



# WIRELESS COMMUNICATION SYSTEM

## Sigfox WS868

### WS868-CO2

*Revision 1.0*

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	Sigfox communication network	1
1.2	Module usage	1
1.3	Hardware features	1
<b>2</b>	<b>Technical parameters overview</b>	<b>3</b>
<b>3</b>	<b>Configuration of the module</b>	<b>4</b>
3.1	Setting of WS868-CO2 module parameters by configuration cable	5
3.1.1	List of module configuration parameters and commands	5
3.1.2	Commands for saving of configuration parameters and reset	5
3.1.3	Commands for setting of timers	6
3.1.4	Commands for module activation and diagnostics	7
3.1.5	Setting of CO2 alarm threshold value and system time	7
3.1.6	Module current status statement	8
3.2	Setting of parameters by using of optical „USB-IRDA” converter	9
3.3	LCD display, control buttons and alarm signaling	11
3.3.1	Displaying of current values	11
3.3.2	Setting of certain module parameters by buttons	11
3.3.3	Signaling of exceeding the threshold of CO2 concentration	12
3.3.4	Overview of module configuration parameters	13
3.4	Structure of module data messages	13
<b>4</b>	<b>Operational conditions</b>	<b>15</b>
4.1	General Operation Risks	15
4.1.1	Risk of mechanical damage	15
4.1.2	Risk of electrical damage	15
4.2	The condition of modules on delivery	15
4.3	Modules storage	15
4.4	Safety precautions	15
4.5	Environmental protection and recycling	16
4.6	Installation of the WS868-CO2 module	16
4.7	Module replacement	17
4.8	Module dismantling	17
4.9	Functional check of the module	17
4.10	Operation of the WS868-CO2 module	17
<b>5</b>	<b>Troubleshooting</b>	<b>18</b>
5.1	Possible causes of module failures	18
5.1.1	Power supply failures	18
5.1.2	System failures	18
5.1.3	Transmitter and receiver failures	18
5.1.4	Sensor failures	19
5.2	Troubleshooting procedure	19
<b>6</b>	<b>Additional information</b>	<b>20</b>

## List of Tables

1	Overview of WS868-CO2 module technical parameters	3
2	Overview of WS868-CO2 module configuration parameters	13

## List of Figures

1	View of WS868-CO2 module	2
2	WS868-CO2 module configuration table	9
3	Detailed view of the WS868-CO2 module	16

# 1 Introduction

This document describes features, parameters and setting possibilities of the WS868-CO2 module, which is intended for measurement of concentration of carbon dioxide (CO2) in the ambient air. The module performs also indicative measurement of relative humidity. Information about measured values are displayed on the module LCD screen and can be periodically transmitted to the superior remote reading system in form of standard radio-messages of Sigfox IoT network.

## 1.1 Sigfox communication network

**Sigfox communication network** is a global radio frequency (RF) communication system intended for collecting data from the huge number of terminal devices that transmit only a very limited amount of data. This kind of network services are commonly referred as „Internet of Things” (”IoT”).

Sigfox technology (including communication protocol) is optimizing for **maximum radio range**, that enables building of country wide RF networks with a maximum cost effectivity. Unification of technology, global register of identification addresses as well as central registration and control system enable interconnection of national networks („roaming”) into one global Sigfox network.

The module is designed for using in free **868 MHz frequency band** with maximum transmitting power of **25 mW** that is commonly used in European countries. Maximum reach of Sigfox services in this band for devices with maximum transmitting power in open terrain is in range of tens of kilometers. This extensive range is enabled by using of ultra-low modulation frequency (Ultra Narrow Band Modulation) where communication sub-channel bandwidth is just 100 - 600 bps (Baud). As the messages are transmitted with such extremely low speed, Sigfox message was invented as short as possible with maximum length of 26 Byte (maximum data content of 12 Byte). Optimized length of message has positive influence on the terminal device energy consumption during transmitting and receiving.

Sigfox network supports also **bi-directional communication**, if „Downlink” service for transfer of data in reverse direction is allowed, in earmarked time interval the Sigfox base station can deliver to terminal device a special downlink radio-message containing configuration commands.

National Sigfox RF network consists of number of base stations, that are connected by data channels into one central node („star” type topology). The messages from Sigfox RF network are transferred from Sigfox central network server to the application servers of authorized users through the **unified data interface** via public Internet.

## 1.2 Module usage

The WS868-CO2 module can be used for remote reading of CO2 concentration in ambient air in interiors (residential buildings, offices, classrooms, storages, halls...) with recommended temperature range of (0 ÷ 70) °C. The module is also equipped with embedded humidity sensor. Current measured values of CO2 concentration and relative humidity are displayed on the module LCD screen, and they are parallely broadcasted in form of Sigfox standard radio-messages.

The INFO-messages are transferred through the Sigfox network to the central network server („Back-End”), from which there are forwarded to assigned IP-address of their addressee through the Internet. The addressee of the messages is an application server of remote reading service operator, where the messages are decoded and processed.

## 1.3 Hardware features

The WS868-CO2 module is equipped with **LCD display, control buttons** and also with **optical and acoustic indication** of exceeding CO2 concentration threshold value. The LCD screen is intended for displaying of measured current values and together with control buttons serves for setting of module basic parameters. Detailed description of module settings by using of LCD and buttons can be found in paragraph 3.3 „LCD display, control buttons and alarm signaling”. Acoustic signaling is triggered by exceeding of preset CO2 concentration threshold. All module parameters can be set via configuration cable. or wirelessly, through the module optical interface IRDA.

The WS868-CO2 module is enclosed in plastic casing designed either for using as a common „desktop” device, or for wall mounting. The module is power supplied by external AC/DC 5V/1000 mA power adaptor (delivered with the module), or from computer USB port with using of USB cable with ”miniUSB” connector (also delivered with module). The module is equipped with internal real-time clock backup battery that maintains correct real time when the power supplying is off.

The device is not suitable for using in exteriors without additional protection.

External appearance of the WS868-CO2 module is shown in the Figure 1.



Figure 1: View of WS868-CO2 module

## 2 Technical parameters overview

Overview of WS868-CO2 module technical parameters is shown in the Table 1 below.

