WIRELESS COMMUNICATION SYSTEM WACO WM868

WM868-CO2

Revision 1.0

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1 Introduction

This document describes the configuration options of the WM868-CO2 radio module, which is used for measuring the concentration of carbon dioxide (CO2) in the air. The module also indicatively measures relative air humidity. The module displays information about the measured values on an LCD display and simultaneously sends it with a set period to a superior remote monitoring system in the form of WACO system radio messages.

1.1 WACO communication system

WACO (Wireless Automatic Collector) is radio frequency (RF) communication system intended especially for the remote reading of consumption meters (smart metering area), automatic data collection from sensors (telemetry area), and bi-directional data transfer among control, sensing and actuating elements in automatic control systems (industrial automation area). Installed WACO radio-frequency elements create local radio network covering object of interest (flat, house, building, compound...) or required area (street, city...).

WACO RF network has a **„mesh"** type of topology, where in reach of each radio element there could be placed several other network elements that could operate also as repeaters of received signal. In this kind of network there are typically several possible communication paths between the central point and other single elements of the network. WACO network communication protocol was designed to provide a **maximum data transmission reliability and redundancy** with using of multiple communication paths, but at the same time the network is protected against circularity and multiplication of messages by sophisticated algorithms so that the network keeps also a **high performance** even with high number of radio elements working in one network.

WACO communication protocol was designed in compliance with a telecommunication standard **ISO/OSI model** that ensures a high variability of supported applications.

WACO radio-frequency devices (hereinafter „radio modules") are equipped with **various types of input/output interfaces** that enables integration of various connected device (meters, sensors, actors...) into one network.

WACO communication system includes also special communication devices - **WACO GateWays**, that enable receiving of radio messages from the local WACO RF-network and transfer them to the local or remote computer through the serial line or Internet and (in inverse direction) receiving messages from the serial line/Internet and broadcast them into „its" RF-network.

1.2 Module usage

The WM868-CO2 module is primarily intended for measuring CO2 concentration in indoor air in residential and working spaces (apartments, offices, school classrooms, warehouses, production halls...) with a recommended temperature range of $(0 \div 70)$ °C. In addition to the CO2 sensor, the module is equipped with a humidity sensor mounted directly on the printed circuit board. The current CO2 concentration and humidity data are displayed on the module's LCD display, and at the same time, the current measured values are transmitted to the superior remote reading/monitoring system in the form of WACO system radio messages, either on request (via the "Wake-On Radio" system) or automatically at a set time interval. In addition to the current CO2 concentration and humidity data, the messages also contain the module's system time, battery voltage, CO2 sensor temperature, and processor temperature. The message is transmitted with port number "37" (application "SISA_TX") to a general address (broadcast type). The "SISA_TX" application does not require message confirmation.

The transmitted messages are further transferred via the WACO network to **communication gateways** of type WM868-RFU (WACO USB GateWay), WM868-RFE (WACO Ethernet GateWay), or WM868-RFG (WACO GSM GateWay), where they are converted from radio format to serial line communication format (WM868-RFU), or to Ethernet/IP computer network format (WM868-RFE), or to GSM/GPRS network format (WM868-RFG). The messages are sent in the appropriate data format to a local or remote computer, which decodes and processes the messages. The computer must be equipped with a decoding program for working with the WACO radio network protocol (so-called "WACO Driver"). The principle of data transmission from the WM868-CO2 module via the WM868-RFE communication gateway is shown in the upper part of Figure 1.

Alternatively, messages with CO2, temperature, and humidity data can be transmitted to the so-called **"Collecting Unit"** of the WACO system, which collects data from battery-powered wireless modules and sensors of the WACO system, converts the data into standard M-Bus protocol messages, and further transmits them to the bus control unit (device of type "M-Bus Master") in M-Bus format over a physical bus or via a virtual WACO bus. The principle of data transmission from the WM868-CO2 module via the WM868-SJ-MS WACO radio network collection unit is shown in the lower part of Figure 1.

