INCA Analyzer Series

UNION Instruments GmbH

INSTRUCTION MANUAL

Gas composition measurement of biogas, raw biogas, landfill gas and bio-methane

Version: V1.01R06
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PLEASE READ THIS BEFORE PROCEEDING!

- Read all instructions prior to installing, operating and servicing the instrument.
- Follow all important notes and cautions marked on and supplied with the instrument.
- If you do not understand any of the instructions contact your Union Instruments GmbH representative for clarification.
- Install your equipment as specified in the installation instructions with appropriate local and national codes. Connect all products to the proper electrical and pressure sources.
- Use only qualified personnel to install, operate, software update and maintaining the instrument to ensure proper performance.
- When replacement parts are required ensure that you use only spare parts specified by Union Instruments GmbH. Unauthorized parts and procedures can affect the instrument's performance, place the operation of your process at risk and VOID YOUR WARRANTY. Look-alike substitutions may result in fire, electrical/chemical hazards or improper operation.
- Equipment door should be closed except when maintenance is being performed by qualified personnel to prevent electrical shock and personal injury.

The features of the instrument and the information in this document are subject to change without notice.

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1 PREFACE

1.1 Purpose

The INCA Analyzer Series are a (semi)continuous[1] measuring instruments to analyze gas compositions in biogas, raw biogas, poor gas and bio-methane. With their capability to measure gas components such as CO_2, CH_4, O_2, H_2S, H_2, specific gravity and additional calculated values, the INCA Analyzer Series can be applied in biogas plants for monitoring, optimization and evaluation of biological processes.

1.2 Technical description

Measurement phase:	discontinuous/continuous/semi-continuous
Channel:	single stream/multiple stream
Autocalibration:	after every purge gas phase (approx. 15 min)
Calibration interval:	manually or automatically (configurable between 1 hour to several weeks)
Calibration duration:	10 minutes (recommended)
Measurement ranges:	depending on the configuration
Ambient conditions	
Temperature:	10 - 40 °C
Humidity:	0 - 95 % relative humidity
Protection class:	IP44
Interfaces:	RS-232 3x digital output (customizable functionality) Optional: 4x or 8x analog output 0 - 20 mA or 4 - 20 mA Ethernet Profibus-DP Modbus RTU

1.3 Remarks

Content of the manual

This manual contains general information of all series of INCA Analyzer. Information concerning specific model of INCA Analyzer are available in the manual of the series.

Further information

Manual INCA xxxx[2]Txxx[3] (e.g. Manual INCA 4000 T100)

[1] Continuous measurement for certain variables of certain INCA types only (see subchapter functionality)
[2] Model of the analyzer
[3] Configuration of the analyzer

2 SAFETY INSTRUCTIONS

This manual should be reviewed with special attention to all the instructions and cautions before the analyzer is out into operation

Power plug and main fuse switch

Before opening the analyzer the power plug has to be disconnected from the power supply. After opening the analyzer the main fuse switch should be turned to OFF position during all installation processes.

Installation

The electrical connection for the analyzer must be carried out by qualified personnel in accordance with all applicable national codes, local regulations and the power supply voltage listed on the rating plate.

Gas connections

Gas connections must be carried out only by qualified personnel in accordance with all applicable national codes and local regulations.

The analyzer will work within the permissible temperature range. To meet the specifications a cooling or heating device might be needed e.g. if the analyzer is placed into another enclosure enough air flow must be provided in the additional casing to purge the analyzers thermal heat and always provide fresh air, which is needed for correct measurement. The analyzer should only be operated indoors. Humidity could affect the measurement and eventually break the analyzer. After assembly all gas-flowing parts should be checked for leakage.

Formation of Ex-mixtures in the device

The analyzer has been carefully leak tested during the production process. There is no operational situation possible, at which gas could penetrate into the device. The enclosure has two independent fans (outside fan and power supply fan) which provide 1~2 m^3 of air circulation per hour. No gas is released inside the enclosure and the flow rate of the gas pump is mechanically restricted to a maximum value of 30 l/h.

Operating and maintenance

The analyzer has left the factory in compliance with all applicable safety regulations. To maintain this operation condition, the user must strictly follow the instructions and consider the warnings in this manual.

Before switching on the analyzer, verify that the electrical supply voltage matches the analyzer's operating voltage as described in the manual.

Substances hazardous to health may emerge from the analyzer's output. Please pay attention to the safety of your operation personnel. Protective measures must be taken, if required.

Application

The analyzer has been designed as a process gas analyzer and is not applicable for personnel protection, area monitoring or detection of MAC or UEL limits.

All applicable safety regulations must be observed when working with toxic or flammable gases.

Definitions

The following definitions apply to WARNINGS, CAUTIONS and NOTES found throughout this manual.

Warning

Highlights an operation or maintenance procedure, condition, statement, etc.

If not strictly observed, could result in injury, death, or long-term health hazards of personnel.

Caution

Highlights an operation or maintenance procedure, condition, statement, etc.

If not strictly observed, could result in injury, damage to or destruction of analyzer or loss of effectiveness.

Note

Highlights an essential operating procedure, condition, statement, etc.

3 GENERAL DESCRIPTION

The INCA Analyzer Series offers a group of gas measurement instruments to analyze gas compositions in different applications such as the production of biogas, raw biogas, poor gas and bio-methane. With their capability to measure gas components such as CO_2, CH_4, C_2H_6, O_2, H_2S, H_2, specific gravity and additional calculated values of the gas, the INCA Analyzer Series can be applied in biogas plants for monitoring, optimization and evaluation of biological processes.

The analyzer is designed as a modular system. It can be equipped with different sensors selectable from a list as the analyzer is ordered. The customers are able to order a specific INCA Analyzer with specific number, range and accuracy of the sensors. Gas conditioning systems including gas cooler is also optional. Please see list of the available sensors.

3.1 Functionality

3.1.1 Phases of the analyzer

The measurement principle of the standard analyzer consists of four phases in an adjustable cycle.

Phases	Description
Purge gas	Purge gas (usually air) is pumped through the system to clean out the pipes from process gas of previous measurement and to moisturize the electrochemical sensors to increase their lifetime.
Condensate drain	If system has a gas cooler the pump will run during that cycle to drain the condensate from the gas cooler. For this purpose the system is either equipped with a hose pump or an ejector using compressed air.
Change channel	The analyzer starts to run the process gas of the active channel (maximum of 10 channels are available depending on system configuration) through the system. This allows the pumps to build up pressure and also for the process gas to reach the sensor before the measurement is started. Pressures of the pumps are checked and errors are stored if minimum pressures are not reached.
Measurement	The sensors are exposed to the process gas and measurement is performed. At the beginning of this cycle the pumps inside the analyzer are calibrated. At the end of the cycle the measured values are stored in memory.

Table 1: Measurement phases

Note

Continuous measurement analyzers do not operate in this cycle scheme. See Figure 3-2.

3.1.2 Diagrams of the phase transition

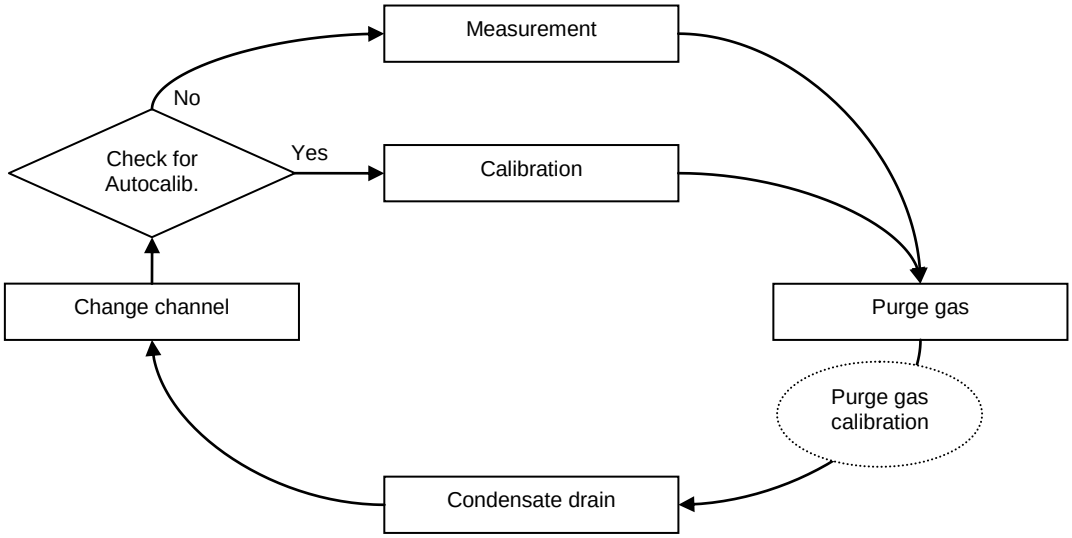


Figure 3-1: Phase transition in standard analyzer

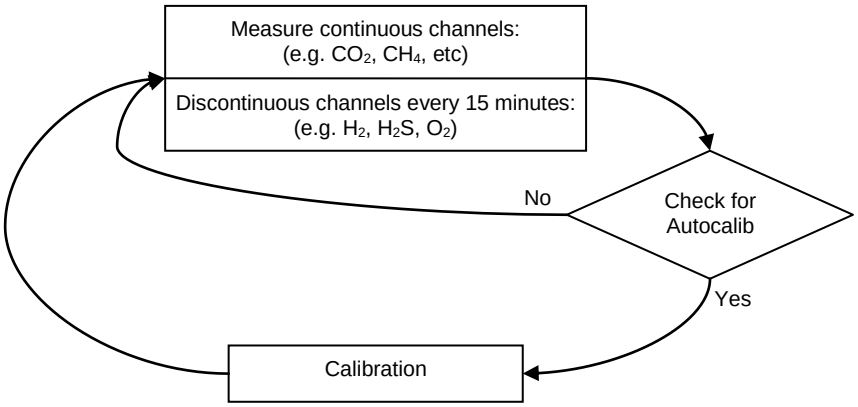


Figure 3-2: Phase transition in continuously measuring analyzer

3.2 Sensor modules

The following sensor modules are available in the INCA Analyzer series.

Type	Variable	Principle	Cross sensitivity	Accuracy	Range	Note
0	$[CO_2]$	NDIR (4.26 µm)	CH_4	±1 % of range	0 – 100 vol.%	P ,T compensated
1	$[CH_4]$	NDIR (3.5 µm)	C_xH_y	±1 % of range	0 – 100 vol.%	P, T compensated
5	$[CH_4]$	NDIR (3.5 µm)	C_xH_y	±1 % of range	0 – 20 vol.%	P, T compensated
6	$[H_2S]$	EC	H_2, CO	±1 ppm	0 – 25 ppm	High sensitive, linear output
7	$[H_2S]$	EC	H_2, CO	±5 ppm	0 – 100 ppm	High sensitive, linear output
8	$[H_2S]$	EC; µPulse	H_2, CO	±10 % of range	0 – 10000 ppm	High sensitive, linear output
9	$[O_2]$	EC	H_2, CO	±3 % of range	0 – 25 vol.%	Linearity : $S=k \log_e 1/(1-C)$
10[4]	$[O_2]$	Paramagnetic	---	±3 % of range	0 – 5 vol.%	Maintenance-free, long lifetime
11[5]	$[O_2]$	Paramagnetic	---	±1.5 % of range	0 – 25 vol.%	Maintenance-free, long lifetime
12	$[H_2]$	EC	CO	±3 % of range	0 – 4000 ppm	Output linear
14	$[CO_2]$	NDIR (4.26 µm)	CH_4, CO	±1 % of range	0 – 5000 ppm	P, T compensated
15[6]	SG	Acoustic	---	±1.5 % of range	0.2 – 2.2	Maintenance-free, long lifetime
16	$[CO_2]$	NDIR (4.26 µm)	CH_4	±1 % of range	0 – 10 vol.%	P, T compensated
19	$[H_2S]$	EC	H_2, CO	±5 ppm	0 – 2000 ppm	High sensitive, linear output
22	$[H_2S]$	EC; µPulse	H_2, CO	±10 % of range	0 – 50000 ppm	High sensitive, linear output
23	$[CH_4]$	EC	C_xH_y	±1 % of range	0 – 5 Vol.%	P, T compensated
24	$[CO_2]$	EC	CH_4	±1 % of range	0 – 20 Vol.%	P, T compensated

Table 2: List of sensor modules

All infrared sensors are pressure and temperature compensated.