Table 1: Overview of WS868-CO2 module technical parameters

RF subsystem parameters		
Frequency band	868,0 až 868,6	MHz
Modulation	DBPSK	
Sub-channel bandwidth	100	Hz
Transmitting power	15	mW
Receiver sensitivity	120	dBm
Communication protocol	Sigfox	
Transmission speed	100	Baud
Antenna connector	SMA female	
Antenna characteristic impedance	50	$\Omega$
Configuration interface RS232		
Transmission speed	4800	Baud
Operation mode	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, none parity	
Signal level	TTL/CMOS	
Sensors		
Range of measured CO2 concentrations	(0 ÷ 10 000)	ppm
CO2 concentration measurement resolution	$\pm 3$	% (*)
Temperature measurement accuracy	$\pm 0,5$	°C
Range of measured humidity	(0 ÷ 100)	%
Humidity measurement accuracy	$\pm 15$	%
Power supplying		
External DC power supply	5	V
Maximum current load	100	mA
Delivered AC/DC adaptor parameters	5V/1000mA	(***)
Power cable connector	miniUSB	
Weight and dimensions		
Length	70	mm
Width	70	mm
Height	27	mm
Weight	cca 150	g
Storage and installation conditions (*)		
Installation environment (by ČSN 33 2000-3)	normal AA6, AB4, A4	
Operation temperature range	(-10 ÷ 50)	°C
Storage temperature range	(0 ÷ 40)	°C
Relative humidity	95	% (w/o condensation)
Degree of protection	IP20	

(\*) at 25 °C and measurement range of (400 ÷ 10000)ppm

(\*\*) for temperature range of (0 ÷ 50)°C

(\*\*\*) the device can be also supplied from common USB port of computer

### 3 Configuration of the module

Configuration parameters of the WS868-CO2 module can be displayed and changed from the common computer (PC) by one of these methods:

- with using of „**USB-CMOS**” converter and configuration cable
- wirelessly, with using of „**USB-IRDA**” or „**USB-IRDA**” converter
- manually - by using of control buttons (only some parameters)

Technique of interconnection of the module with configuration computer and general rules of configuration are described in detail in the chapter 2 of „**Configuration of wacoSystem product family devices**”, that can be downloaded from the producer website:

[www.wacosystem.com/support/](http://www.wacosystem.com/support/)  
[www.softlink.cz/en/documents/](http://www.softlink.cz/en/documents/)

The description and meaning of all configuration parameters that can be checked and changed by cable can be found in the section 3.1 „Setting of WS868-CO2 parameters via configuration cable”.

Description of interconnection of the converter with PC („USB-IRDA”) or smartphone („BT-IRDA”) and general rules of configuration with using of **optical converters** are described in the chapter 3 of above mentioned manual „Configuration of wacoSystem product family devices”. The description and meaning of the parameters that can be changed by optical converter can be found in the section 3.2 „Setting of parameters by using of optical „IRDA” converter”.

Configuration of selected parameters by using of control buttons is described in the paragraph 3.3 „Display unit, control buttons and alarm signalling”.

### 3.1 Setting of WS868-CO2 module parameters by configuration cable

In following part of the document there is a description of these parameters of the WS868-CO2 module, that can be displayed and examined from PC connected to the module by configuration cable. Some of the parameters can be changed by configuration commands entered „from the console”.

#### 3.1.1 List of module configuration parameters and commands

List of all configuration parameters of the module can be displayed by entering of `"/` command and pressing of „ENTER” key. The following list of parameters will display in the terminal window:

```
co31s>/
CONFIGURATION: OK
Mode Setup: 1
XTAL ppm: 0
sending time: 60
Minimum sending time: 60
CO2 send alarm flag: 1
measure time: 60
downlink : 0
Debug level: 0
CO2 alarm threshold: 1500
co31s>
```

List of all configuration commands (`"/?`) can be displayed by entering of `"/?` command into the command line and pressing of „ENTER” key. The following list of commands will display in the terminal window:

```
co31s>/?
/W - write configuration
/# - erase configuration
/x - RESET
/M - enable mode setup on startup
/! ppm - set Xtal ppm
/s min. - set sending time in minutes
/S min. - set minimum sending time in minutes
/A 0|1 - clear/set CO2 send alarm flag
/m sec. - set measure time in seconds
/d n - n-th uplink message has downlink capability, 0 - no downlink
/D number - debug level
/C number - set CO2 threshold (default 1500)
co31s>
```

Overview of configuration parameters with short description of their meaning can be also found in table 2 on the page 13.

The meaning and detailed description of individual parameters can be found in the following part of chapter 3.1.

#### 3.1.2 Commands for saving of configuration parameters and reset

The module contains two sets of configurations: operating configuration and saved configuration. At the start of the system the module copies saved configuration into the operating configuration, with which continues to work. If user changes configuration parameters, it does so only in operating configuration.

Current status of storing of configuration parameters can be displayed in the list of all configuration parameters as „CONFIGURATION” item:

```
CONFIGURATION: OK
```

Information „OK” means, that the operating configuration is stored (it is identical with stored configuration)

Information „NOT WRITTEN” means, that the operating configuration is different from the configuration stored in Flash.

Configuration **can be saved** to Flash memory by using of **"/W"** command. Example:

```
co31s>/W
```

*If the current operating configuration was not stored to FLASH memory, the module returns to the saved configuration after reset. If the parameter should be changed only temporarily (for example switch-on „test” function during diagnostics), it is not necessary to save operating configuration into FLASH memory (after diagnostics the function will be switched-off anyway). If the parameter should be changed permanently, there is necessary to save the configuration to FLASH memory.*

Configuration can be **erased from the Flash memory** by using of **"/#"** command. Example:

```
co31s>#
```

**WARNING!** This command is recommended to use only by users with good knowledge of the system, or after consultation with the manufacturer.

The **module reset** can be performed by using of **"/x"** command. Example:

```
co31s>/x
```

After entering the command, the module goes to software restart.

### 3.1.3 Commands for setting of timers

This group of commands enables setting of measurement and broadcasting intervals and setting of receiving („downlink”) mode. There are following commands:

---

<b>/s min</b>	<i>spontaneous messages broadcasting period (min)</i>
<b>/m sec</b>	<i>A/D converter measurement interval (sec)</i>
<b>/d number</b>	<i>setting of frequency of „downlink” activation</i>

---

The **„/s min”** command can be used for setting of the module **broadcasting period**. The period is set in minutes (\*) and the module broadcasts its INFO-messages spontaneously with this period. Example of setting of broadcasting period to 1 hour (60 minutes) and corresponding record in the module configuration summary:

```
co31s>/s 60
...
sending time : 60
```

(\*) For earlier version of the module the broadcasting period should be set **in seconds**. In this case the parameter is presented in the list of all configuration commands (**“HELP”**) as **„/s sec”**.

**WARNING!** Frequency of broadcasting in Sigfox network is under regulation. Each device working in Sigfox network has assigned its service profile that enables only limited number of broadcasted messages per day. Exceeding this limit can cause some restriction or sanction from the Sigfox service provider. When setting this parameter, check whether the setting complies with a service contract, that is valid for configured device.