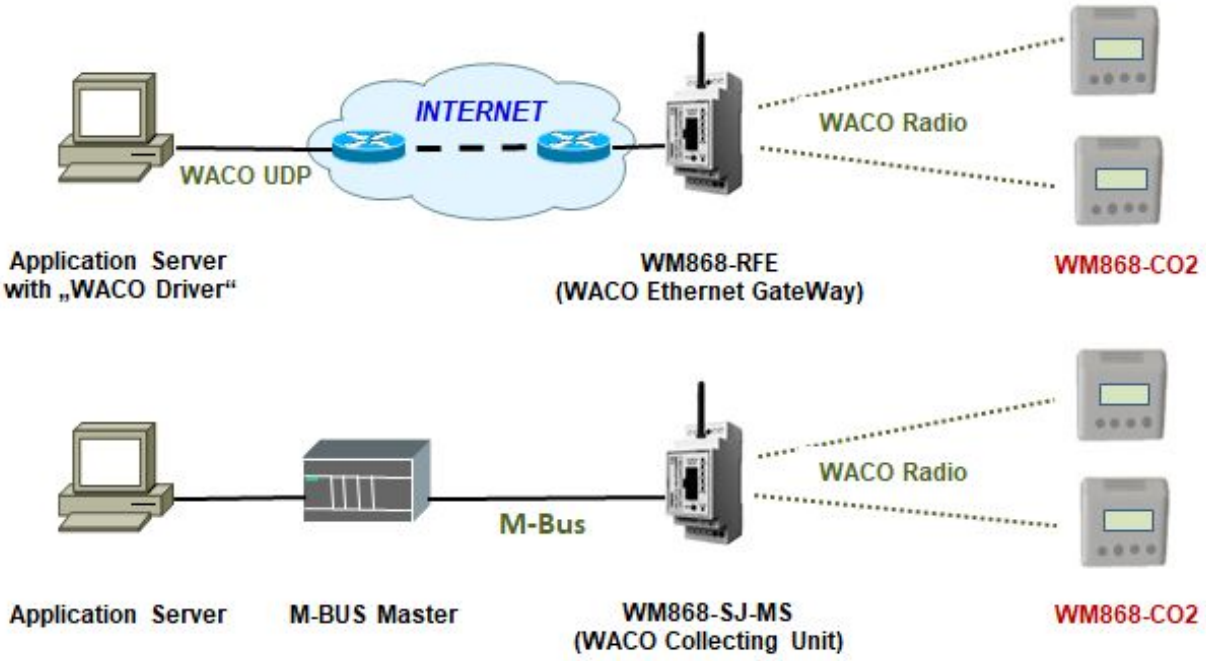


Figure 1: Principle of data transmission from the WM868-CO2 module

1.3 Module features

The WM868-CO2 module is equipped with an **LCD display, control buttons, and sound signaling** for exceeding the set CO2 concentration limit. The LCD display is used to show current air quality data and, together with the control buttons, is also used to set basic module parameters. The description of module control using the LCD display and control buttons is given in section 3.9 "Display and control buttons". Sound signaling is activated when the set CO2 concentration limit is exceeded. All module parameters can be set locally using a configuration cable and also remotely using the radio remote configuration system.

The WM868-CO2 module is enclosed in a plastic case designed for free placement on a table (desktop) or for wall mounting. The module is powered from an external 5V/1000 mA power adapter, which is included in the delivery, or from a computer's USB port via a USB cable with a mini-USB connector (also included). The module is equipped with an internal backup battery that ensures the maintenance of the set real-time even when external power is disconnected.

The module is not suitable for outdoor placement without additional protection.

The appearance of the WM868-CO2 module is shown in Figure 2.

Figure 2: Appearance of the WM868-CO2 module

2 Overview of technical parameters

An overview of the technical parameters of the WM868-CO2 module is given in Table 1.

Table 1: Overview of technical parameters of the WM868-CO2module

Transmitter and receiver parameters		
Frequency band	868.0 to 868.6	MHz
Modulation type	FSK	
Number of channels	3	
Channel width	200	kHz
Transmitting power	10	mW
Receiver sensitivity	106	dBm
Communication protocol	WACO	
Transmission rate	38400	Baud
Antenna connector	SMA female	
Characteristic impedance of antenna input	50	Ω
RS232 configuration interface		
Transmission rate	4800	Baud
Operation mode	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, no parity	
Signal level	TTL/CMOS	
Sensors		
Range of measured CO2 concentrations	(0 ÷ 10 000)	ppm
Accuracy of CO2 concentration measurement	± 3	% (*)
Range of measured humidity	(0 ÷ 100)	%
Accuracy of humidity measurement	± 15	%
Power supply		
External DC source	5	V
Maximum current consumption	100	mA
Parameters of supplied AC/DC adapter	5V/1000mA	(***)
Power cable connector	miniUSB	
Mechanical parameters		
Width	70	mm
Length	70	mm
Height	27	mm
Weight	approx. 150	g
Storage and installation conditions		
Installation environment (according to ČSN 33 2000-3)	normal AA6, AB4, A4	
Operating temperature range	(-10 ÷ 50)	°C
Storage temperature range	(0 ÷ 70)	°C
Relative humidity	95	% (without condensation)
Degree of protection	IP20	