[4] under development
[5] under development
[6] under development

3.2.1 NDIR module

The NDIR module is used for measuring CO_2, CH_4 and other possible hydrocarbon gas. Using non-dispersive infrared (NDIR) technique and dual beam method, the setup of two IR sensors and two IR detectors detects two different wavelengths depending on the type of gas, accuracy and range of the measurement. Please see the sensors list for more details.

The module is temperature and pressure compensated and capable to detect and correct the IR-source aging, which is typical for devices using the NDIR technique. If necessary, the sensor head can be individually replaced. See spare parts list at the end of this manual.

The accuracy is better than 1% of full range.

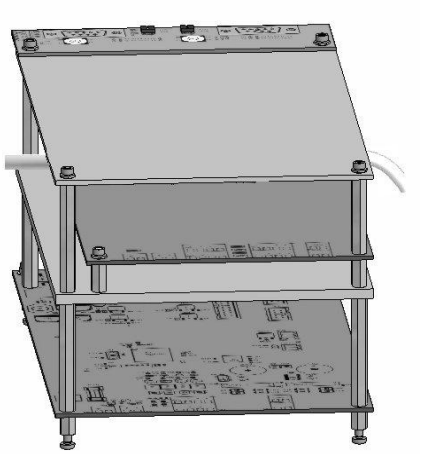


Figure 3-3: NDIR module

3.2.2 EC and EC-µPulse module

The electrochemical module with or without the µPulse module can measure the following gases: O_2, H_2 and H_2S. It has a high durability and a low sensor load using a patented measurement process (µPulse). This technique allows very wide measurement ranges, for example H_2S (0 - 10000 ppm) without burdening the sensor life time.

If necessary, the sensor head can be individually replaced. See spare parts list at the end of this manual.

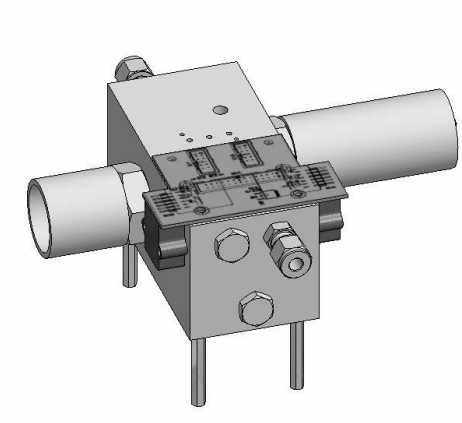


Figure 3-4: EC/EC-µPulse module

3.2.3 Paramagnetic oxygen sensor (Parox) module

The Parox sensor measures the oxygen concentration in a gas by using the oxygen paramagnetic properties.

The paramagnetic sensor offers better accuracy and is practically insensitive to other gases. Compared to EC sensors, it needs no maintenance and offers a longer life time.

Figure 3-5: Parox module

3.2.4 Specific gravity module

The specific gravity module is designed for a continuous, on-line analysis of a gas stream. It determines the specific gravity of the process gas in a specially designed sample chamber using presence of a modulated acoustical field.

The module has high intrinsic linearity, long term stability and a short response time. It requires no regular maintenance. After installation the sensor housing must be able to move freely on the springs.

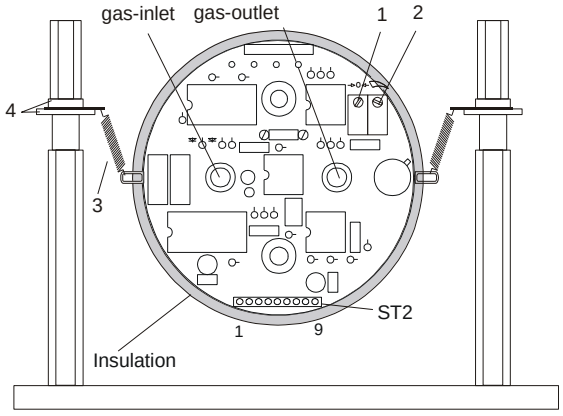


Figure 3-6: Specific gravity measuring cell, heated and insulated

1	Potentiometer 1 Zero	3	Suspension springs
2	Potentiometer 2 Span	4	Insulating discs

Measurement range : 0.2 – 2.2
Specific gravity of air : 1

3.3 Communication with PC using INCACtrl

The INCA Analyzer comes with INCACtrl, a software running on MS Windows XP/Vista™ serving as an interface to communicate through a PC with the analyzer. The software serves as a configuration tool and allows to

- set device specific configuration data
- set measurement specific parameter data
- read the current measurement data from the analyzer
- log current measurement data from the analyzer
- set calibration gas compositions and calibration settings

Requirements:

1. INCA Analyzer
2. INCACtrl software
3. A PC/laptop (operating system: MS Windows XP/Vista™)
4. Null modem cable

3.3.1 Establishing communication with INCACtrl

Do the following steps to establish a communication between INCACtrl running on a PC/laptop with the INCA Analyzer:

1. Connect the RS-232 interfaces between the INCA Analyzer and a PC/laptop using a null modem cable.

2. Start INCACtrl.exe

3. Click **Options → COM port settings** to configure the communication port. By default, **Autodetect COM port** is selected. A port can be manually selected in the menu.

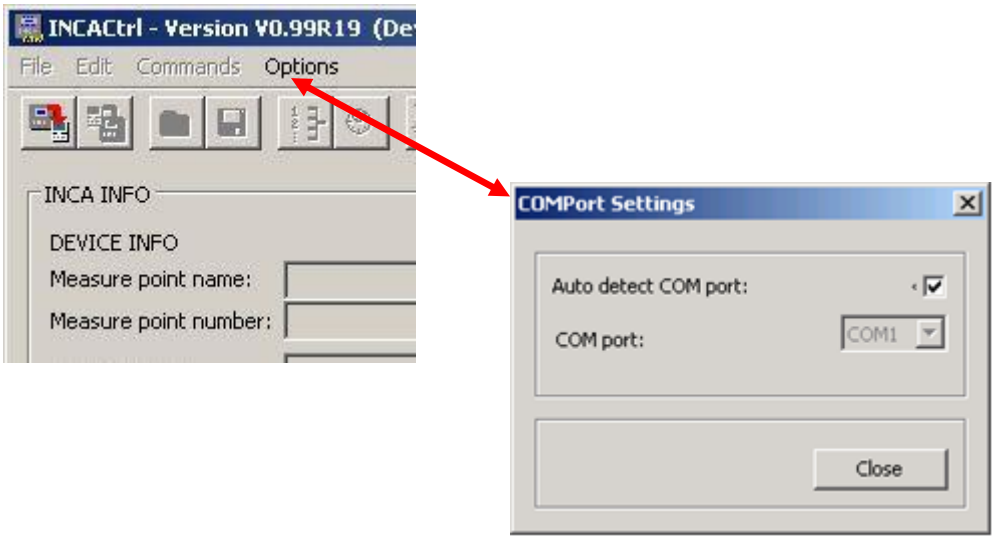


Figure 3-7: INCACtrl COM port settings

4. Click the icon to establish a connection.

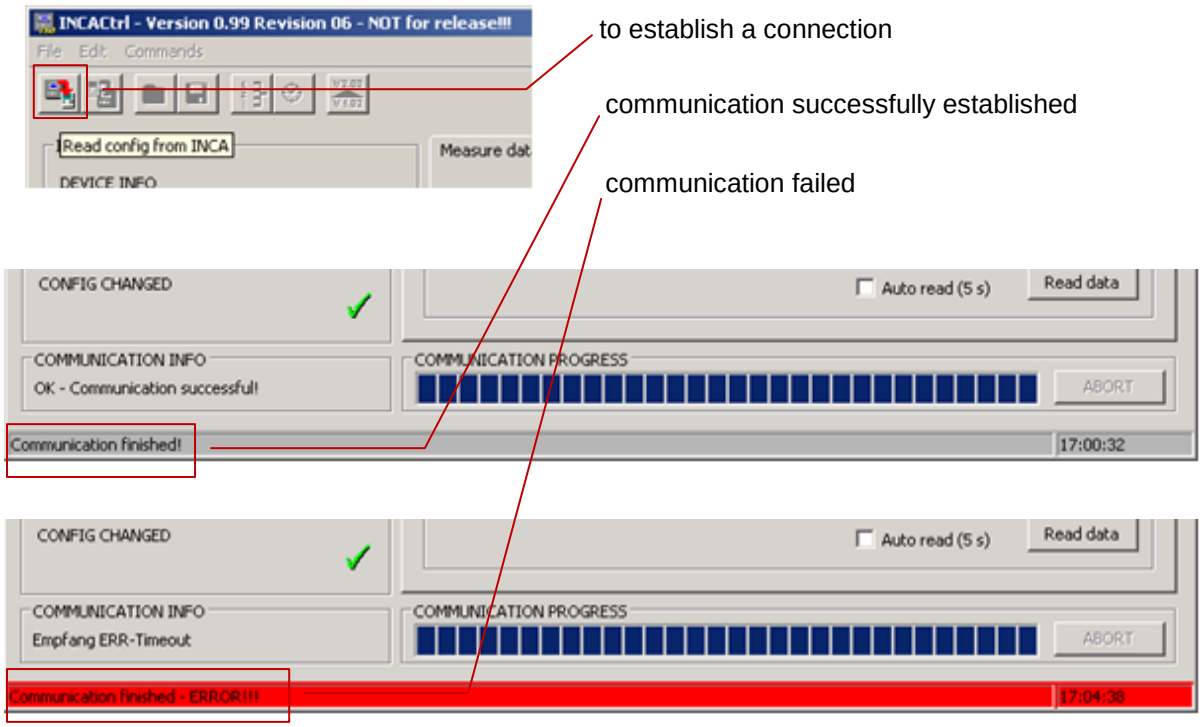


Figure 3-8: Establishing connection between INCACtrl and INCA Analyzer

If you get an error message, check the modem cable. The COM-port setup should also be checked by deactivating the auto-detect and manually choose the port where the null modem cable is connected.

3.3.2 Saving the configuration to the INCA Analyzer

Note

Any change of INCACtrl configuration will only become effective after saving them to the INCA Analyzer.

1. Check the following sign in the INCACtrl. Red cross shows that some changes are made in the INCACtrl configuration

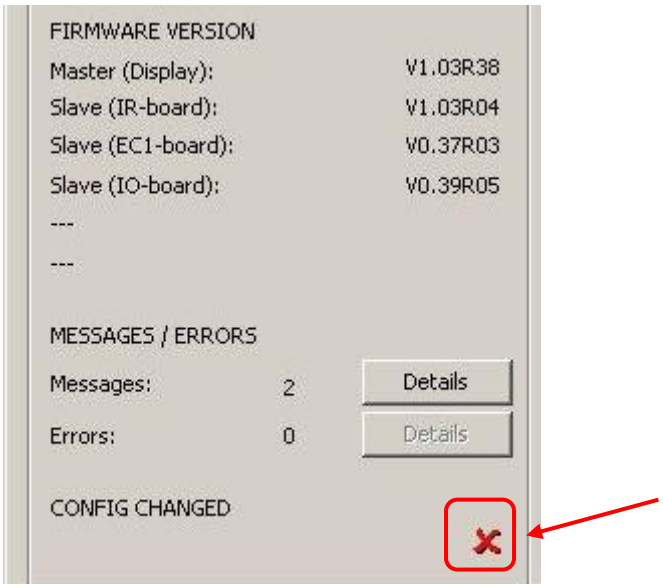


Figure 3-9: Configuration changed

2. Click on this button to save the INCACtrl configuration to the INCA Analyzer.

Figure 3-10: Saving the configuration

3. The green check mark is shown if the saving was successful.

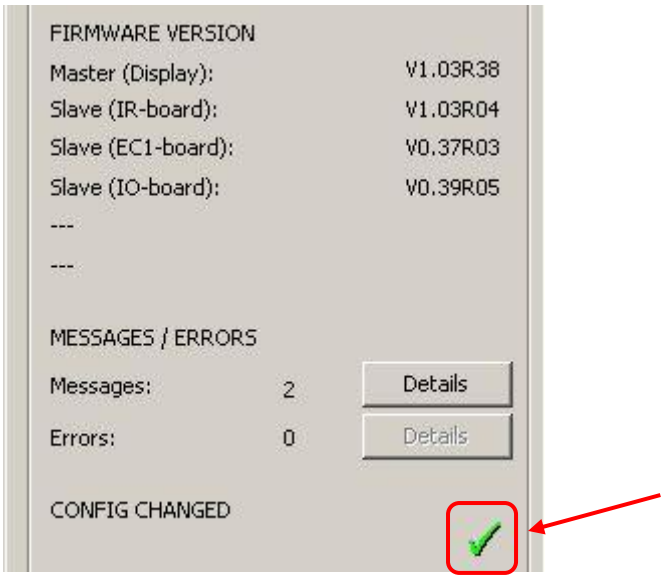


Figure 3-11: Green check mark - saving configuration was successful

4 SYSTEM MAIN MENU

Main menu structure of the analyzer can be broke down as:

Main menu
- *Settings*
  - *Language*
  - *Password*
  - *Cal. purge gas*[7]
  - *Output data*
  - *Communication*
- *Parameters*
  - *Cooler gas temp*[8]
  - *EC meas. cycle*[9]
- *Commands*
  - *Change channel*[10]
  - *Restart system*
  - *Clear messages*
  - *Cal. purge gas*
  - *Cal. gas I*
  - *Cal. gas II*[11]
  - *Reset cal.*
- *System info*
- *System messages*

Figure 4-1: Display overview

[7] only active for certain configurations
[8] only active for INCA Analyzers with gas cooler
[9] only active for certain configurations
[10] only active for INCA Analyzers with more than one channel (multi-channel analyzer)
[11] under development

In the figure above the measuring phase is active and the analyzer will switch to next phase in 4 minutes 57 seconds. Channel 1 of 3 available channels is active and currently measured.
For a continuous measurement setup the display indicates the continuous measurement with a blinking asterisk (“*”) symbol.