The **„/m sec”** command can be used for setting of the time interval for measurement of some operational parameters (temperature, voltage...). As the latest values of measured quantities are broadcasted in INFO-messages, measurement interval should be always shorter than broadcasting period. Example of setting of measurement interval of analogue quantities to 5 minutes (300 seconds) value and corresponding record in the module configuration summary:

```
co31s>/m 300
...
measure time : 300
```

By using of **„/d number”** command a frequency of activation of receiving („Downlink”) channel can be set. The number **“n”** in this command determines frequency of receiving channel activation according to this principle:

- if **„0”** value is set, receiving channel is closed („Downlink” service disabled)
- if **„1”** value is set, receiving channel is opened after each INFO-message
- if **„2”** value is set, receiving channel is opened after every second INFO-message
- if **„n”** value is set, receiving channel is opened after each n-th INFO-message



Example of setting of receiving channel activation frequency to such mode, when the receiving channel opens after every fourth broadcasted message, and corresponding record in the module configuration summary:

```
co31s>/d 4
downlink: 4
```

*Example: If the module broadcasts INFO messages eight times per day (sending time = 10800 second) and downlink channel will be opened after each fourth transmission, the module will be able to receive downlink message two times per day.*

**WARNING!** "Downlink" service of the Sigfox network is under regulation. This service is allowed only for some Sigfox service profiles and with limited frequency. When setting this parameter, check whether the setting complies with a service contract, that is valid for configured device.

The „/S min" command is intended for entering of the **minimum period** of spontaneous broadcasting of INFO-messages, that can be set by buttons. This setting can protect user from unintentional **breach of Sigfox service contract** in case of unskilled handling with the module.

Example of setting of minimum broadcasting period parameter to 1 hour (60 minutes) and corresponding row in configuration statement:

```
co31s>/S 60
...
Minimum sending time: 60
```

### 3.1.4 Commands for module activation and diagnostics

This group of commands is intended for the module initial setting during the manufacturing process, and for module diagnostics by manufacturer. **These commands are only for manufacturer use.**

There are following commands:

/M	<i>switching to module initialization mode "Mode setup" (Do not use! Only for factory setting!)</i>
/! ppm	<i>entering of "XTAL" correction constant (Do not use! Only for factory setting!)</i>
/D number	<i>„debug" statement switch-on (Do not use! Only for factory setting!)</i>

**WARNING** It is strongly recommended not to use these command during normal operation. Using of these commands can cause device malfunction!

The „T" command (without „slash") can be used for immediate transmitting of standard INFO-message (out of scheduled time). This command can be used for example for checking of radio connection during the module installation. When using this command, it is necessary to realize that each device working in Sigfox network has assigned its service profile that enables only limited number of broadcasted messages per day. Exceeding this limit can cause some restriction or sanction from the Sigfox service provider.

### 3.1.5 Setting of CO2 alarm threshold value and system time

The "/C [number]" is intended for setting of **CO2 concentration threshold value**, exceeding which will rise alarm, that is signaled acoustically and optically. (see paragraph 3.3. Threshold value is set in „ppm" units, default setting is 1500 ppm. The module is in alarm state until the current CO2 value decline under threshold value. Example of setting of threshold value parameter to "1200 ppm" value:

```
co31s>/C 1200
```

The threshold value level will appear in the configuration statement (displayed by „/" command) in „CO2 alarm threshold" row as follows:

```
CO2 alarm threshold: 1200
```

The "//A [0/1]" command is intended for enabling/disabling of transmission of alarm messages. If the value of the parameter is "1" („enabled"), the module transmits the message with current CO2 concentration value immediately after threshold level was crossed (i.e. when the threshold is exceeded, as well as when the current value goes back to normal). If the parameter is set to "0" („disabled"), the module broadcasts only regular messages.

Example of setting the parameter to "0", when transmitting of threshold crossing (=alarm) messages is disabled:

```
co31s>/A 0
...
CO2 send alarm flag: 0
```

*Setting of this parameter is important in that case, if the module broadcasting period is preset close to the maximum daily limit of transferred messages stated in the relevant Sigfox service contract, and each extra transmission can cause breach of contract.*

The module system time can be set by using of "r [hour min sec day month year]" command (without slash). Example of setting of system time to "2.1.2019 12:19:00" value:

```
co31s>r 12 19 00 02 01 2019
12:19:0 2.1.2019 (49)
co31s>
```

As the RTC circuit, that keeps system time, is supported by embedded backup battery, system time is kept also when the module is switched off (with disconnected power supply). Setting of correct system time is not requisite for module usual operation.

### 3.1.6 Module current status statement

The **module current status statement** can be displayed by entering of "i" command (without „slash“) into the command line and pressing of „ENTER" key. Following statement will appear in the terminal window:

```
CO31S HW 1.31 SW: 7.0
Reset cause=4 (0002) Uptime=114
ID: 0018dcff
PAC: 3ca18dcf23a720e2
temperature[1]: +24.7
temperature[2]: +23.9
humidity[1]: 27
voltage[1]: 3162
CO2eq: 943
CO2eq: 0
CO2eq: 1077
CO2 sum: 47344 cnt: 50 average: 946
Buzzer const: 0
12:56:7 28.1.2019
State TXIE RXIE
-----
0 0 0 0/128
edgeCounter 0
co31s>
```

In the first row there are displayed following device specifications: **manufacturer type** (Device name), **hardware version/revision** (HW version.revision) and **software version/revision** (SW version.revision). In the second row there are values of **reset cause** and value of module "Uptime".

In the third row there is a value of module Sigfox **ID**, that is an **unique identifier of the device** in the Sigfox global network. This ID is permanently assigned to the given module and cannot be changed.

In the fourth row there is a value of module Sigfox "**PAC**" **code** (Personal Authentication Code), that is an unique identifier of **assigning** of the given device to **concrete customer** - service contractor. Initial PAC-code is assigned to the module in factory and can be changed only with co-operation with Sigfox network provider (with possible change of service contractor). Initial PAC-code is written in module configuration as an information for user. Setting of this parameter has no influence on the module functionality. After possible change of service contractor, the new contractor could decide to register change of PAC-code in the module configuration or not.

In next rows there are values of **current temperature** measured by CO2 sensor (Temperature [1]), **current processor temperature** (Temperature [2]), **current relative humidity** (Humidity [1]) and **current voltage of power supply** (Voltage [1]).

In the last section there are statistics of CO2 concentration measured values within the time interval from last broadcasting (last, minimum, maximum and average value) and number of measurements. Remaining data (excluding module **system time** in common time format) are intended only for module diagnostics.

The „**Uptime**” parameter value shows the time interval passed from the last device reset in seconds so that the exact moment of the last module reset can be recognized by this parameter. The parameter is of „read only” type.

