are listed. The colouring of the fields means:

- Green: Calibration carried out successfully
- Blue: Calibration underway
- Red: Calibration failed
- Yellow: Calibration cancelled


		State	Recent Values	History	Admin	Help	Contact
Calibration							Close
1255	Media	State	History	Setup			
CH4 sensor		H2 sensor		H2S hi sensor		O2 sensor	
Calibration gas air		Calibration gas air		Calibration gas air		Calibration gas air	
Calibration gas 1		Calibration gas 2		Calibration gas 1		Calibration gas 1	
Calibration gas 2						Calibration gas 2	

Figure 19: Admin > Calibration > Status

By clicking on the fields, the window 'Extended Calibration Status' (Fig. 20) will open. This window shows the setpoints and actual values of the measuring gas and the sensor for the sensor/medium constellations as well as the status of the calibration.

The following messages are possible for the status of the calibration:

If the **calibration has not been completed** yet, the following messages can be displayed in the Status display (Fig. 19) :

- "No calibration started yet"
- 'Calibration running'
- 'Calibration cancelled' (highlighted in yellow)

If the **calibration was completed successfully**, the following messages are possible:

- "Calibration: no changes necessary": It was not necessary to adapt the calibration curve as the deviation from the setpoint value was too small
- "Calib: Measurement successfully completed." The calibration curve has been adjusted.

In the case of a failed calibration, the following messages are displayed (for troubleshooting see Chapter 8.3.1.5):

- **"Calibration failed: sensor drift too high":**
The actual signal during calibration is outside the valid min./max. signal of the sensor. When clicking the error button the message "Calibration partly failed" is displayed.
- **"Calibration - need another run":**
The calibration is running, but the constancy of the measured values is not yet achieved. Another calibration cycle is necessary.
- **"Calibration failed":**
This message is displayed when two or more calibration cycles are allowed, but no constancy of the measured value has been achieved yet on reaching the maximum permitted number of cycles. This is even the case if the signal is within the acceptable limits.

The screenshot displays a web-based interface for sensor calibration. At the top, there is a navigation bar with tabs for 'State', 'Recent Values', 'History', 'Admin', 'Help', and 'Contact'. Below this, a 'Calibration' section is active, with sub-tabs for 'Media', 'State', 'History', and 'Setup'. The main content area is titled 'Extended Calibration State' and contains the following information:

- Sensor:** CH4 sensor - Medium: Calibration gas 1
- SETPOINT concentration:** 57.00 % (no adjustment at: +/- 0.20 %)
- SETPOINT signal:** 21444 (+/- 2439)
- During calibration:**
 - 19 Dec 10:07:
 - ACTUAL VALUE:** 57.86 % (average is used, NUMBER of values: 3)
 - ACTUAL VALUE signal:** 20462 at 955.2 mbar
 - calibration, measurement successfully finished.
- Check after calibration:**
 - 19 Dec 10:08:
 - ACTUAL VALUE:** 57.49 %
 - ACTUAL VALUE signal:** 20574
- Details of last calibration run:**
 - run: 1/max. 4 signal: 20477 value: 57.91 pressure: 955.4

On the left side of the interface, there is a vertical sidebar with a logo at the top, the number '1255', and a clock showing '10:12'.

Figure 20: Admin > Calibration > Status > Extended Calibration Status

8.3.1.3 Calibration - History

Admin > Calibration > History

Under the 'History' Tab (Fig. 21) the calibration cycles are documented.

The screenshot shows the 'Admin > Calibration > History' interface. At the top, there is a navigation bar with tabs for 'State', 'Recent Values', 'History', 'Admin', 'Help', and 'Contact'. Below this is a 'Calibration' section with a 'Close' button and sub-tabs for 'Media', 'State', 'History', and 'Setup'. The main area displays a list of calibration events with timestamps and sensor data. A 'next' link is visible at the bottom.

Figure 21: Admin > Calibration > History

8.3.1.4 Calibration - Settings

Admin > Calibration > Settings

In the 'Settings' Tab (Fig. 22) the measuring channels that are available in the device are displayed. Each measuring channel is calibrated separately. The display indicates which sensors in the corresponding measuring channel are connected in series: e.g. channel 01 (CH₄, CO₂, O₂).