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

(**) for temperature range (0 ÷ 50)°C

(***) the device can also be powered from a computer's USB port

3 Configuration of the module

Configuration parameters of the WM868-CO2 module can be displayed and changed from the common computer (PC) or smartphone by one of these methods:

- with using of **„USB-CMOS"** converter and configuration cable
- wirelessly, with using of **„USB-IRDA"** converter
- wirelessly, with using of radio-frequency communication gateway
- 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 section 3.1 „Configuration of the module with using of the configuration cable". The description and meaning of all configuration parameters that can be checked and changed by cable can be found in the section 3.6 „Setting of WM868-CO2 parameters via configuration cable".

Description of interconnection of the "USB-IRDA" converter with PC and general rules of configuration with using of this **optical converter** are described in the section 3.2 „Configuration of the WM868-CO2 module with using of optical converter". The description and meaning of the parameters that can be changed by optical converter can be found in the section 3.7 „Setting of parameters by using of optical „IRDA" converter".

Description of interconnection of the radio-communication gateway with computer and general rules of configuration **via radio** are described in the section 3.3 „Configuration of the module via radio". The description and meaning of the parameters that can be changed via radio can be found in the section 3.8 „Setting of WM868-CO2 parameters via radio".

Configuration of selected parameters by using of control buttons is described in the paragraph 3.9 „Display unit, control buttons and alarm signalling".

3.1 Configuration of the module with using of the configuration cable

Configuration of the module can be performed by using of any PC with MS Windows or Linux operating systems interconnected by configuration data cable. The module's communication interface is of RS-232 (COM) type with CMOS signal level. The "CONFIG CMOS" configuration connector is placed on the module's printed circuit board.

3.1.1 Connecting of WM868-CO2 module to computer

Configuration can be performed by using of common USB port of the computer. For the interconnection with a USB port of computer it is necessary to use a manufacturer's original configuration cable with „USB-CMOS" converter (see Figure 4). This converter creates a virtual serial port through the USB interface and adapts voltage levels of the module's configuration port to the standard USB port of common PC. So as to be able to create a virtual serial connection via USB interface, there must be a relevant driver installed in the computer operation system. After the „USB-CMOS" converter is connected to computer for the first time, operating system will find and install appropriate generic driver of „USB Serial Device" category automatically. After driver installation is completed, the device will appear in the „Ports (COM and LPT)" section of the „Device Manger" window as „USB Serial Device (COMx)" (see figure 3).

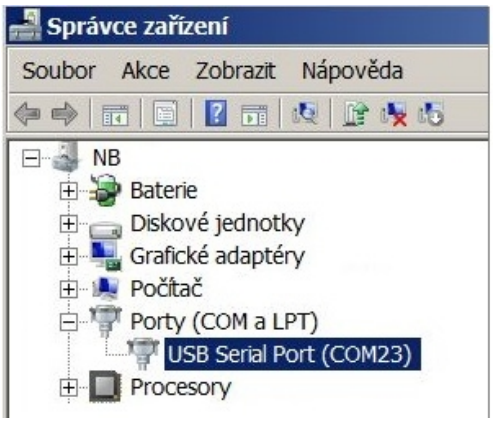


Figure 3: Appearance of the USB-CMOS converter in Windows „Device Manager"

As some of the older MS Windows versions do not support a generic driver for USB serial ports, the automatic

installation of the driver could fail (system reports „Driver software installation failure", or „driver not found"). In this case there is necessary to install the driver manually, following the steps in paragraph 3.4 „Installation of USB-CMOS converter driver".

Insert USB-CMOS converter to the USB port of computer. Open module's casing to enable access to the configuration connector. Connect configuration cable to the „CONFIG CMOS" port on the WM868-CO2 module printed circuit board as depicted in the figure 4 „Configuration via USB port of computer". Thus the computer is connected with the module and ready for performing any changes in configuration.

Figure 4: Configuration via USB port of computer

3.1.2 Using of „PuTTy" freeware program for configuration

The module configuration can be done with using of any suitable program for the serial line communication. The description bellow is relevant for the open-source software „PuTTY" that is available for free on www.putty.org.