The „**Reset Code**” parameter value gives an information about the last reset circumstances. Following reset codes are relevant for this type of device:

- „0” means „Cold start” (caused by user „RESET” command)
- „1” means „Warm start” (based on „suspension” cause)
- „2” means „Watchdog reset” (reset by „watchdog” system)
- „3” means „Error reset” (incorrect instruction or inconsistent data)
- „4” means „Power reset” (caused by low power voltage)

The parameter has „read only” character and it is used mainly for the diagnostics.

### 3.2 Setting of parameters by using of optical „USB-IRDA” converter

All parameters that is necessary to set-up during common operation can be configured by optical interface. The settings can be performed through the ventilation vent without necessity to open the module’s cover. The sensor of optical converter is placed on the module PCB near the power connector, its position is marked on the figure 3 by violet arrow.

Any changes in module’s settings can be performed in **Module configuration table** that opens by click on the „Read device” button in „WACO OptoConf” program window. View of configuration table is depicted in figure 2.

The screenshot shows a window titled "Waco configuration" with a "File Config" menu. The main area is labeled "Info WS868-CO2" and contains a list of configuration parameters. The parameters are organized into two sections: "read only" (factory settings) and "writeable" (user settings). The "read only" section includes Device name, Device type, Device subtype, Serial No, HW Version, HW Revision, SW Version, SW Revision, CO2, Humidity, Temperature, CPU voltage, Sigfox ID, and Sigfox PAC. The "writeable" section includes Send alarm, Send periode, Measure periode, Min. send periode, CO2 alarm, and CO2 alarm level. The "read only" section is marked with a lock icon, and the "writeable" section is marked with an unlocked icon. The "Write" and "Read" buttons are located at the bottom right of the window.

Parameter	Value	Type
Device name	CO31S	read only
Device type	870	read only
Device subtype	114	read only
Serial No	00 18 DC FF	read only
HW Version	1	read only
HW Revision	31	read only
SW Version	7	read only
SW Revision	0	read only
Send alarm	yes	writeable
Send periode	63 min	writeable
Measure periode	120 sec	writeable
Min. send periode	60 min	writeable
CO2	890 ppm	read only
CO2 alarm	1 501 ppm	writeable
Humidity	23,7 %	read only
Temperature	27,7 °C	read only
CPU voltage	3,16 V	read only
Sigfox ID	0018DCFF	read only
Sigfox PAC	3CA18DCF23A720E2	read only

Figure 2: WS868-CO2 module configuration table

In the **upper section of the table** there are „read only” type of parameters (factory settings) that refer to the identification of the module and its components. There are following parameters:

<b>Device name</b>	<i>device name by manufacturer</i>
<b>Device type</b>	<i>device type by manufacturer</i>
<b>Device subtype</b>	<i>device subtype by manufacturer</i>
<b>Serial No.</b>	<i>unique module identifier in Sigfox network</i>
<b>HW Version</b>	<i>hardware version by manufacturer</i>
<b>HW Revision</b>	<i>hardware revision by manufacturer</i>
<b>SW Version</b>	<i>software version by manufacturer</i>
<b>SW Revision</b>	<i>software revision by manufacturer</i>

All the parameters contain information about device identification, series and hardware/software version and are intended only for manufacturer's use.

In the **middle section of the table** there is a group of commonly used configurable parameters of the WS868-CO2 module. There are following parameters:

<b>Send alarm</b>	<i>alarm message broadcasting enabled/disabled</i>
<b>Send periode</b>	<i>setting of broadcasting period</i>
<b>Measure periode</b>	<i>setting of interval of A/D measurement</i>
<b>Min. send periode</b>	<i>setting of minimal broadcasting period</i>
<b>CO2 alarm</b>	<i>setting of CO2 signaling threshold value</i>

The „**Send alarm**” field is used for enabling/disabling of broadcasting of „alarm” messages, when the CO2 concentration will exceed alarm threshold value. More detailed description of this variable and possibilities of its setting are explained in details in paragraph 3.1.5 „Setting of CO2 alarm threshold value and system time”.

The „**Send periode**” field is used for setting of broadcasting period of regular information messages. Value of the period should be set in minutes. More detailed description of this variable and possibilities of its setting are explained in details in paragraph 3.1.3 „Commands for setting of timers”.

The „**Measure periode**” field is used for setting of analog quantities (temperature, voltage..) measurement interval in seconds. More detailed description of this variable and possibilities of its setting are explained in details in paragraph 3.1.3 „Commands for setting of timers”.

The „**Min. send periode**” field is intended for entering of the **minimum period** of spontaneous broadcasting of INFO-messages, that can be can be set by buttons. More detailed description of this variable and possibilities of its setting are explained in details in paragraph 3.1.3 „Commands for setting of timers”.

The „**CO2 alarm**” field is intended for setting of CO2 concentration threshold value, exceeding which will rise alarm, that is signaled acoustically and optically. More detailed description of this variable and possibilities of its setting are explained in details in paragraph 3.1.5 „Setting of CO2 alarm threshold value and system time”.

Setting of all above mentioned variables can be performed by editing (rewriting) of current value to required number and clicking to „Write” button. The process can be observed by flashing of green LED on the converter and yellow LED on the module. After each writing of new values the „WACO OptoConf” program automatically re-read actual data from the module, so that if required values will display in the configuration window at the end (after yellow LED on the module ceases flashing), the process was completed successfully.

In the **lower section of the table** there are current values of internal sensors of CO2, humidity, temperature and power voltage. There are following parameters:

<b>CO2</b>	<i>current value of CO2 concentration (read only)</i>
<b>Humidity</b>	<i>current value of relative humidity (read only)</i>
<b>Temperature</b>	<i>current value of temperature (read only)</i>
<b>Voltage</b>	<i>current power voltage (read only)</i>

The „**CO2**” value is a current value of CO2 concentration measured by CO2 sensor. The value is quoted in ”ppm” units, their meaning is described in details in paragraph 3.3 ”LCD display, control buttons and alarm signaling”.

The „**Temperature**” value is a current temperature of CO2 sensor. This information is intended only for module diagnostics (\*).

The „**Humidity**” value is also measured by CO2 sensor. This information can be used as indicative measurement of relative humidity of ambient air with limited accuracy (\*).

(\*) During measurement the CO2 sensor produces appreciable quantity of heat energy, that can influence accuracy of temperature and humidity measurement. Degree of influence depends mainly on the intensity of air flow through the sensor that is influenced by module location, position and other circumstances.

The „**Voltage**” value shows current value of power voltage in Volts. This information re and battery voltage of the module. This information is intended for module diagnostics

All above described parameters are of „**read only**” type. Current values of module internal sensors are broadcasted in each operational data message (see description of information messages in section 3.4 „Structure of WS868-CO2 module data messages”).