If the **calibration is successful**, no more messages are displayed. The sensors are adjusted within the tolerance limits. The calibration process takes approx. 10 minutes, depending on the sensor and channel features.

The following settings are possible from user level 1000 onwards (enter Admin > User Level - Enter "1000" (Chapter 4.7.3)).

Table 10: Setting calibration

Option	Remark
Off	Deactivates the calibration for the respective measuring channel.
Auto	The calibration is started automatically depending on the set interval. It has to be ensured that the calibration gas is connected.

Options

Option	Remark
Manually	The calibration is started manually using the 'Start' button. Non-relevant items for manual calibration are displayed in rounded brackets, e.g. Interval -> (3d).
Start	Starts a manual calibration. The 'Start' button is only available if the calibration is set to manual. After clicking 'Start', the pop-up window "Start Calibration now? Yes/No" will appear. After confirming and air calibration, there will be a double request to connect the calibration measuring point with the calibration gas. Confirm both messages with Yes.
Interval	Time interval for the automatic calibration.
Again	Repeat interval for the automatic calibration if the calibration fails.
Repeat	The number of retries if the calibration fails. When this number is reached, no more repeats are carried out until the next interval.
Last	Display of last calibration with corresponding date and status.
Next	Date display for the next automatic calibration.
Start Use	The point within a calibration cycle from which on the values will be used.
Runs	Number of runs within one calibration.
+ Sensors	Display of the active sensors. By clicking, sensors can temporarily be removed for the next calibration. These sensors will not be calibrated then.
- Sensors	Display of the sensors removed temporarily. By clicking on them, the temporarily removed sensors can be activated again.

	Off	Auto	Manual	Start	Interval	Retry
K01 (CH4,CO2,O2)	Off	Auto	Manual	Start	(-)	(1d)
K02 (H2)	Off	Auto	Manual	Start	(-)	(1d)
K03 (H2S_hi)	Off	Auto	Manual	Start	(-)	(1d)

Figure 22: Admin > Calibration > Settings

8.3.1.5 Error Failed Calibration

If problems occur during the calibration, three different error messages may be displayed. These errors cannot be deleted. They will be reset automatically after a successful calibration.

Calibration partly failed, channel ...:

During calibration of multiple sensors at the same time, the calibration failed for some (not all) of the sensors.

Calibration failed:

In the case of a calibration with multiple calibration cycles, the measured values were within the acceptable limits for at least one sensor, but within one calibration cycle (repetitions) the dispersion of the measured values was higher than allowed.

Calibration - deviation too high - sensor defective:

During a calibration all sensors were outside the acceptable limits.

A calibration may fail due to one of the following reasons:

- No calibration gas connected
- Wrong calibration gas connected
- No gas flow (e.g. due to closed-off pressure reducer or blockage)

- Sensor depleted
- Sensor faulty

8.3.1.6 Display of Measured Values during Calibration

The measured values of the calibration can be viewed like all other measured values in the "History" or "Current Values" tabs. To do this, the calibration measuring point must be selected in the respective "Settings" sub-menu (see Chapter 4.5 and Chapter 4.6). This option is only possible for an automatic calibration with firmly connected calibration gas.

8.3.1.7 Test Measurement with Calibration Gas

The calibration gas measuring points can be measured for test purposes without adjusting the sensors. In order to do this, the user level has to be changed to User Level 300 (Admin > User Level - Enter "300" (Chapter 4.7.3)). After that, click on **Admin > Start Measurement**. All measuring points (including the test gases) are queried. For "normal" measuring points (e.g. fermenter/CHP...) answer 'No' when asked "Start Measuring now". Click "Yes" to confirm the desired calibration measuring point. Depending on the customer's needs, any combination of test gases and measuring channels can be configured for this manual measurement.

8.3.1.8 Exchange of Calibration Gases

It is necessary to use certified test gases (for the right composition please contact Awite). Please ensure to order new calibration gases well in advance, as the production of individual mixtures takes several weeks.

Due to impurities in the calibration gases and their components, it is important to order the calibration gases with specific purities (gas qualities).