Figure 4-2: Display for continuous measurement configuration

Note

All the keys are active as soon as the display is set to its high brightness. Pressing any key makes the display illuminate, which means that keys are active.

4.1 Display keys

4.1.1 Menu function keys

Six main menu keys are located under the screen: *up* ▲, *down* ▼, *left* ◄, *right* ► are keys for navigation, ESC for cancel or go back to previous layer and MENU/↵ to jump to main menu and also to confirm inputs/commands.

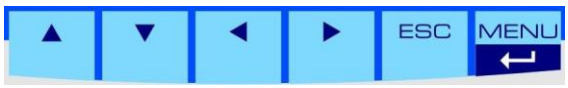
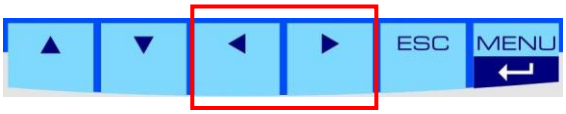


Figure 4-3 Main menu keys

The *left* ◄ and *right* ► keys are used to show the measured values.

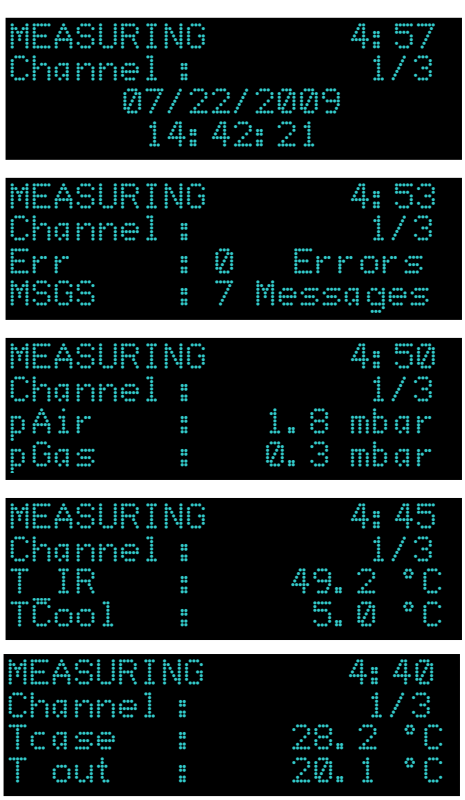


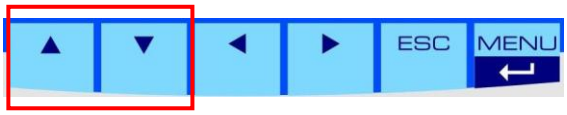
The display shows the *Measuring* phase is active.

Press ◄ and ► to show the measured values.

REMARK:
An asterisk mark which is shown in the display before a measurement value marks that a saved value is being displayed. Values are updated in the display after each measurement phase.
For continuously measuring gases no asterisk is shown since the value is updated continuously.

The *up* ▲ or *down* ▼ keys are used to show the measured pressures and errors/messages.





Press *up* ▲ or *down* ▼ to show the measured pressures and errors/messages.

The pAir and pGas are pressures of air and gas measured by relative pressure sensors.

The *up* ▲ or *down* ▼ do not have function when the display showing the measurement values.

REMARK:
The *up* ▲ or *down* ▼ keys only work when displaying date/time. When the output of measurement values is chosen, the keys will not change the display output.

4.1.2 Measurement data keys

Measurement data functions are available above the screen; with each of them having two keys to change the displayed data.

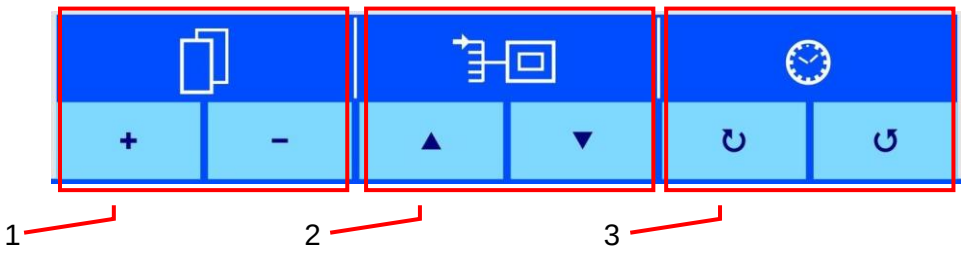
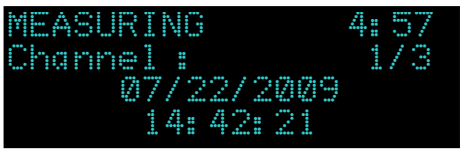


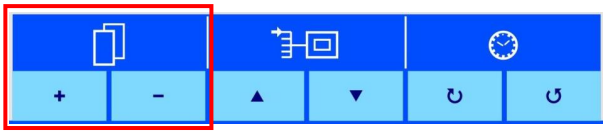
Figure 4-4 Measurement data keys

1 Gas display keys
2 Channel display keys
3 Measuring time keys

Measurement data keys	Description
	Gas display: shows measured concentration of each gas.
	Channel display: shows measured concentration of each channel.
	Measuring time: shows measured concentration of the previous measurements up to 10 previous values.

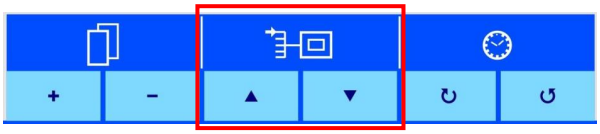
Table 3: Measurement keys description



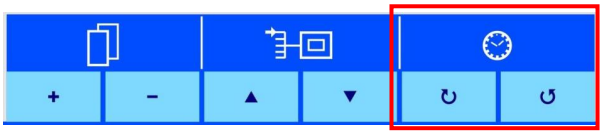


Pressing **+** or **–** of the *Gas display key* means showing the actual measured concentration of each gas.

REMARK:
An asterisk mark which is shown in the display before a measurement value marks that a saved value is being displayed. Values are updated in the display after each measurement phase.
For continuously measuring gases no asterisk is shown since the value is updated continuously.



Pressing *up* ▲ or *down* ▼ of the *Channel display keys* means showing the actual reading of each channel.



Pressing ↻ and ↺ means showing the last 10 values of the measured data.

4.2 Analyzer display during warm-up

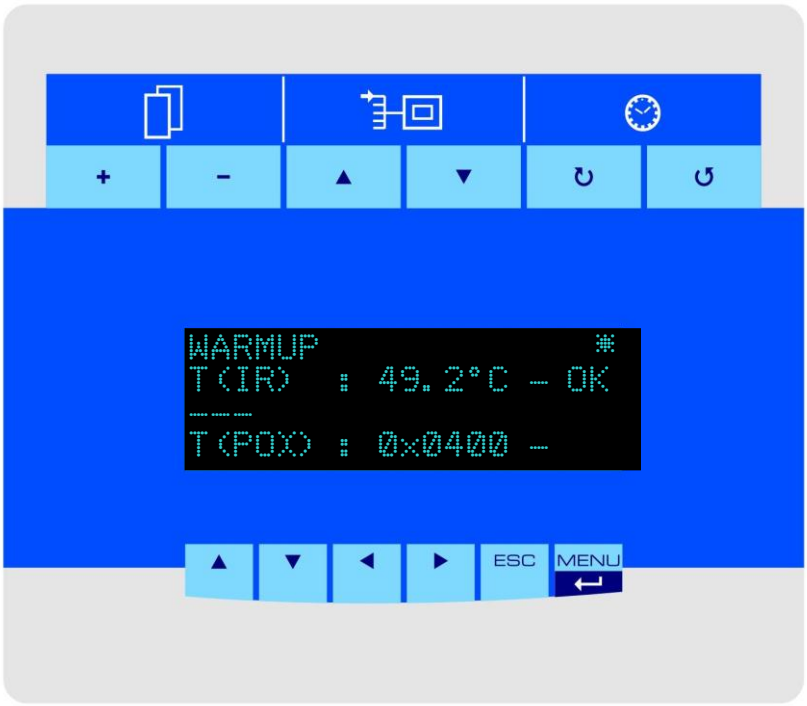


Figure 4-5: Start-up display

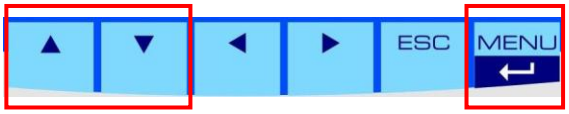
The analyzer with NDIR (infra red) sensor module or a Parox sensor needs warm-up time (usually 10-20 minutes) to meet their operating temperatures. The figure above shows the temperature of NDIR sensor group and the status of the Parox sensor. Since the T(IR) already meets its operating temperature, “OK” is shown in the display.

Operating temperature:
NDIR sensor module : 49 or 64 °C
If the Parox sensor reaches its operating temperature, the display shows T(POX) = 0x0000.

Analyzers without those parts do not need any warm-up time and therefore can be operated immediately. The device starts the actual operating phase after completing the warm-up process. These phases run through and start again from the beginning in a cycle.

4.3 Menu structure

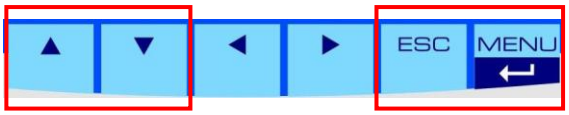
MENU/↵ key takes the display to the main menu system. The menu key *up* ▲ or *down* ▼ changes the highlighted menu up or down. Pressing the MENU/↵ means execute the highlighted menu.



Press MENU/↵ to enter *Main menu*

Press ▲ and ▼ to highlight the submenu. Press MENU/↵ to enter the selected submenu.

The symbol "▲" and "▼" on the left side of the display shows the previous or next submenu on the same layer.



Under *Main menu* pressing MENU/↵ means entering sub menus, for example *Settings*.

Press ▲ and ▼ to highlight the submenu. Press MENU/↵ to enter the selected submenu or press ESC to go back to *Main menu*.

Pressing ESC under *Main menu* means exit from *Main menu*.

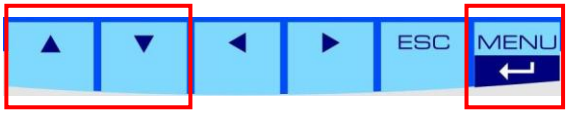
Note

The menu structure could be different for particular INCA Analyzer. It is available upon requirement and factory configuration of the INCA Analyzer.

4.4 Settings

4.4.1 Language

The language dialog allows the user to select the language of the system. There are three languages available: English, German, and Italian.