In the last two rows there are displayed two **unique identifiers** of the module within Sigfox network.

The „**Sigfox ID**” is an **unique identifier of the device** in the Sigfox global network. This ID is permanently assigned to the given module and cannot be changed.

The „**Sigfox PAC**” (Personal Authentication Code) is an unique identifier of **assigning** of the given device to **concrete customer** - service contractor. Detailed description of this identifier can be found in paragraph 3.4 „Module current status statement”.

### 3.3 LCD display, control buttons and alarm signaling

The **LCD-display** is intended for displaying of measured current values of the WS868-CO2 module. Together with the **control buttons** it can be used also for setting of several basic parameters of the module.

The **indication LED** and **acoustic signal generator** serve for indication and acoustic signaling in case of exceeding CO2 concentration threshold value.

#### 3.3.1 Displaying of current values

After the module is switched on, the „CO-2” info-text will appear on the display for approximately 3 seconds. After that the primary (default) mode will be switched on, in which the current measured values are displayed. The display can be anytime switched from „setup” mode to primary mode by pressing of „ESC” button.

When the **primary mode** with displaying of current measured values is active, the **CO2 concentration** value displays in **upper row** of the display. In **lower row** of the display there alternate (in circa 5 second rotation) following values:

- **current time** in „hh:mm” format
- current **relative humidity** value in %

When switched to primary mode, the information will display on the LCD like this (example):



In the left side there is an example of displaying of actual time (under CO2 concentration value). In the right side there is an example of displaying of relative humidity. This information is only indicative, relative humidity value can be influenced by heating of CO2 sensor.

#### 3.3.2 Setting of certain module parameters by buttons

The module can be switched to the setting mode by pressing of „**ENT**” button and holding for approximately 3 seconds. Information in upper row will remain without changes, in lower row there will display an information about actual time in „hh:mm” format with blinking hours („hh”) value. Value of blinking entry can be **changed** by using of „+” and „-” buttons, changeover to setting of **next entry** can be performed by pressing of „**ENT**” button, setting mode can be anytime terminated by „**ESC**” button. Full date and time information can be set in following sequential steps, controlled by „**ENT**” button:

- current time in **hh**:mm format (editing hours)
- current time in hh:**mm** format (editing minutes)
- current date in **DD**:MM format (editing day in month)

- current date in DD:MM format (editing month in year)
- current year in **RRRR** format (editing year)
- setting of CO2 concentration **threshold value**
- setting of **broadcasting period** in minutes
- activation/deactivation of **acoustic signalling**

Example of displaying of all entries on the LCD screen in setting mode can be seen in the following figure:



In the first left picture there is an example of displaying of actual time (in three steps - time/day/year). In the second left picture there is an example of displaying of CO2 concentration threshold value. Exceeding this value will rise alarm, that is announced by optical and acoustical signaling. In the third from the left picture there is an example of displaying of broadcasting period value in minutes. If this entry is set to "30" value, the module will send standard information message every 30 minutes. Setting of this entry can be limited by "/S" command to prevent user from unintentional **breach of Sigfox service contract**. In the very right picture there is an example of control of acoustic signalling. Setting to "0" value means deactivation of acoustic signalling of threshold value exceeding, setting to "1" means activation of the acoustic signalling.

There are following general rules for working in setting mode:

- changes will be applied to **blinking entry**;
- value will increase by "+" button, decrease by "-" button;
- increasin/decreasing can be performed **gradually**, by short pressing of button, or **quickly**, by holding of the button;
- changeover to setting of next entry can be done by short press of "ENT" button;
- setting mode can be terminated by short press of "ESC" button.

### 3.3.3 Signaling of exceeding the threshold of CO2 concentration

Exceeding threshold value of CO2 concentration will rise alarm, that is signaled **acoustically** (dashed beeping) as well as **optically** (blinking of red LED). All the time the value is over the limit there displays a **symbol of rotating fan** in the right side of the LCD screen. Setting of CO2 concentration threshold limit can be made manually by LCD and buttons as described in previous paragraph, or via configuration cable by using of "/C" command (see paragraph 3.1). Setting of CO2 concentration threshold limit can be performed also wirelessly, by using of USB-IRDA optical converter (see paragraph 3.2).

Threshold value displays in the configuration parameters statement (see paragraph ) as follows:

CO2 alarm threshold: 1450

*The module indicates CO2 concentration in "ppm" units, that express number of CO2 particles in million air particles ("Parts Per Million"). When measuring of CO2 concentration in living quarters and common interiors it is recommended to set the threshold limit to 1000 - 1500 ppm, where at 1000 ppm (Pettenkofer's number) the first signs of tiredness can be observed and at 1500 ppm the air is considered as exhausted and should be changed. Exceeding value of 5000 ppm is considered as serious health risk.*

Exceeding preset threshold of CO2 concentration will activate generator of acoustic signal (if it is not permanently deactivated) together with blinking of red LED above the display. Acoustic signaling can be temporary switched off by short press of "ESC" button. Signaling LED keeps on blinking until the concentration value gets under threshold value. During all the time when the concentration is over limit there is a "running fan" symbol displayed on the module LCD.



### 3.3.4 Overview of module configuration parameters

Overview of configuration parameters that can be used for user settings of the WS868-CO2 module is shown in the Table 2 below. The parameters are presented in the same order as they appear in the List of all configuration parameters displayed by `"/"` command (see paragraph 3.3.3).

Table 2: Overview of WS868-CO2 module configuration parameters

Item	Name	Type	Description	Default.
1	Config.	text	Configuration status	read only
2	Mode Setup	0/1	Module initialization status	read only
3	XTAL	number	RF subsystem correction constant	
4	Sending Time	number	Broadcasting period in minutes	60
5	Minimum sending time	number	Minimum broadcasting period set by buttons	60
6	CO2 alarm flag	0/1	Alarm messages switch on/off	1
5	Measure time	number	A/D measurement interval	60
6	Downlink	number	Downlink activation frequency	0
12	Debug level	number	Debug level	0
10	CO2 alarm threshold	number	Acoustic signaling switching level	1500

In „Default” column there are default (factory) settings of the parameter. Colour marking of this field has following meaning:

- green colour - commonly used parameters that should be setup in reliance on the specific usage
- red colour - parameters that are not recommended to change
- grey colour - values that cannot be changed („read only”)

### 3.4 Structure of module data messages

The WS868-CO2 module is intended for measurement of CO2 concentration in interiors and sending of measured data through the Sigfox RF network. The module regularly transmits standardized Sigfox INFO-messages with maximum length of 26 Byte, and with maximum length of data payload of 12 Byte.