Table 11: Definition of purities:

Designation	Purity	Rest (ppm)
N18	98	20000 ppm
N25	99.5	5000 ppm
N35	99.95	500 ppm
N40	99.99	100 ppm
N45	99.995	50 ppm
N48	99.998	20 ppm

Designation	Purity	Rest (ppm)
N50	99.999	10 ppm
N55	99.9995	5 ppm
N60	99.9999	1 ppm

Table 12: The following purity specifications for the individual components are normally specified and sufficient for the calibration gases in our systems:

Gas components	Designation
Methane (CH ₄)	N45
Carbon dioxide (CO ₂)	N35
Oxygen (O ₂)	N45
Nitrogen (N ₂)	N50
Hydrogen sulphide (H ₂ S)	N25
Hydrogen (H ₂)	N50
Carbon monoxide (CO)	N37

When new calibration gases are used, the exact concentrations of the components have to be entered into the process analysis system (see Chapter 8.3.1.1). Please use the actual values stated on the protocol on the neck of the appropriate gas cylinder (and not the label on the cylinders).

8.3.2 Without Fixed Calibration Gas Connection

In the case of gas analysis systems without a fixed calibration gas connection, the calibration gas has to be connected to a "normal" measuring point for the duration of the calibration. After the calibration, the calibration gas cylinder is disconnected from the gas analysis system. The calibration is carried out analogously to Chapter 8.3.1.

8.4 AwiLAB Gas Analysis System

8.4.1 Function AwiLAB Gas Analysis System

The extension AwiLAB is controlled by the gas analysis system AwiFLEX. Up to 7 measuring points / reactors can be connected to the AwiLAB. The produced gas is counted by a milligas counter or drum gas meter before it reaches the AwiLAB and collected in the AwiLAB in one gas bag per measuring

point. When the gas bag is full, the remaining gas is released into the atmosphere. The gas composition is analyzed from the gas bag in the gas analysis system AwiFLEX.

8.4.2 Settings AwiLAB Gas Analysis System

All settings for the AwiLAB can be made in the Admin > AwiLAB area. The individual measuring points / reactors can be selected in the tab 'AwiLAB' (Fig. 23). In addition, all the counters can be reset here, e.g. for re-starting experiments. The collective or individual emptying of all bags is possible as well.