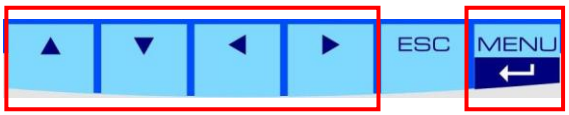
Under *Settings* menu, press ▲ and ▼ to highlight *Language* and press MENU/↵.

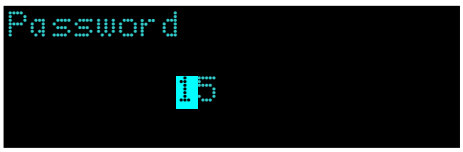
Use ▲ and ▼ to select the language

Press MENU/↵ to store setting

4.4.2 Password

The password dialog allows locking the menu to protect the analyzer's settings from accidental changes. The password has a maximum of *4 digits*. As soon as a number is set and saved the password is active. Next time entering the menu, the correct password needs to be entered to perform any changes. Setting the password to '0' will deactivate the password lock of the menu.





Under *Settings* menu, press ▲ and ▼ to highlight *Password* and press MENU/↵.

Press ◄ and ► to move the blinking cursor to have more password digits. Use ▲ and ▼ to enter the number for every digit.

Press MENU/↵ to store password

Caution

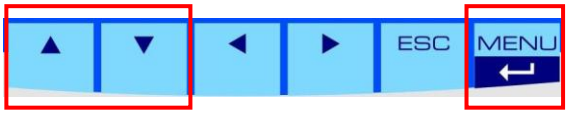
There is no master password. It is not possible to restore password from the analyzer's menu. Use INCACtrl to reset the password.

Note

Setting password to '0' will deactivate the password lock of the menu.

4.4.3 Calibration purge gas (on/off)

The ‘calibration after purge gas’-option is activated by setting this menu **on** or **off**.



Under *Settings* menu, press ▲ and ▼ to highlight *Cal. purge gas* and press MENU/↵.

Use ▲ and ▼ to select **on** or **off**

Press MENU/↵ to store setting

4.4.4 Output data (on/off)

The menu activates the **unidirectional** interval data output using the RS-232 interface. The output data is always transmitted with a baud rate of 9600 bits/s, regardless of the ‘Communication’ setting. Nevertheless it is mandatory to turn this setting ‘off’ when using the H-Bus protocol to communicate with the analyzer and to read its measurement data.

4.4.5 Communication

The menu provides the communication option of the RS-232 connectivity for **bidirectional** communication:

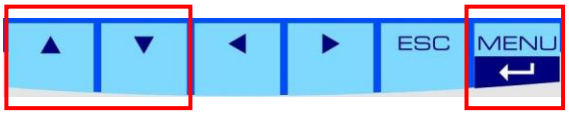
1. INCACtrl – For INCA configuration tool and H-Bus protocol working at 115200 bits/s
2. H-Bus (9600) – H-Bus protocol working at 9600 bits/s
3. H-Bus (2400). – H-Bus protocol working at 2400 bits/s

Further information can be found under the Chapter Output option.

4.5 Parameters

4.5.1 Gas cooler temperature

Set the temperature of the gas cooler (only available if gas cooler is installed).



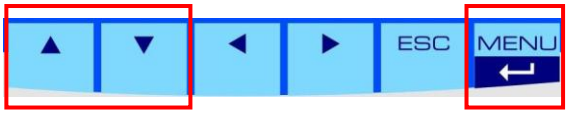
Under *Parameters* menu, press ▲ and ▼ to highlight *Gas cooler temp* and press MENU/↵.

Use ▲ and ▼ to give temperature value of the gas cooler.

Press MENU/↵ to store setting

4.5.2 EC measurement cycle

The measuring cycle of electrochemical sensors is set using this dialog. “1” means that on every measuring phase the cycle runs. “2” means that only every other measuring phase the cycle for EC sensor runs and the gas is measured.



Under *Parameters* menu, press ▲ and ▼ to highlight *EC meas. cycle* and press MENU/↵.

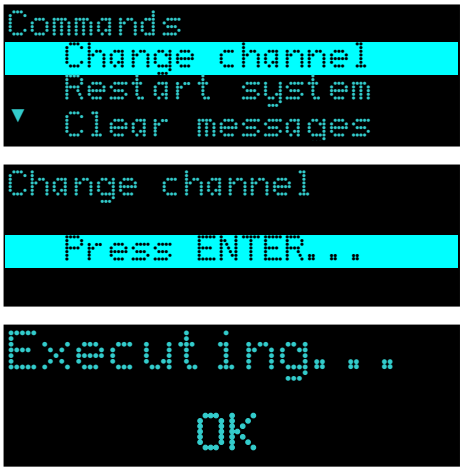
Use ▲ and ▼ to select the cycle’s setting.

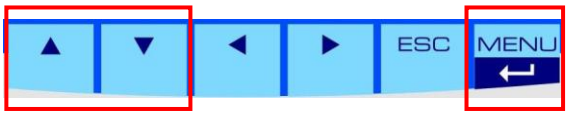
Press MENU/↵ to store setting

4.6 Commands

4.6.1 Change channel

This command is only active for analyzers with more than one channel (multi-channel analyzer) and allows to request the measurement of a certain channel.





Under *Commands* menu, press ▲ and ▼ to highlight *Change channel* and press MENU/↵.

Press MENU/↵ to execute the command.

4.6.2 Restart system

This command restarts the system.

Note

The *Restart system* command can also be used to interrupt the calibration process.

4.6.3 Clear messages

Clear the messages that are stored in the system.

4.6.4 Calibration purge gas

Calibration using purge gas is started.

4.6.5 Calibration gas I

Start the calibration using calibration gas I.

4.6.6 Calibration gas II[12]

Start the calibration using calibration gas II.

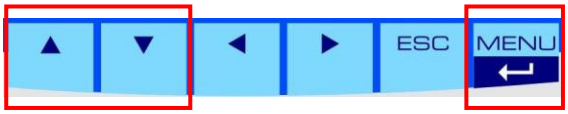
[12] under development

4.6.7 Reset calibration

Reset to the factory calibration. For each gas measured in the analyzer, the command has to be chosen and the gas must then be selected and confirmed by pressing MENU/↵.

4.7 System info

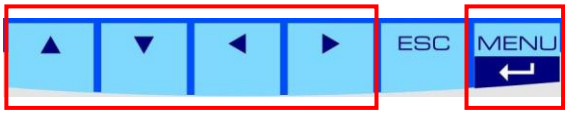
Show the system info.



Under *Commands* menu, press ▲ and ▼ to highlight *Change channel* and press MENU/↵.

4.8 System messages

Show the message(s) that are stored in the system.



Under *Main menu*, press ▲ and ▼ to highlight *System messages* and press MENU/↵.

Press ▲ and ▼ to show next message(s).

Press ◄ and ► to message's date/time and code.

Note

If optional SD card is installed, error codes are displayed with text as seen in the figures above. Otherwise they are displayed only in their codes.

Please see the messages (errors and events) description list in the appendix to understand the messages.

5 CALIBRATION

5.1 Calibration

The analyzer is pre-calibrated by the manufacturer. In the field the analyzer can be re-calibrated using special calibration gases. The calibration gas needs to be connected to the analyzer for manual calibration. For automatic calibration setup (e.g. every week), a calibration gas has to be connected permanently to the analyzer's calibration gas inlet

Warning

The gas inlet pressure must not exceed 20 mbar (0.29 psi).

5.1.1 Type of calibrations

There are two types of calibrations:

1. **Calibration using purge gas (i.e. *purge gas calibration*)**
2. **Calibration using calibration gases (simply referred to as *calibration*)**

Gases used in calibration process (codes)	Composition				
	CO_2	CH_4	H_2S	O_2	N_2
Purge gas (S)	--	--	--	20.9 vol.%	80.1 vol.%
Calibration gas A1 (A1)	48 vol.%	52 vol.%	25 ppm	--	--
Calibration gas B1 (B1)	--	100 vol.%	25 ppm	--	--
Calibration gas C (C)	100 vol.%	--	--	--	--

Table 4: Example of calibration gases

Through the calibration process, calibration points of each sensor measured and determined. Depending on the type of sensors used in the analyzer, a purge gas (usually air, 20.9 vol.% O_2; 80.1 vol.% N_2) and one or more calibration gases are required for a complete calibration process. Table above shows an example of gases which are used in to calibrate the sensors.

The table above shows an example of gases which are used to determine calibration points of a particular type of analyzer. The analyzer has the following measurement ranges:

carbon dioxide (CO_2)	0 - 100	vol.%
methane (CH_4)	0 - 100	vol.%
hydrogen sulfide (H_2S)	0 - 10000	ppm
oxygen (O_2)	0 - 25	vol.%

Using those gases, the following calibration points can be measured.

Measured variable / Calibration point	CO_2	CH_4	H_2S	O_2
Zero	B1	S,C	S,C	A1,B1,C
Span	C	B1	A1,B1	S
Mid	A1	A1		

Table 5: Calibration points measured by the example of calibration gases

Caution

It is not possible to calibrate the CO_2 channel with ambient air since there is a cross sensitivity between CH_4 and CO_2 calibrated into the CO_2 channel. For that reason a CO_2-zero-calibration with air would destroy this special calibration and lead to wrong measurements. CO_2-zero-calibration is only possible with 100 vol.% CH_4.

5.1.2 Preparation for calibration

The following materials are required in the calibration process:

Figure 5-1: Requirement for calibration

1. Calibration gases with two-stage pressure regulator (see list of calibration gases)
2. Pressure regulator (input 1-10 bar and output 0-60 mbar)
3. Stainless-steel pipes with 6 mm fitting
4. Manometer with mbar display
5. PTFE tube (4x6 mm)
6. Nullmodem cable (RS-232)
7. Leak test detector
8. PC or laptop with RS-232 interface
9. Screw wrench (9/16 inch for the 6mm fittings)
10. INCACtrl – software

5.1.3 INCACtrl calibration setting

The communication between PC/laptop with the analyzer is performed using a RS-232 connection and INCACtrl software. Connect the RS-232 interfaces of the PC/laptop and the INCA Analyzer using null modem cable. The RS-232 interface of the INCA Analyzer is located on the INCA main board. The main board is on the back of the analyzer's door.

Open the analyzer's door to connect the null modem cable.

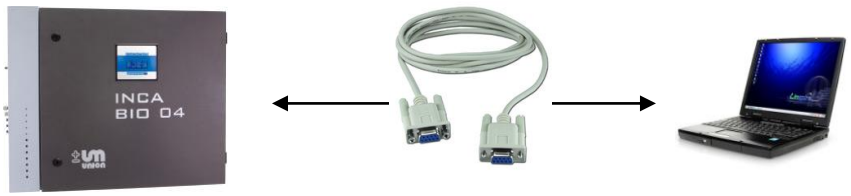


Figure 5-2: Communication between the INCA Analyzer and PC

Note

Attention!!!
The following procedure only shows an example of INCACtrl setting for a calibration using calibration gas B1 (100 vol.% CH_4 and 25 ppm H_2S).

Setting up calibration gas composition and calibration settings is done through INCACtrl software. For additional information on INCACtrl software please see the INCACtrl user manual.

1. Start INCACtrl.exe and establish a connection between the analyzer and your PC – see chapter **3.3.1 Establishing communication with INCACtrl**.

2. Select tab: ***Calibration***:

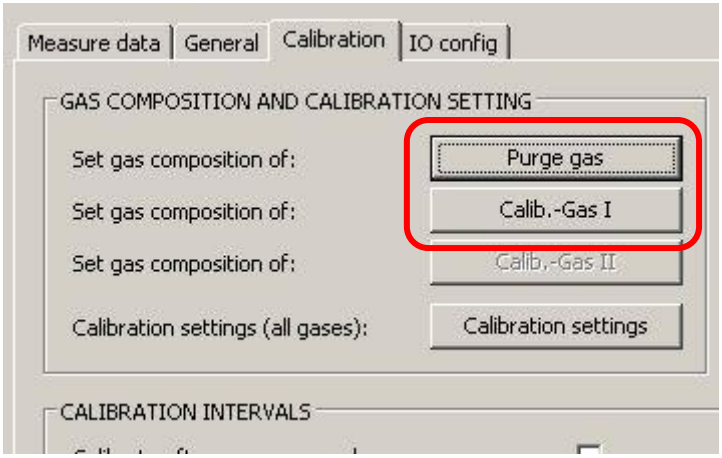


Figure 5-3: INCACtrl – gas composition and calibration setting

Click the ***Purge gas*** button if you want to change setting of purge gas composition or ***Calib.-Gas I*** button if you want to change setting of the calibration gas composition.