The module broadcasts two types of information messages:

- regular info-message
- spontaneous alarm message at exceeding of alarm threshold value

Both types of messages have identical content, the only difference is setting of „Message type” field, where regular message is marked as "0" and alarm message is marked as "128".

The message data content („payload”) of WS868-CO2 module is 10 Byte long and contains following information:

Item	Bytes	Name	Description
1	1	type	Message type (0 - regular message, 128 - alarm)
2	1	TID	Transaction ID - increases with each transmitted message
3	1	Temperature	temperature in Celsius (8-bit signed integer, LSB first)
4	1	Humidity	relative humidity in per-cent (8-bit signed integer)
5	2	CO2	CO2 concentration current value (16-bit integer, LSB first)
6	2	CO2 avg	average CO2 value since previous message (16-bit integer, LSB first)
7	2	CO2 max	maximum CO2 value since previous message (16-bit integer, LSB first)

The „**Message type**” (1 Byte) enables distinguishing of messages by their content (operational messages, messages with meter variables, alarm messages). Regular operational data message is always marked as "0" type, alarm message at exceeding of threshold value is marked as "128" type.

The „**Transaction ID**” (1 Byte) is order number of the message intended for control over data communication. With each new message the number increases.

The „**Temperature**” value (1 Byte) represents current status of temperature measured by combined sensor. This value has only informative meaning.

The „**Humidity**” value (1 Byte) represents current status of humidity measured by combined sensor. This value has only informative meaning.

The „**CO2**” values (3 x 2 Byte) represent CO2 concentration data measured by combined sensor. The first value (”CO2”) is current (the last measured) concentration, the second value (”CO2 avg”) is an average of all measurement since last broadcasting, the third value (”CO2 max”) is the maximum of all measurement since last broadcasting.

**IMPORTANT NOTE!** Broadcasting of „alarm” type messages can be blocked by setting of ”clear/set CO2 send alarm” parameter to ”0” value by using of ”/A” command (see paragraph [3.1.5](#)).



## 4 Operational conditions

This section of the document describes basic recommendations for transportation, storing, installation and operation of WS868-CO2 radio modules.

### 4.1 General Operation Risks

The WS868-CO2 radio modules are electronic devices power-supplied from an external AC/DC power adaptor. The modules measure concentration of CO2 in ambient air in short intervals and regularly broadcast messages with measured values. During their operation be aware mainly of the following risks:

#### 4.1.1 Risk of mechanical damage

The devices are enclosed in plastic boxes with narrow (35 mm x 2 mm) ventilation slits (vents), that enable flowing of air around internal CO2 sensor. The casing protects module electrical components from the direct damage by human touch or static electricity, but does not protect from the mechanical or electrical damage by thin tool through the vent. Another potential risk is the damage by water or excessive humidity. The module is designed for operation in interiors and can be used either as a portable desktop device, or with fixed installation on the wall or ceiling by using of screw or glue. In normal operation no special precautions are needed, besides avoiding of the mechanical damage from strong pressure or shocks and prevention from water penetration.

Special attention is required for antenna, power supply and cable. In operation it is necessary to prevent any damage of AC/DC power adaptor and power cable. DC power cable cannot be stressed by mechanical tension or bending. In case of damage of its isolation it is recommended to replace the cable immediately. If the module is equipped with a remote antenna on a coaxial cable, much attention should be paid for the antenna and the antenna cable as well. The minimum bending radius of the antenna cable with 6 mm diameter is 4 cm, for the antenna cable with the 2,5 mm diameter the bending radius is 2 cm. Violation of these bending parameters can lead to breach of homogeneity of the coaxial cable that can cause reducing of radio range of the device. Further it is necessary to ensure that the connected antenna cable will not stress the antenna connector of the device by tension or twist. Excessive loads can damage or destroy antenna connectors.

The module is intended for operation in normal interiors with temperature range of  $(-10 \div +50)^{\circ}\text{C}$  and humidity up to 90% without condensation. Direct installation of the device in exteriors is not allowed.

#### 4.1.2 Risk of electrical damage

Electrical installation of the module can be performed only by a person what is trained for this device installation. The device is powered by DC power with 5 V safe voltage with a very low current consumption (up to 100 mA). Power AC/DC adaptor (AC 230V / DC 5V/1000 mA) is a part of delivery, but it is possible to use any adaptor with the same parameters, approved for operation in the country of installation. The device can be supplied also from the common USB port of computer, this function is not guaranteed by producer and it is necessary to check it out. Power supplying can be disconnected by unplugging of power adaptor or by taking power connector out of the device.

### 4.2 The condition of modules on delivery

Modules are delivered in standard cardboard boxes. The standard delivery includes also antenna, power adaptor and the USB cable.

### 4.3 Modules storage

Modules should be stored in dry rooms with a temperature range  $(0 \div 30)^{\circ}\text{C}$ .

### 4.4 Safety precautions

**Warning!** Fixed (permanent) installation of the WS868-CO2 module can be provided only by a person with necessary qualification in electrical engineering.

## 4.5 Environmental protection and recycling

The equipment contains non-rechargeable lithium battery. It is necessary to remove battery before module disposal and dispose battery separately in compliance with the dangerous waste disposal rules. Damaged, destroyed or discarded devices cannot be disposed as household waste. Equipment must be disposed of in the waste collection yards, which dispose electronic waste. Information about the nearest collection yard can be provided by the relevant local (municipal) authority.

## 4.6 Installation of the WS868-CO2 module

The modules are enclosed in plastic casings with an IP20 degree of protection. The casing consists of two parts:

- the module base with ventilation slits and with the printed circuit board;
- cap of the box with depressions for fixing screw holes.

Detailed view of the module dismantled into both parts can be seen in the left part of the figure 3. Position of module backup battery on the module printed circuit board is marked by red colour, antenna connector by green colour, configuration connector by yellow colour, power connector by blue colour and optical sensor by violet colour.