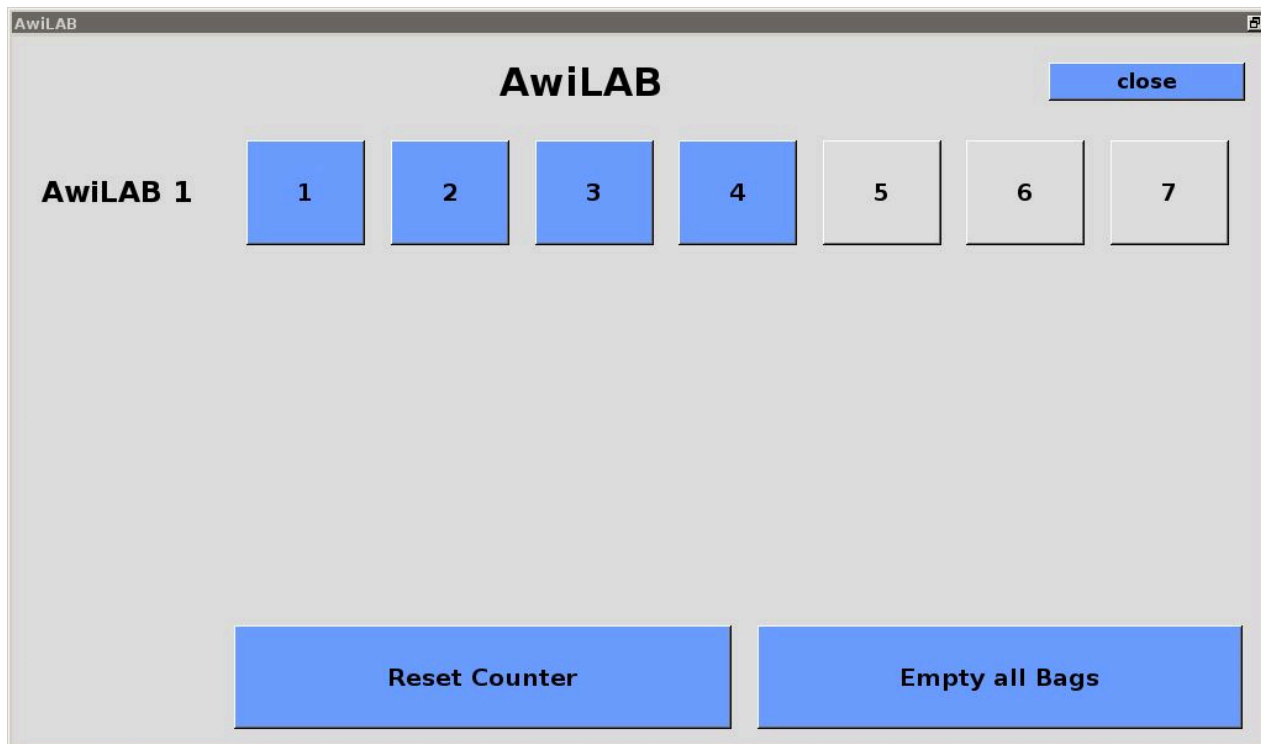


Figure 23: Admin > AwiLAB

Fig. 24 shows the range for the settings for the individual measuring points / reactors (in this example with 3 individual gas meters):