3. Set the composition.
   The following figures show an example of setting when using calibration gas B1 (100 vol.% CH_4 and 25 ppm H_2S).

   See figure below. Change the “Gas“, “Conc” (concentration) and “Unit” according to the calibration gas you want to use.

Note

Pay attention on step 3 if you are using different composition of calibration gas. See the list of calibration gases.

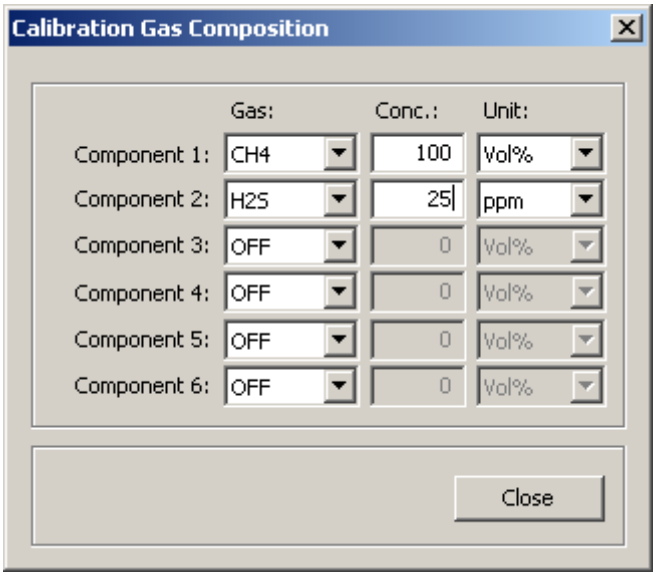


Figure 5-4: INCACtrl - calibration gas composition

4. Close the window and click on the button: ***Calibration settings***:

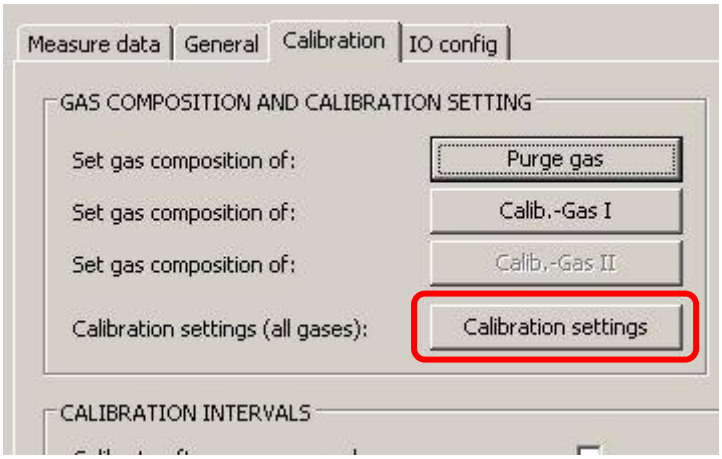


Figure 5-5: INCACtrl - calibration setting

Note

The calibration setting using INCACtrl depends on the composition of calibration gases.

5. Calibration points.
   Choose the calibration points according to your calibration gas. In this example, the following points are selected: Zero CO_2, Span CH_4, Span H_2S, Zero O_2.

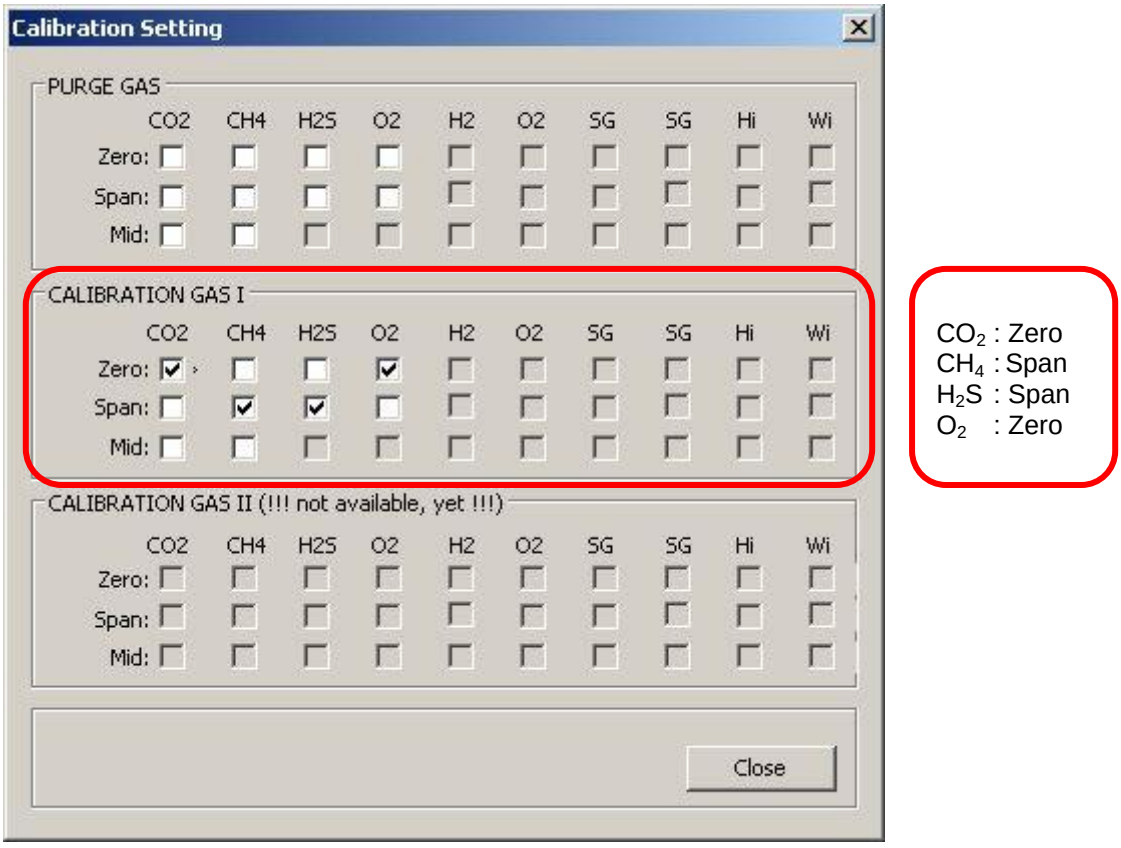


Figure 5-6: INCACtrl - setting of calibration points

Close the window.

6. Check the measure phase time of calibration gas I by clicking the tab: **General**. It should be set to minimum value of 600 s (10 minutes).

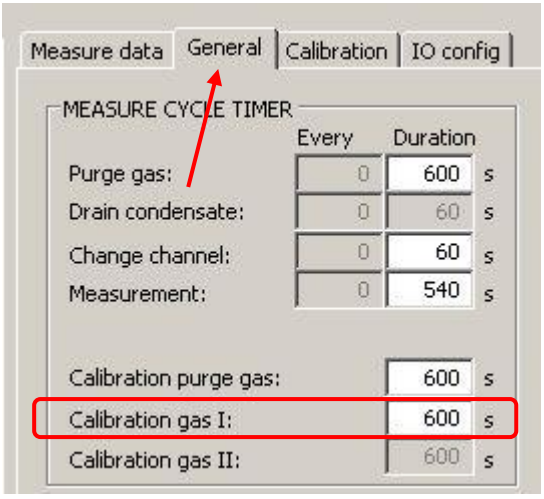


Figure 5-7: INCACtrl - setting of calibration duration

7. Save the configuration to the analyzer.
   Click the following button to save the configuration into the analyzer.

Figure 5-8: Saving the configuration to the analyzer

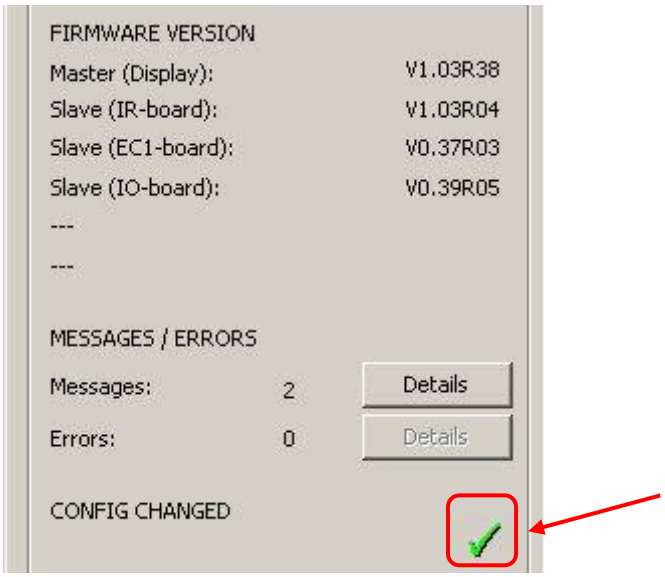


Figure 5-9: New configuration is successfully saved to the analyzer

8. Close the INCACtrl software if all settings are correct. Remove the null modem cable from the interface.

5.1.4 Automatic calibration

The analyzer is pre-programmed doing automatic calibration after every purge gas phase. Depending on the setup of the analyzer (continuous or discontinuous measurement), a purge gas phase is run through from every 15 minutes up to 12 hours between the calibration phases. For automatic calibration, the calibration gas must be permanently connected to the analyzer. Automatic purge gas calibration is performed at the end of the purge gas phase.

It is possible to configure the interval of the automatic calibration using INCACtrl software. (Tab: **Calibration → CALIBRATION INTERVAL**)

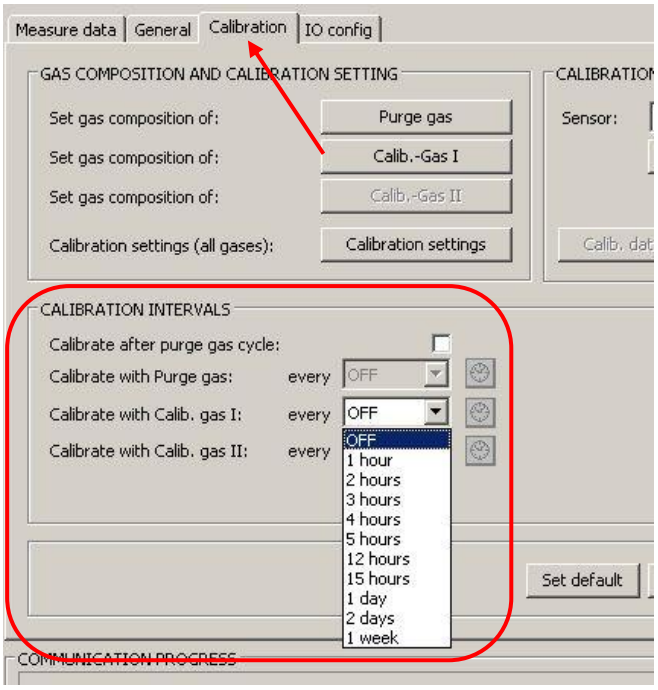
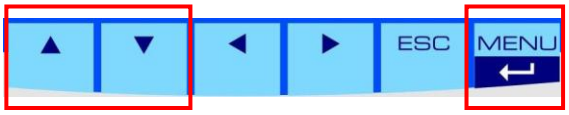


Figure 5-10: Calibration intervals

5.1.5 Manual calibration

Manual calibration can be performed using the user interface of the display. Under *Commands* menu, there perform calibration using purge gas.

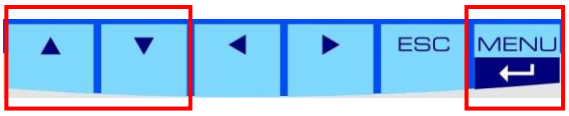


Under the *Commands* menu, press ▲ and ▼ to highlight *Cal. purge gas* and press MENU/↵.

Press MENU/↵ to execute the command.

Calibration using calibration gas

The calibration process can manually be started by a command from user interface of the display.



Under *Commands* menu, press ▲ and ▼ to highlight *Cal. gas I* and press MENU/↵.

Press MENU/↵ to execute the command.

Note

A running calibration can always be interrupted or stopped by choosing Restart system in the display command menu.

Note

INCACtrl software is always required to set up the calibration gas compositions and the calibration points for the calibration process. The setting cannot be performed via display menu.