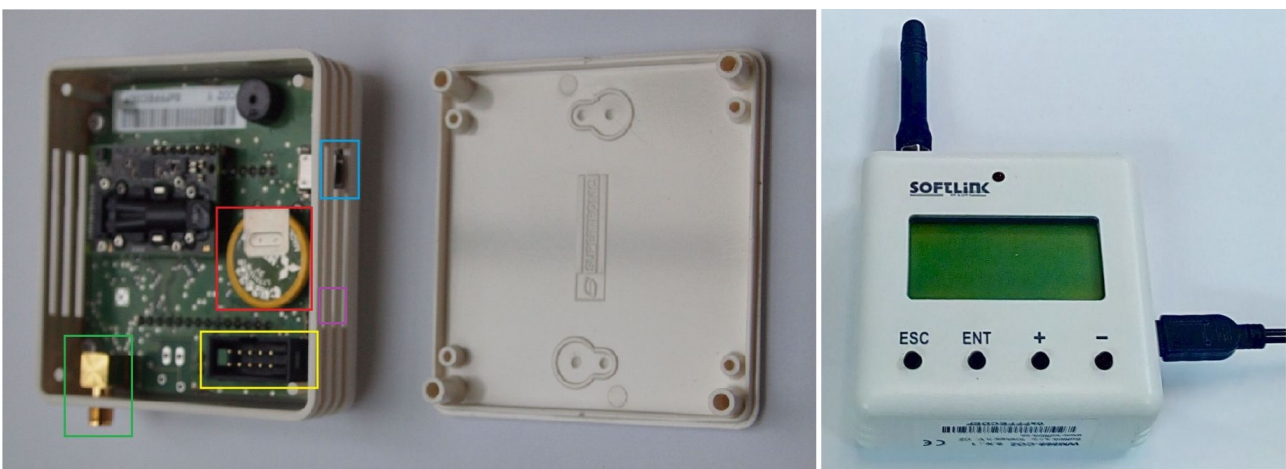


Figure 3: Detailed view of the WS868-CO2 module

When mounting the device follow these instructions:

- remove the cap from the module (by fingers tug, or thin screwdriver...);
- attach the cap to a suitable place on the wall or ceiling by one (\*) or two screws, or by glue. Drill the holes in the cap first, a then drill the matching holes in the wall. Use common screws of adequate size (e.g. 2,5 x 30 mm) and wall plug or rawlplug;
- bring power cable to the module and stick power connector. The connector is of „miniUSB” type and its socket is from the side as seen in the figure 3 (marked by blue colour). The module will start up;
- perform an elementary module diagnostics and alternatively go through the module configuration (setting of parameters) as described in chapter 3 „Module configuration”;
- insert the module base into the cap. When mounting on the wall, the LCD display should be in a correct position;
- if the internal rules or the mounting process needs the antifraud seal to be installed (as the protection from the unwanted influencing), stick the antifraud seal across the joint between the two parts of the box.

*(\*) As the module has a very low weight, it could be attached to the wall/ceiling just by one screw in the middle of the box, or glued by suitable glue (or just by two-sides adhesive tape).*

After the mounting check out the module identification (whether the right device is mounted to right place), its functionality and the correctness of output values (measured temperature should correspond with reality). Check the module measurement function by checking of displayed information and test remote reading function by „end-to-end” method, that means by checking of the readings directly in the central system of remote reading.

When locating installation place, it is necessary to take into account, measurement purpose (spreading CO2 in the room, air flowing...), availability of Sigfox network radio signal, as well as protection of the device against possible mechanical damage.

If the module is used as portable desktop device, place it on the convenient place where it is not influenced by external conditions (\*), stick power connector and plug AC/DC adaptor into the wall socket.

(\*) *When measuring CO<sub>2</sub> concentration, it is recommended to place the module to the top of common desk. It should be as far as possible from persons sitting nearby and out of the main direction of exhaling air.*

**Important note!** *CO<sub>2</sub> sensor function is slightly influenced by direct sunlight. For increasing of measurement precision and accuracy it is advised to place the module to the position with no direct sunlight.*

## 4.7 Module replacement

When there is necessary to replace the WS868-CO<sub>2</sub> module due to the module failure follow this procedure:

- check the antifraud seal before dismantling – the antifraud seal damage must be solved according to the internal rules of the customer/project;
- switch-off the module by pulling out of power cable connector;
- remove the module base from the cup (by fingers tug, or thin screwdriver...). Mark the module as "dismantled" and fill in the relevant documentation, prescribed for this situation by the internal rules;
- open a new module and put the new module to the original (attached) cap (if there is not some reason to change the cap as well);
- switch-on the module by sticking of power connector and perform an elementary module diagnostics (see paragraph 4.9 „Functional check of the module“). Especially check setting of broadcasting period and minimum broadcasting period as described in paragraph 3.1.3, as well as the level of acoustic signaling as described in paragraph 3.1.5;
- write down the unique Sigfox ID and seal number of the module and (if possible) arrange making of all appropriate changes in the database of the remote reading system immediately;
- put together defective module with the leftover cup.

If a defective portable device should be replaced, check whether the device is incorporated in the remote reading system. If so, make appropriate changes also in the remote reading system database.

## 4.8 Module dismantling

When dismantling of fixed installation device, switch the module off, open the module and dismantle the cap from the wall/ceiling. Put the module parts back together (put the cap on the base of the module), mark the module as „dismantled“ and fill in the relevant documentation, prescribed for this situation by the internal rules. If possible, arrange deactivation of the module in the database of remote reading system immediately.

If operation of portable device should be terminated, check whether the device is incorporated in the remote reading system. If so, deactivate the module in the system.

## 4.9 Functional check of the module

After putting the module into operation (or after each repair and replacing of the module) it is recommended to check module basic functionality as follows:

- check module measuring functions by inspection of measured values indicated on the module LCD (see paragraph 3.3);
- check broadcasting functions by checking of correctness and up-to-dateness of data rendered by the module in remote reading system.

## 4.10 Operation of the WS868-CO<sub>2</sub> module

When working in the **automatic reading system** the WS868-CO<sub>2</sub> module performs remote reading of CO concentration and broadcasts measured values fully automatically. The greatest risks of module service breakdown are commonly caused by human activities within the installation site, especially risk of mechanical damage of the module by improper handling around the installation site, or by temporary or permanent shading of the antenna by metal object (e.g. due to building operations). The typical result of the damage is full loss of connection with the module. Relocation or shading of the module (or its antenna) can cause decreasing of radio signal strength with negative influence on the reliability of remote reading, or full interruption of radio connection.

To prevent an unexpected breakdown of the module, it is recommended to perform regular monitoring of its readings. If some of the parameters goes beyond the common steady value, it is recommended to contact the installation site caretaker and ask for the potential cause of the anomaly or perform the physical check on the installation site.

The module can be also used beyond the remote reading system, only for local monitoring of CO<sub>2</sub> concentration. In this case it is necessary to prevent the device (including antenna, power adaptor and cables) from mechanical and electrical damage and regularly check consistency of measured values on the LCD. If there is any doubt about the module functionality, it is recommended either to replace the device or check its functionality by comparing of measured values with data from reference device. For increasing of measurement precision and accuracy it is advised to place the module to the **position with no direct sunlight**.