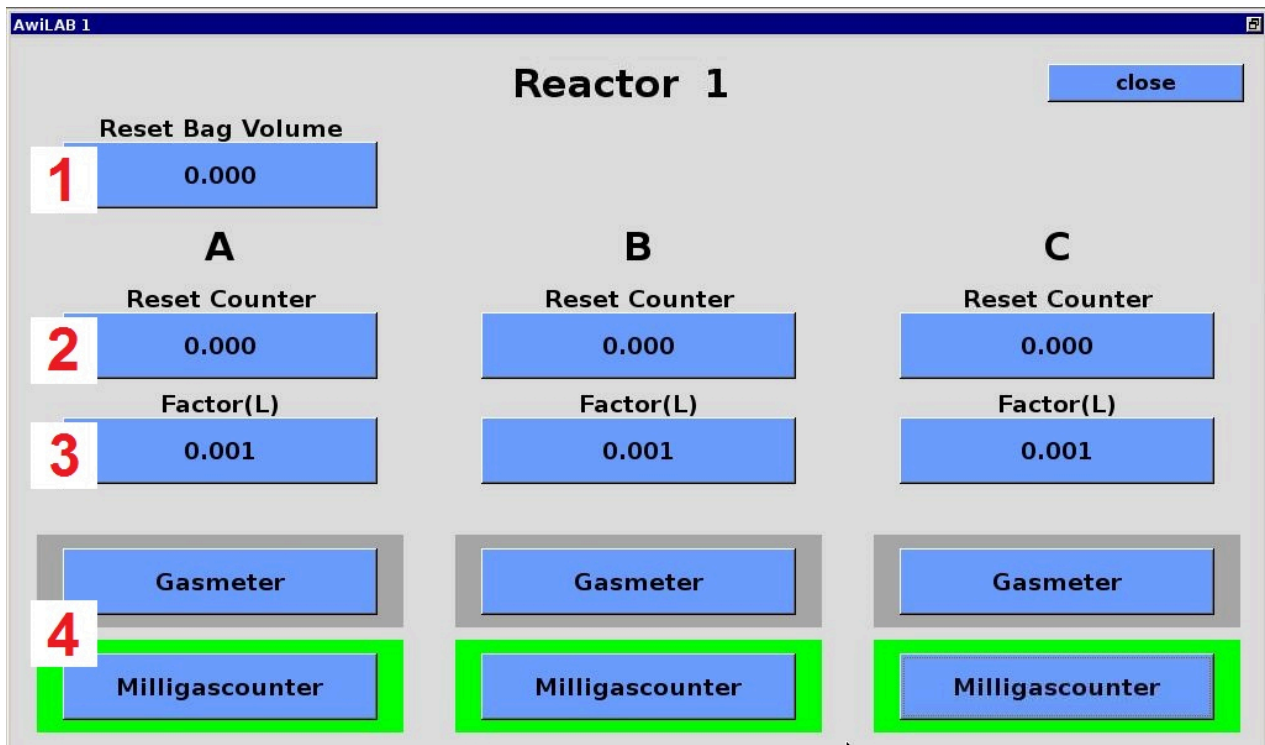


Figure 24: measuring point-specific settings AwilAB

1. Under 'Reset bag volume', the current fill level of the bags is displayed and can be set to zero. Caution: No actual emptying of the bag takes place.
2. The gas meters count the fully produced gas, even when the bag is full and the gas is released to the outside. The meter readings are visible and can optionally be reset individually.
3. The field Factor shows the amount in liters that is counted by the milligas counter / drum gas meter per pulse. This factor must always be adjusted before putting the meter into operation (Fig. 25 'Factor'). In the case of the milligas counter, this factor is indicated on the type plate as measuring chamber volume. In drum gas meters, the amounts per revolution and the pulses per revolution are displayed. These must be converted and entered accordingly (example: 0.5 liters/revolution and 200 pulses/revolution corresponds to 0.0025 liters as input value)
4. Here it is established whether to count with a drum gas meter or milligas counter. The selected meter is highlighted in green. When changing a counter, a prompt to re-enter a new factor, which will then always be necessary, appears.

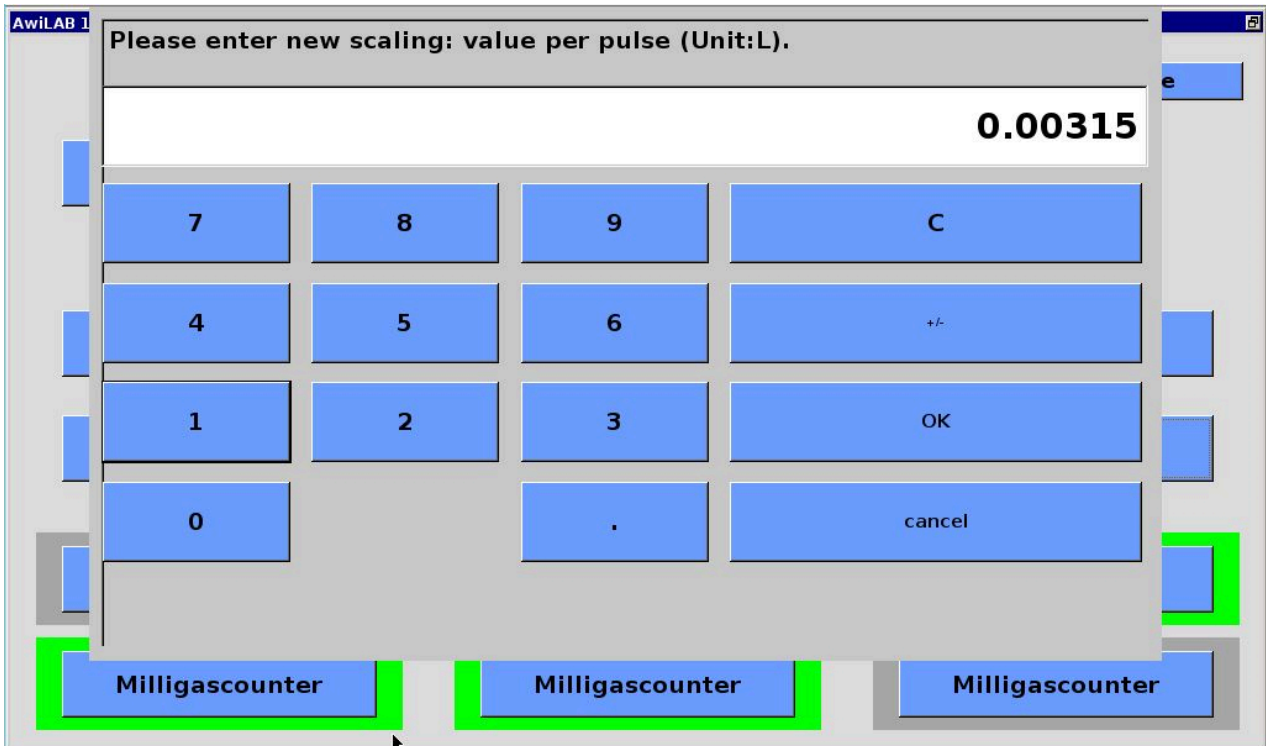


Figure 25: Scaling Milligas Counter / Drum Gas Meter