More information on calibration setting and procedure of certain type of INCA Analyzer, see the corresponding manual.

6 OUTPUT OPTION

The INCA Analyzer can be configured to output the main measurement data through a RS-232 connection. As an option this data can be distributed to field bus devices such as Profibus-DP, Modbus RTU, etc.

6.1 Auto-output implementation

6.1.1 Data structure

The transmitted data will be sent in a data block of 240 bytes in size. This amount of data suits the size of a Profibus-DP telegram.

To enable the detection of a data block with a fieldbus device the 240 bytes are sent within a frame (header and tail):

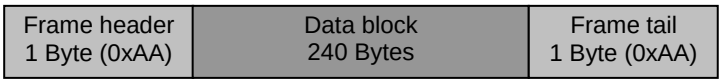


Figure 6-1: Data structure with a frame

Header und tail of the frame are filtered using a HMS Anybus-Communicator (ABC) field bus module and will therefore not be displayed in the data buffer of the device. If data is received directly through a RS-232 connection the header and the tail need to be filtered or ignored by the receiving program.

The 240 bytes are represented in the following structure (ANSI C - notation) and are sent in the Intel format (Little-Endian or LSB first – least significant byte first):

```
ST_TIME_INT     dateTime;
 _WORD          currChnl;
 _WORD          currValues[10];
 _WORD          enclosureTemp;
 _WORD          ambPressure;
 _BYTE          relayServiceRequest[6];
 _WORD          status;
 _WORD          fatalErrorMessage;
 _WORD          errorMessages[10];
 _BYTE          dataValid;
 _WORD          airPumpPressure;
 _WORD          gasPumpPressure;
 _BYTE          measureState;
 _DWORD         secondsInState;
 _BYTE          dataValidDiscontChnls;
 _WORD          gasCoolerTemp;
 _WORD          irTemp;
 _WORD          paroxState;
 _WORD          outerCaseTemp;
 _BYTE          useValidFlagDiscontChnls;
 _BYTE          reserve[156];
```

Using definition:

`_BYTE`	represents 1 Byte (8 Bit)
`_WORD`	represents 2 Bytes (16 Bit)
`ST_TIME_INT`	represents 8 Byte (see below)

The structure ST_TIME_INT for the time representation is defined as follows:

```
_BYTE   sekunden;      //seconds
_BYTE   minuten;       //minutes
_BYTE   stunden;       //hours
_BYTE   tag;           //days
_BYTE   wochentag;     //week day
_BYTE   monat;         //month
_WORD   jahr;          //year
```

The bytes are sent in the above byte order of the structure. The 175 bytes of the reserve are not relevant and do not need to be interpreted. They are reserved for future use.

Additional definition
Invalid values are set to zero. Invalid values occur during the warm up phase of the system after power up or if there is an error. This information can be taken from the status and the transmitted error information.

6.1.2 Interface parameter

Configuration
9600 bit/s, 8 Data bit/n, 1 Stop bit, no parity

Interval for sending
Values are automatically transmitted every 15 seconds.

6.1.3 Data description

The transmitted data is defined as follows:

Name	Bytes	Description
dateTime	8	Current timestamp of the measurement instrument (military time) 1. Byte: seconds (decimal) 2. Byte: minutes (decimal) 3. Byte: hours (decimal) 4. Byte: days (decimal) 5. Byte: - *not defined* - 6. Byte: month (decimal) 7-8 Byte (1 Word): year (decimal)
currChnl	2	Current measured channel / measurement point Range: 1…8
currValues[10]	20	Current measured values from instrument (values, which are also displayed in the instrument). Values, which are transmitted with a decimal place information (DPI), need to be divided by 10^{DPI} to recover the decimal place information For example: CH_4: a transmitted value of 4921 represents 49.21 Vol.% 1. Word: CO_2 DPI: yes (2) Unit: Vol.% 2. Word: CH_4 DPI: yes (2) Unit: Vol.% 3. Word: H_2S DPI: no Unit: ppm 4. Word: O_2 DPI: yes (2) Unit: Vol.%

		5. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 6. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 7. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 8. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 9. Word: *n.d.* DPI: *n.d.* Unit: *n.d.* 10. Word: *n.d.* DPI: *n.d.* Unit: *n.d.*
enclosureTemp	2	Enclosure temperature (check if value is in valid range: e.g. -25.00 °C – 75.00 °C) Value is transmitted with decimal place information (DPI) Word: T_ENC DPI: yes (2) Unit: °C
ambPressure	2	Absolute ambient pressure Value is transmitted without decimal place information (DPI) Word: P_AMB DPI: no Unit: mbar
relayServiceRequest[6]	6	Maintenance request Each byte represents one output relay. Currently 3 relays can be defined. 1. byte: K0 2. byte: K1 3. byte: K2 4. byte: *- not defined -* 5. byte: *- not defined -* 6. byte: *- not defined -*
status	2	Instrument status Information about the main instrument status. *Value* – *Definition* 0 – OK – no problems detected 1 – Instrument is warming up (wait) 2 – Fatal error (fatalErrorMessage should be read)
fatalErrorMessage	2	Fatal error Error code (refer to document *„INCA – Error codes and description.pdf“* or INCA manual)
errorMessages[10]	20	Instrument errors Last ten errors of instrument. These errors do NOT coactive lead to a fatal error but inform about requested maintenance or setup problems.
dataValid	1	Data validity of values in *currValues[10]* Informs about validity of measured values and tells if values can be used to be stored. While this value is 1 (true) the instrument also stores the current value at the end of the measurement cycle. Values are defined as invalid while the instrument is purging air or purging calibration gas and performing a calibration. *Value* – *Definition* 0 – Values are not valid 1 – Values are valid
airPumpPressure	2	Pump pressure (air, respectively purge gas) Value is transmitted with decimal place information (DPI) Word: P_AIR DPI: yes (2) Einheit: mbar
gasPumpPressure	2	Pump pressure (process gas respectively calibration gas) Value is transmitted with decimal place information (DPI) Word: P_GAS DPI: yes (2) Einheit: mbar
measureState	1	Current measurement state of device *Value* – *Definition* 0 – Warming up 1 – Purging purge gas (air) 2 – Condensate drain 3 – Measuring

		4 Change channel / measurement point 5 Calibrate with purge gas 6 Calibrate with calibration gas I 7 Calibrate with calibration gas II 15 Error
secondsInState	4	Time in seconds how long analyzer has been in current state (→ measureState).
dataValidDiscontChnls	1	Data validity of values in *currValues[10]* for discontinuously measured channels (e.g. H_2S oder H_2). Only valid for devices which are configured as continuous measurement devices, but also have channels measuring discontinuously. *Value* *Definition* 0 Values are not valid 1 Values are valid
gasCoolerTemp	2	Temperature of gas cooler (if information is available, otherwise 65535 (or 0xFFFF) is returned) Value is transmitted with decimal place information (DPI) Word: T_COOL DPI: yes (2) Unit: °C
irTemp	2	Temperature of infrared cuvette (if information is available, otherwise 65535 (or 0xFFFF) is returned) Value is transmitted with decimal place information (DPI) Word: T_IR DPI: yes (2) Unit: °C
paroxState	2	State of Parox sensor (if information is available, otherwise 65535 (or 0xFFFF) is returned) *Value* *Definition* 0x0000 OK 0x0400 Parox sensor is warming up
outerCaseTemp	2	Ambient temperature (outer case) (check if value is in valid range: e.g. -25.00 °C – 75.00 °C) Value is transmitted with decimal place information (DPI) Word: T_OUT DPI: yes (2) Unit: °C
useValidFlagDiscontChnls	1	Flag, which tells, if the 'dataValidDiscontChnls' information is supposed to be evaluated or not
reserve[156]	156	- *nicht definiert* -

Table 6: Data description

6.2 H-Bus protocol (Master-Slave)

6.2.1 Data structure

Communication with analyzer with a protocol with the following data structure:

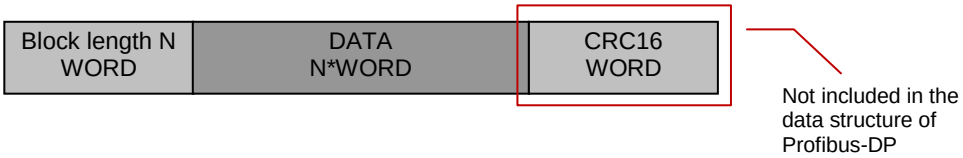


Figure 6-2: H-Bus data structure

Maximum N : 256
Configuration RS-232: 2400 or 9600 Baud, 8 Databit/n, 1 Stopbit, no parity
The DataPackage contains commandos and eventually used data which should be transferred.

Coding of the data is in Intel format (Little Endian). The CRC16 is included only for H-Bus.

For Profibus-DP

Output buffer	5 words (10 Bytes) 2-word-command; 3-word-command
Address	Adjustable in the module (DIP-switch)

For Modbus RTU

Output buffer	5 words 2-word-command; 3-word-command
2-word-command	Register number 1025, 1026
3-word-command	Register number 1027, 1028, 1029
Address & Baud rate	Adjustable in the module (DIP-switch)

Caution

Profibus-DP/Modbus RTU use Baudrate of 9600 Bits/s. The setting is done through the display: Menu→Settings→Communication→H-Bus (9600). Under this setting, communication with INCACtrl is not possible.

6.2.2 Commands description

Note

The following information in brackets indicates the difference of Profibus-DP/ Modbus from direct RS-232 communication.

Note

Communication using Profibus-DP/Modbus RTU does not need CRC16 calcula-tion of bus-master since we use CRC16 calculation of Profibus-DP/Modbus RTU slave.

Command	Bytes	Description
0x0000	6 (4)*	Anybus Flush Format : 0x0001 0x0000 (CRC16)* Response : 0x0001 0x0000 (CRC16)* As dummy instruction during connection of Anybus. It is necessary since it is not allowed to have two identical commands in a row using Profibus-DP.
0x0011	88 (86)*	Sending all measured data Format : 0x0001 0x0011 (CRC16)* Response : 0x002A 0x0011 **measured_data status** (CRC16)* The structure will be sent for each channel which is configured. The block length : 4 x number of channels + 2. Number of channels : 10 Actual measured data, which are displayed on the display. Values, which are transmitted with decimal place information (DPI), need to be divided by 100 to recover the decimal place information. For example: CH_4: a transmitted value of 4921 represents 49.21 vol.% **Measured_data**: 1.Word: Channel 1- CH_4 DPI: yes(2) Unit: vol.% 2.Word:: Channel 1-CO_2 DPI: yes(2) Unit: vol.% 2.Word: Channel 1-O_2 DPI: yes(2) Unit: vol.% 3.Word: Channel 1-H_2S DPI: no Unit: ppm 4.Word: Channel 2-CH_4 DPI: yes(2) Unit: vol.% 5.Word: Channel 2-CO_2 DPI: yes(2) Unit: vol.% … … … 39.Word: Channel 10-O_2 DPI: yes(2) Unit: vol.% 40.Word: Channel 10-H_2S DPI: no Unit: ppm 41.Word: Status **Status**: Status = 1 ; Warmup Status = 0 ; OK Status = -1 ; Message Status = -2 ; Error (fatal) The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value or a sensor error disrupt the measured value. **Example**: "0x01 0x00 0x11 0x00 0x0D 0xE0" ; Valid request command 0x0011 (resolved byte-by-byte)
0x0012	128 (126)*	Sending all Measured data (6 Gases) Format : 0x0001 0x0012 (CRC16)* Response : 0x003E 0x0012 **measured_data status** (CRC16)* Identical to command 0x11, only with additionally H_2 and O_2 (Parox) data. The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value or a sensor error disrupts the measured value. **Measured_data**: 1.Word: Channel 1-CH_4 DPI: yes(2) Unit: vol.% 2.Word:: Channel 1-CO_2 DPI: yes (2) Unit: vol.% 2.Word: Channel 1-O_2 DPI: yes (2) Unit: vol.%