## 5 Troubleshooting

### 5.1 Possible causes of module failures

If during operation of WS868-CO<sub>2</sub> module some anomaly, malfunctions or other troubles are recognized, the possible causes of the failures can be classified by following categories:

#### 5.1.1 Power supply failures

The module requires power supplying from an external AC/DC adaptor according to the specification in paragraph 2 „Technical parameters overview”. Alternatively, the module can be supplied also from the USB port of computer. This functionality is not guaranteed, so it is necessary to check it for particular computer in advance. Power supplying is signaled by presence of indications on the module LCD display. Malfunction or breakdown of the power supplying will cause a complete breakdown of the device. Correctness of power supplying can be checked by this procedure:

- check if there is no electricity breakdown in the building;
- check, whether the power AC/DC adaptor is plugged in;
- check functionality of power adaptor by replacement for surely functional unit;
- in case of any doubt take the measurement of the voltage.

If the power adaptor is out of order, replace it for functional one. If the power adaptor is properly working with correct voltage but there are no indications on the LCD screen, the module is probably out of order. Perform the replacement of the module according to the instructions in paragraph 4.7 and check functionality of the new module. If the new device works properly, label the original module as „defective” and fill in the appropriate documentation prescribed by internal rules for this case.

#### 5.1.2 System failures

As „system failure” are considered mainly failures of module’s processor, memory, internal supplying or any other failures that cause a complete breakdown of the device. If the device is such status, when there are some figures on the LCD screen, but the values are apparently incorrect, the module does not respond to control buttons, does not respond to any commands through the configuration port, and this status will not change even after module restart (disconnecting and reconnecting of power supply), the system failure probably occur. Perform the replacement of the module according to the instructions in paragraph 4.7 and check functionality of the new module. If the new device works properly, label the original module as „defective” and fill in the appropriate documentation prescribed by internal rules for this case.

#### 5.1.3 Transmitter and receiver failures

If the module is powered by correct voltage, the module communicates through the configuration port, responds to the configuration commands but the radio-messages from the module are still not received steadily, the possible reason of the trouble can be a failure of transmitting or receiving of radio signal. The typical indication of transmitting or receiving failures is state of „partial” functionality with frequent breakdowns in the receiving data from the module.

All above described troubles could have on common ground, which is unreliability of radio-communication caused by one of these reasons:

- weak radio-signal of Sigfox network in installation site. RF signal availability can be influenced by weather conditions (rain, fog..), or by some changes in the transmitting or receiving side (around module installation site as well as around Sigfox base station).
- permanent or occasional shading of radio signal caused by construction works or any construction changes within the premises, or by operation around the installation site (moving of machines, cars, etc.);
- permanent, periodical or occasional interference (jamming) of radio signal from external source (another radio system in the same frequency band, or industrial disturbance);
- low level of transmitting signal caused by transmitter failure;
- low level of receiving signal caused by receiver failure;
- low level of transmitting and receiving signal caused by damage of antenna or antenna cable (if external antenna used).

If above described indications of unreliable radio-communication become evident, proceed with troubleshooting of the malfunctioning in following steps:

- visually check surrounding of the installation site to find out if there are any changes that can influence radio signal (e.g. new objects, things, machines...). If there are such negative circumstances, solve the trouble by reorganization of the object or by relocation of the module or its antenna (if external antenna used);
- visually check an external antenna and antenna cable (if used), possibly replace these elements for the spare ones with proven functionality;
- check correctness of module settings and perform the check of module overall functionality as described in paragraph 4.9;
- replace the module according to the paragraph 4.7 and perform the setting and check of overall functionality of the new module as described in paragraph 4.9 after that;
- if the module is not properly working even after its replacement for proven device and equipment, the trouble can be caused by weak signal of Sigfox network or interference (jamming) from external source in the installation site. In this case consult actual status of Sigfox coverage and its future development with your Sigfox network provider.

#### 5.1.4 Sensor failures

Typical sign of CO2 sensor failure is reading of incorrect CO2 concentration values, that means status, when the data from the module are received regularly, but the values differ from reality or are totally senseless. In this case visually check whether there are any significant changes in the installation circumstances (e.g. relocation of the module, installation/deinstallation of a heater nearby..). If the deviation of the temperature or humidity values has no natural explanation, check correctness of the module identification within the remote reading system (ID confusion possibility). If the module is implemented in the system correctly, then the most probable reason of the trouble is failure of the module CO2 sensor. In this case replace the module according to the paragraph 4.7.

## 5.2 Troubleshooting procedure

To identify a reason of device failure or any anomaly in its operation follow this procedure:

1. The module displays figures on the LCD screen, responds to control buttons, communicates normally (radio messages are coming regularly), but the values of CO2 concentration are apparently incorrect (under certain circumstances, or permanently). In this case it is recommended to check functionality of CO2 sensor as described in the paragraph 5.1.4 „Sensor failures”.
2. The module displays figures on the LCD screen, responds to control buttons, but the data from the module are coming irregularly, with periodical breakdowns. In this case it is recommended to check functionality of the transmitting and receiving of the radio-signal as described in the paragraph 5.1.3 „Transmitter and receiver failures”;
3. The module displays figures on the LCD screen, responds to control buttons, but no data are coming from the device. In this case it is recommended to check functionality of the RF-subsystem and correctness of module identification and implementation within the remote reading system.
4. The module does not display any figures on the LCD screen, does not respond to control buttons and configuration commands, no data are coming from the device. In this case it is recommended to check functionality of the module sub-system in following order:
  - check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures”;
  - check functionality of the system as described in the paragraph 5.1.2 „System failures”;

**NOTE:** The WS868-CO2 modules are reliable devices with relatively simple and resilient construction, so that any possible failure of the device is very likely caused by external circumstances, especially mechanical damage, wrong power supplying, or excessive humidity. After each replacement of the module caused by its failure it is recommended to check the root cause of the failure and take necessary measures to eliminate any persisting troubles.

## 6 Additional information

This manual is focused on description, parameters and configuration options of WS868-CO2 RF-modules, designed for operation in Sigfox IoT network in 868 MHz frequency band, that are a part of the Softlink's **wacoSystem** product family. More information about all WS868 (Sigfox), WM868 (WACO), WB169 (Wireless M-BUS), or NB (NB-IoT) series of modules can be found on the manufacturer website:

[www.wacosystem.com](http://www.wacosystem.com)  
[www.softlink.cz](http://www.softlink.cz)

If interested in any additional information related to application of radio modules of WS868, WM868, WB169, NB series or other manufacturer's equipment for telemetry and remote reading of consumption meters, feel free to contact manufacturer:

**SOFTLINK s.r.o.**, Tomkova 409, 278 01 Kralupy nad Vltavou, Czech Republic  
Phone.: +420 315 707 111, e-mail: [sales@softlink.cz](mailto:sales@softlink.cz), WEB: [www.softlink.cz](http://www.softlink.cz).