		3.Word: Channel 1-H_2S DPI: no Unit: ppm 4.Word Channel 1-H_2 DPI: no Unit: ppm 5.Word Channel 1-O_2-Parox DPI: yes(2) Unit: vol.% 6.Word: Channel 2-CH_4 DPI: yes(2) Unit: vol.% 7.Word: Channel 2-CO_2 DPI: yes(2) Unit: vol.% … … … … 59.Word: Channel 10-H_2 DPI: no Unit: ppm 60.Word: Channel 10-O_2-Parox DPI: yes(2) Unit: vol.% 61.Word: Status **Status**: Status = 1 ; Warmup Status = 0 ; OK Status = -1 ; Message Status = -2 ; Error (fatal) The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value or a sensor error disrupts the measured value.
0x0016	26 (24)*	Read old data of each channel (minutes) Format : 0x0001 0x0016 (CRC16)* Response : 0x000B 0x0016 **data_block** (CRC16)* **Data_block** : 1.Word: Reading 1 2.Word:: Reading 2 … … 10.Word: Reading 10 The value -1 (Hexadecimal 0xFFFF) shows that there is no valid measured value
0x0017	26 (24)*	Read error numbers Format : 0x0001 0x0017 (CRC16)* Response : 0x000B 0x0017 **data_block** (CRC16)* **Data_block** : 1.Word: Error 1 2.Word:: Error 2 … … 10.Word: Error 10 Error is stored separately for each channel. It is defined and stored as hexadecimal. See Annex Error and Event list. Example: Error number (in Dec) : 785 Error number (in Hex) : 0x0311 Description : Min. pump pressure not reached check pumps
0x0018	---	--*not defined* --
0x0021	---	--*not defined* --
0x0022	---	--*not defined* --
0x0023	---	--*not defined* --
0x0031	8 (6)*	Start measurement Format : 0x0002 0x0031 **channel** (CRC16)* Response : 0x0002 0x0031 **channel** (CRC16)*

		Channel = 0…9
0x0032	---	*--not defined --*
0x0033	---	*--not defined --*
0x0040	8 (6)*	Read firmware version Format : 0x0032 0x0040 (CRC16)* Response : 0x0002 0x0040 SWVERSION (CRC16)* (U_WORD) Exponent -2 i.e. 100 == Version 1.00 (V1.00)
0x0050	6 (4)*	Start calibration using calibration gas I Format : 0x0001 0x0050 (CRC16)* Response : 0x0001 0x0050 (CRC16)*
0x0051	22 (20)*	Read calibration deviation Format : 0x0001 0x0051 (CRC16)* Response : 0x0009 0x0051 **data_block** (CRC16)* **Data_block**: (4Byte)Data Time*) of the last span calibration (in sec.) 0xFFFFFFFF = no calibration 1.Word CO_2 Zero point deviation (value-10000) DPI:yes(2) 2. Word CO_2 the last span deviation (value -10000) DPI:yes(2) 3. Word CO_2 before the last span deviation (value -10000) DPI:yes(2) 4. Word CH_4 Zero point deviation (value -10000) DPI:yes(2) 5. Word CH_4 the last span deviation (value -10000) DPI:yes(2) 6. Word CH_4 before the last span deviation (value -10000) DPI:yes(2) *) Unix time, since 1.1.1970 00:00 h. Can also be used to determine the relative time difference between two Calibrations, so it can be known that a calibration was performed.
0x0052	6 (4)*	Start calibration using calibration gas II Format : 0x0001 0x0052 (CRC16)* Response : 0x0001 0x0052 (CRC16)*

Table 7: Commands description

*) When communicating using Profibus-DP/Modbus RTU, there is no need for CRC16 checksum and these two bytes can be neglected.

7 SERVICE AND MAINTENANCE

Warning

The power plug and gas flow must be disconnected during maintenance and service.

Warning

Gas leak may possibly occur in case of installation or service failure with both health hazards and corrosion damage possibilities.

Warning

Periodic maintenance: All the gas connections should be leak tested every 6 months

Note

Use only original spare parts from the manufacturer to ensure the safety and the accuracy of the analyzer.

Note

If a replacement of an electronic board (main board, I/O board) becomes necessary, a new firmware of the board is required which is delivered together with the new board and the instruction.

Caution

Ignoring regular maintenance in the recommended service intervals may lead to a fault or series of faults that may result in a total analyzer shutdown.

Interval	Maintenance work/replacement
Every 6 months	- All gas connections in the analyzer should be leak tested
Every 1 year	- Air filter - Water trap Sensor replacement: - O_2 sensor (for continuous measurement) - H_2S sensor - H_2 sensor
Every 2 years	- Fire barrier - Fans (for casing and gas cooler) - Gas pump - Air pump - Peristaltic pump (for INCA 4000 T1000) Sensor replacement: - O_2 sensor (for discontinuous measurement)

Table 8: Maintenance work

7.1 Pumps

7.1.1 Diaphragm pump unit

In normal operation the lifetime of both diaphragm pumps is approximately 16000 hours (approx. 2 years).

The air pump does not have a valve. The gas pump has a solenoid valve to prevent air setback into the system.

Both units can be obtained as a spare part and are easily replaceable by the user. New tube connections are also supplied with the pumps.

7.1.2 Peristaltic pump

The peristaltic (hose) pump is a consumable part and should be replaced every 2 years by the user. The hose which can be damaged by abrasives is available as a spare part.

7.1.3 Ejector with valves

The ejector is maintenance-free and has a long lifetime (no specific data available from the manufacturer).

7.2 Sensor modules

7.2.1 Electrochemical sensor

The lifetime of the electrochemical sensors (H_2S, H_2 and O_2) depends on the gas concentrations in the process gas.

H_2S and H_2:
The average lifetime of the H_2S and H_2 sensors is approximately 18 months (more than one year) if operates on normal process gas concentrations.

O_2:
Cont. measurement configuration: approx. 1 year.
Discontinuous measurement (standard): > 2 years.

Pre-calibrated electrochemical sensors are supplied as a spare part. Easy replacement guarantees very little down time of the analyzer.

7.2.2 Optical sensor

The CH_4 and CO_2 optical sensors have a limitless lifetime but are sensitive to dirt and humidity. If necessary (e.g. due to water penetration) the complete sensor block with heater and IR detectors must be replaced. The complete module can be installed by the user.

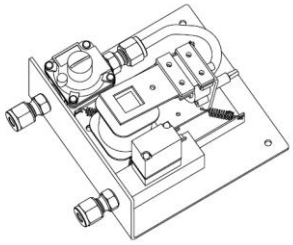
7.2.3 Paramagnetic sensor

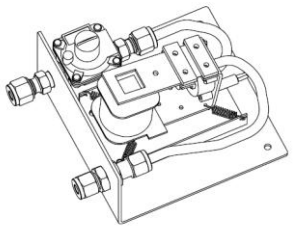
The module is maintenance-free and has a long lifetime (no specific data available from the manufacturer).

7.2.4 Specific gravity sensor

The module is maintenance-free and has a long lifetime (no specific data available from the manufacturer).

8 SPARE PARTS LIST

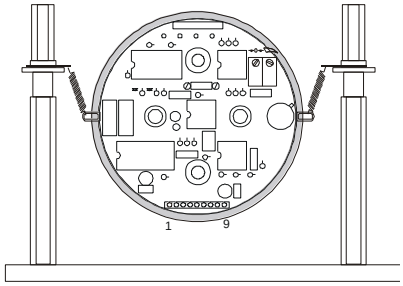
	Assembly group diaphragm gas pump MVG accessories hoses Weight: 675 grams
Description	: Assembly group diaphragm gas pump
Item number	:

	Assembly group diaphragm air pump Accessories hoses Weight: 550 grams
Description	: Assembly group diaphragm air pump
Item number	:

	Electrochemical Sensor H_2S - complete with brackets and electronics - calibrated by the manufacturer Weight: 80 grams
Description	: Electrochemical Sensor H_2S
Item number	:

	Electrochemical Sensor O_2 - complete with brackets and electronics - calibrated by the manufacturer Weight: 150 grams
Description	: Electrochemical Sensor O_2
Item number	:

	Flame arrestor - maximum pressure: 1.1 bar absolute - maximum temperature 60 °C - explosion group IIC Weight: 200 grams
Description	: Flame arrestor SS
Item number	:

	Specific Gravity Sensor - heated - +/-15V / 7VA - **Range 0,2 – 2,2 dv** Weight: 1700 gram
Description	: Specific gravity sensor module
Item number	:

9 APPENDIX

9.1 Abbreviations

EC	Electrochemical
IR	Infrared
MAC	Maximum acceptable concentration
NDIR	Non-dispersive infrared
PTFE	Polytetrafluoroethylene
SG	Specific gravity
UEL	Upper explosion limit

9.2 Errors and events list

9.2.1 State machine errors

Error code	Display description	Full description
0x0100	EVENT OVERFLOW	Firmware development error Too many events were entered into state machine configuration
0x0101	STATE OVERFLOW	Firmware development error Too many states were entered into state machine configuration
0x0102	TIMER LOAD OVERFLOW	Firmware development error Too many timers were initialized in state machine

Fatal state machine error

Error code	Display description	Full description
0x0180	ERROR LIST FULL	Error list is full Can be configured by INCACtrl if this error is supposed to be triggered by software. If not, software will just overwrite oldest errors when new errors occur

9.2.2 Communication errors

Error code	Display description	Full description
0x0200	COMM OPEN PORT	WIN32 exception error Opening COM port failed, COM port either not available or already opened up
0x0201	COMM CLEAR RW BUFFERS	WIN32 exception error Clearing of r-w buffers failed and threw an exception
0x0202	COMM SEND DATA	WIN32 exception error Attempt to sending data on serial port failed and threw an exception
0x0203	COMM TIMEOUT RECEIVE	Bus protocol communication error Not all data was received while communicating due to a timeout
0x0204	COMM CLOSE PORT	WIN32 exception error Closing of COM port failed and threw an exception

0x0210	COMM CMD NOT FOUND	Bus protocol configuration error A command was requested which is not supported/defined by bus protocol
0x0211	COMM CMD TIMEOUT REC. HEADER	Bus protocol communication error Receiving header of protocol failed due to a timeout
0x0212	COMM CMD TIMEOUT REC. TAIL	Bus protocol communication error Receiving tail of protocol failed due to a timeout
0x0213	COMM CMD CRC16 FAILED	Bus protocol communication error Error receiving correct data - checksum
0x0214	COMM CMD WRONG ADDRESS	Bus protocol communication error Wrong address was received by bus master
0x0215	COMM CMD WRONG LENGTH	Bus protocol communication error An invalid length definition was received
0x0216	COMM CMD SEND DATA	Bus protocol communication error Sending data on bus failed
0x0217	COMM CMD CLEAR RW BUFFERS	Bus protocol communication error Clearing r-w buffers failed
0x0218	COMM NO COM PORT OPEN	Bus protocol communication error No COM port open for communication
0x0219	COMM CMD BUFFER SIZE	Bus protocol communication error Buffer size check failed
0x021A	COMM CMD TIMEOUT RECEIVE	Bus protocol communication error Failed receiving all data due to a timeout
0x021B	COMM CMD TIMEOUT HEADER PRT.2	Bus protocol communication error Failed receiving all data while communicating with extended bus communication due to a timeout
0x0230	COMM CMD TIMEOUT RECEIVE ECHO	Bus protocol communication error No echo received on bus due to a problem with bus hardware
0x0231	COMM TIMEOUT NO ANSWER	Bus protocol communication error No answer was received (from a slave) after requesting data
0x0232	COMM SEND BUFFER OVERFLOW	Bus protocol communication error Length set by protocol command setup function is too large for send buffer
0x0233	COMM RECEIVE BUFFER OVERFLOW	Bus protocol communication error Length set by protocol command setup function is too large for receive buffer

9.2.3 Errors reading from or writing to EEPROM

Error code	Display description	Full description
0x0220	COMM SAVE DATA OLD COPY FCTN.	Reading saved EEPROM (sensor/slave) data error Error in old copy function – function error not further specified since this function will not be used anymore in newer firmware versions (>V1.04).
0x0221	COMM SAVE DATA READ NOT OK	Reading saved EEPROM (sensor/slave) data error Slave responded with “not OK” message. Possible solution: More time needed between writing and reading of EEPROM data subsequently
0x0222	COMM SAVE DATA READ NOT CON.	Reading saved EEPROM (sensor/slave) data error No slave EEPROM connected at required EEPROM number

0x0223	COMM SAVE DATA READ NOT AVLB.	Reading saved EEPROM (sensor/slave) data error Function not supported by slave
0x0224	COMM SAVE DATA READ RANGE	Reading saved EEPROM (sensor/slave) data error Too much data was requested from EEPROM
0x0225	COMM SAVE DATA WRITE NOT OK	Writing saved EEPROM (sensor/slave) data error Slave responded with “not OK” message. Possible solution: More time needed between writing and reading of EEPROM data subsequently
0x0226	COMM SAVE DATA WRITE NOT CON.	Writing saved EEPROM (sensor/slave) data error No slave EEPROM connected at required EEPROM number
0x0227	COMM SAVE DATA WRITE NOT AVLB.	Writing saved EEPROM (sensor/slave) data error Function not supported by slave
0x0228	COMM SAVE DATA WRITE RANGE	Writing saved EEPROM (sensor/slave) data error Too much data supposed to be written to EEPROM
0x0229	COMM SAVE DATA EEPROM NOT DEF.	Reading or writing saved EEPROM (sensor/slave) data error EEPROM is not defined – needs to be defined
0x022A	COMM SAVE DATA PTR. NOT SET	Reading or writing saved EEPROM (sensor/slave) data error Pointer to data not set
0x022B	COMM SAVE DATA BUF. TOO LARGE	Reading or writing saved EEPROM (sensor/slave) data error Data buffer too large for communication buffer Solution: Increase communication buffer or reduce size of data to be stored on EEPROM
0x022C	COMM SAVE DATA NO DATA	Reading or writing saved EEPROM (sensor/slave) data error Size of data not set no data can be stored
0x022D	COMM SAVE DATA EEPROM NOT FND.	Reading or writing EEPROM (sensor/slave) data error No EEPROM found – error code of old copy function

9.2.4 Sensor errors

Error code	Display description	Full description
0x0300	SENS CMD BUF FULL	Firmware development error Command list for a sensor is full
0x0301	SENS UNKNOWN DATA TYPE	Firmware development error Unknown data type was loaded with command – values can not be copied
0x0302	SENS DIVISION BY ZERO	Firmware development error Values are set in a way so a division by zero could occur
0x0303	SENS UNKNOWN COMMAND	Firmware development error Unknown command type was set with command
0x0304	SENS CMD WRONG TYPE	Firmware development error Type not supported for command list
0x0305	SENS CAL STATUS ZERO IR1	Zero calibration could not be performed on IR channel 1 --- currently not used ---
0x0306	SENS CAL STATUS SPAN IR1	Span calibration could not be performed on IR channel 1 --- currently not used ---
0x0307	SENS CAL STATUS ZERO IR2	Zero calibration could not be performed on IR channel 2 --- currently not used ---
0x0308	SENS CAL STATUS SPAN IR2	Span calibration could not be performed on IR channel 2 --- currently not used ---
0x0309	SENS CAL STATUS ZERO EC1	Zero calibration could not be performed on EC channel 1 --- currently not used ---

0x030A	SENS CAL STATUS SPAN EC1	Span calibration could not be performed on EC channel 1 --- currently not used ---
0x030B	SENS CAL STATUS ZERO EC2	Zero calibration could not be performed on EC channel 2 --- currently not used ---
0x030C	SENS CAL STATUS SPAN EC2	Span calibration could not be performed on EC channel 2 --- currently not used ---
0x030D	SENS EC PRESSURE AIR	Min. pump pressure not reached – check pumps
0x030E	SENS EC PRESSURE GAS	Min. pump pressure not reached – check pumps
0x030F	SENS EC3 PRESSURE AIR	Min. pump pressure not reached – check pumps
0x0310	SENS EC3 PRESSURE GAS	Min. pump pressure not reached – check pumps
0x0311	SENS EC4 PRESSURE AIR	Min. pump pressure not reached – check pumps
0x0312	SENS EC4 PRESSURE GAS	Min. pump pressure not reached – check pumps
0x0313	SENS CALC. VALUE NOT DEFINED	Firmware development error Method not defined in child class
0x0314	SENS FATAL CHNL. ERR NOT DEF.	Firmware development error Method not defined in child class
0x0315	SENS ABORT MEAS. NOT DEF.	Firmware development error Method not defined in child class
0x0316	SENS FACTORY CALIB. NOT DEF.	Firmware development error Method not defined in child class
0x0317	SENS IR CALIB. NOT READ	Firmware development error Sensor calibration was not read before trying to reset calibration to factory settings
0x0318	SENS IR PRESS. PROCESS GAS	Error for continuous measurement instrument Minimal required pressure in process gas stream not reached – pressure measured through absolute pressure sensors of IR electronic
0x0319	SENS IR PRESS. CALIB GAS	Error for continuous measurement instrument Minimal required pressure in calibration gas stream not reached – pressure measured through absolute pressure sensors of IR electronic
0x031A	SENS SET FACT. CALIB NOT DEF.	Firmware development error Method not defined in child class
0x031B	SENS TYPE NOT DEFINED	Sensor type not defined – error in calibration

Fatal sensor errors

Error code	Display description	Full description
0x0380	SENS GLOB ERROR	Error is returned by a sensor
0x0381	SENS GLOB ERROR IO	Global error occurred in IO board
0x0382	SENS GLOB ERROR IR	Global error occurred in IR board
0x0383	SENS GLOB ERROR EC	Global error occurred in EC board
0x0384	SENS CHNL. ERROR IR1	Fatal channel error occurred in IR channel 1
0x0385	SENS CHNL. ERROR IR2	Fatal channel error occurred in IR channel 2
0x0386	SENS CHNL. ERROR EC1	Fatal channel error occurred in EC channel 1
0x0387	SENS CHNL. ERROR EC2	Fatal channel error occurred in EC channel 2
0x0388	SENS GLOB ERROR EC3	Global error occurred in EC3 board
0x0389	SENS GLOB ERROR EC4	Global error occurred in EC4 board
0x038A	SENS ANLG. OUTPUT NOT VALID	Firmware development error Analog output number too large
0x038B	SENS EC CALIB PTR NOT SET	Firmware development error EC span calibration aborted due to missing pointer
0x038C	SENS EC CALIB ABORT ZERO	Zero calibration for EC sensor aborted

0x038D	SENS EC CALIB ABORT SPAN	Span calibration for EC sensor aborted
0x038E	SENS EC CALIB ABORT MIXER	Mixer calibration for EC sensor aborted
0x038F	SENS EC CALIB ABORT NO DEF.	Calibration for EC sensor aborted
0x0390	SENS NO SLAVE FOUND	No slave was found when booting instrument – check bus connections inside the instrument and firmware versions of slave
0x0391	SENS IR BUFFER OVERFLOW	Internal buffer overflow – calibration data not conform to definition – device needs to be recalibrated in factory
0x0392	SENS IR OLD VERS. CALIBRATION	Old version of calibration on IR slave – device needs to be recalibrated in factory
0x0393	SENS EC OLD VERS. CALIBRATION	Old version of calibration on EC slave – device needs to be recalibrated in factory
0x0394	SENS IR WARMUP OVERRUN	Temperature warming-up of IR board failed
0x0395	SENS IR CHNL. 1 ADC0 ERR	Measured ADC0 signal of IR sensor channel 1 too high
0x0396	SENS IR CHNL. 1 ADC1 ERR	Measured ADC1 signal of IR sensor channel 1 too high
0x0397	SENS IR CHNL. 2 ADC0 ERROR	Measured ADC0 signal of IR sensor channel 2 too high
0x0398	SENS IR CHNL. 2 ADC1 ERROR	Measured ADC1 signal of IR sensor channel 2 too high
0x0399	SENS IR TEMP ADC ERROR	Measured ADC signal of temperature sensor too high
0x039A	SENS IR CHNL. 1 REFERENCE ERROR	Reference signal of channel 1 (IR sensor) is unstable
0x039B	SENS IR CHNL. 2 REFERENCE ERROR	Reference signal of channel 2 (IR sensor) is unstable
0x039C	SENS IR CHNL. 1 REFERENCE LOW	Underflow of reference signal of channel 1 (IR sensor)
0x039D	SENS IR CHNL. 2 REFERENCE LOW	Underflow of reference signal of channel 2 (IR sensor)
0x039E	SENS IR TEMP BROKEN	Temperature sensor failure detected

9.2.5 Command list and task request list errors

Error code	Display description	Full description
0x0400	REQUEST LIST TASK NOT DEF.	Firmware development error Task for request list not defined

Fatal command list and task request list errors

Error code	Display description	Full description
0x0480	CLIST OVERFLOW	Firmware development error Overflow when adding commands
0x0481	REQUEST LIST OVERFLOW	Firmware development error Overflow adding tasks to request list
0x0482	RESET CALIB. LIST OVERFLOW	Firmware development error A not defined sensor was requested to be set to factory

		calibration
0x0483	DYN STR. LIST OVERFLOW	Firmware development error Overflow when creating dynamic signal list

9.2.6 Menu errors

Error code	Display description	Full description
0x0500	MENU OBJECT OVERFLOW	Firmware development error Too many object loaded into menu
0x0501	MENU VALUE NULL POINTER	Firmware development error CMenuValue class object failed to initialize due to NULL pointer
0x0502	MENU TYP UNKNOWN	Firmware development error Defined value type in menu not defined
0x0503	MENU PARSE NUM WRONG ORDER	Error occurred when entering a number, probably too many characters or a minus sign after a number
0x0504	MENU PARSE NUM TOO MANY DOTS	Error occurred when entering a number A number was entered with two or more dots
0x0505	MENU PARSE NUM CONVERSION	Error occurred after entering a number. The entered number could not be converted.
0x0506	MENU ADD SAVE TASK	Firmware development error Adding task to scheduler failed – a changed value was not saved
0x0507	MENU ADD SEND COMM COMMAND	Firmware development error Adding task to scheduler failed – a changed value was not sent to end slave
0x0508	MENU ADD WAIT TASK	Firmware development error Adding task to scheduler failed – a display task will not be performed – restart system
0x0509	MENU MAX INFO ELEMENTS	Firmware development error Too many info elements were added to menu
0x050A	MENU ADD SEND COMMAND	Firmware development error Adding task to scheduler failed – a changed value was not sent to end slave

9.2.7 Storage errors

Error code	Display description	Full description
0x0600	STORE INIT	Error occurred when saving values
0x0601	STORE OPEN FILE FOR READING	WIN32 error Opening file for reading failed
0x0602	STORE OPEN FILE FOR WRITING	WIN32 error Opening file for writing failed
0x0603	STORE ALLOCATE MEMORY	WIN32 error Error allocating memory
0x0604	STORE BUFFER NOT EMPTY	Data buffer not empty
0x0605	STORE BUFFER TOO SMALL	Data buffer too small
0x0606	STORE PTR. SAVE PARAMETERS	Data pointer not set
0x0607	STORE TYPE NOT DEFINED	Storage type not defined
0x0608	STORE NO STORED DATA	Storage of data failed

9.2.8 SD card errors

Error code	Display description	Full description
0x0700	SDCARD POWER ON CMD0	Power on command failed
0x0701	SDCARD INITIALIZE CMD1	Initialize command failed
0x0702	SDCARD READ SECT. SEND CMD	Read section from card failed
0x0703	SDCARD READ SECT. START BYTE	Read section start byte failed
0x0704	SDCARD WRITE SECT SEND CMD	Write section to card failed
0x0705	SDCARD WRITE SECT BUSY	Timeout occurred for writing to card
0x0710	SDCARD FILE IO MOUNT	File mount error
0x0720	SDCARD FILE IO OPEN	File open file error
0x0730	SDCARD FILE IO READ	File read error
0x0740	SDCARD FILE IO WRITE	File writ error
0x0750	SDCARD FILE IO SEEK	File seek error
0x0760	SDCARD FILE IO UNLINK	File delete error

9.2.9 H-Bus errors

Error code	Display description	Full description
0x0801	HBUS CRC	Error occurred when check CRC16 of H-Bus communication
0x0802	HBUS UNKNOWN COMMAND	Unknown command detected on H-Bus

9.2.10 Event messages (not defined as errors)

Error code	Short description	Full description
0x5000	EVENT BOOTING SYSTEM	System was booted up
0x5001	EVENT ENTER WARMUP	System entered warm-up
0x5002	EVENT TIME FORWARD	Daylight saving active time was set forward
0x5003	EVENT TIME BACKWARD	Daylight saving active time was set backward
0x5004	EVENT ENTER ERROR	Message is stored when entering the error state
0x5005	EVENT CALIB STARTED	Event written when calibration is started --- currently not used ---
0x5006	EVENT CALIB FINISHED	Event written when calibration is finished --- currently not used ---