„PuTTY" software runs after clicking on the downloaded file „putty.exe". There will open a window of the terminal communication (see Figure 5). For switching the program into the serial line communication, choose „Serial" option of the connection type in the „Session" tab.

Check (or set up) the communication speed („Speed") to 4800 bits/s and then enter into the „Serial line" tab the number of the serial port that the system automatically assigned to the virtual port at the moment of interconnection module to the computer. The number of the serial port can be found in OS Windows by using of „Device Manager" (Control Panel/System and Maintenance/Device manager) by clicking on „Ports (COM a LPT)" where the numbers of ports appear (e.g. „COM23" - see figure 3).

Click on „Open" button in „PuTTY" program and open the terminal window. After pressing of „ENTER" key there will appear a command prompt **„co31w"** which announces that the module is ready to be configured (see figure 6).

3.1.3 General rules for configuration of the module by configuration cable

Activate the terminal window for the configuration via the configuration cable according to the instructions above. These general rules are valid for entering commands in the command line:

- the command must be entered only when a prompt for command appears in front of the cursor mark (colored or flashing little square); the prompt is either „co31w" or „mon" format (see figure 6);
- it is possible to enter only one command each time;

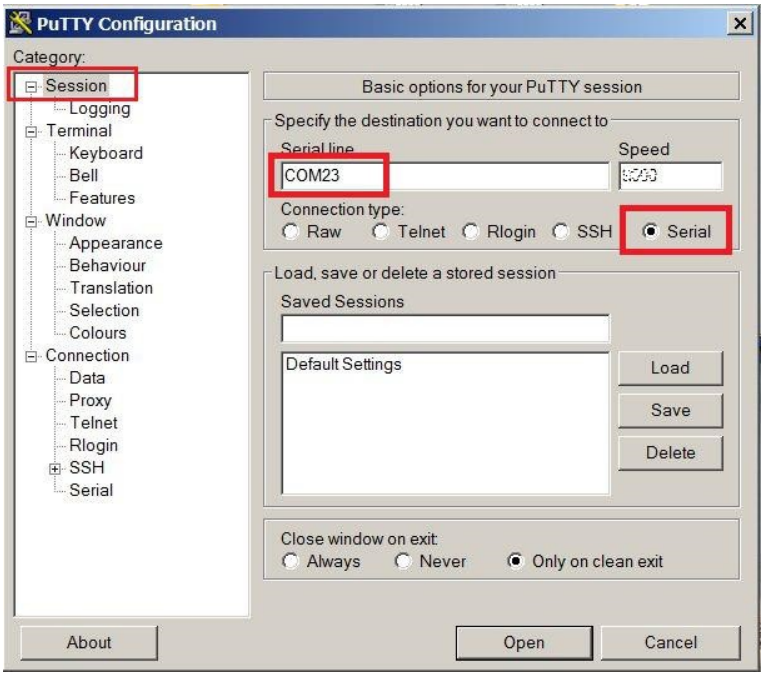


Figure 5: Terminal setting for serial line communication

Figure 6: Open terminal window for module configuration via serial line

- the command could be entered in an alphanumeric character (or several characters);
- the command is sent to device by clicking on „ENTER" key. After the command being carried out, the prompt will appear again and it is ready for a new command to be entered. In case the command fails to execute, there will appear an error report;
- check the execution of the command by displaying of the list of configuration parameters which appears by entering "show" or "/" and pressing on „ENTER" key;
- to display a summary of configuration commands and their parameters („HELP"), enter "?" (question mark), or "/?" and press „ENTER" key;
- when entering characters, distinguish strictly the capital and small letters (according to the documentation or „HELP");
- Do not enter other characters than those listed in „HELP" or in the documentation, otherwise you would be risking the unwanted command enter that might be the same as the ones used for manufacturer settings, diagnostics or service and repair.

3.2 Configuration of the module with using of optical converter

The module is equipped with an InfraRed interface that is intended for configuration with using of **„USB-IRDA"** converter. This converter serves for wireless transfer of configuration data (commands and values) between module and configuration computer via modulated beam of light in infrared band. By using of this kind of configuration there is possible to make all common settings through the transparent casing without necessity to open the module's cover (see figure 7). Optical beam goes through the transparent casing and it is decoded by the infrared modem placed on the module's printed board (PCB). A special software application program **„WACO OptoConf"** written in Java language can be used for required settings. This program can be installed to the computers with MS Windows as well as Linux operating systems.

Figure 7: Configuration of the module with using of optical converter

3.2.1 Installation of the „WACO OptoConf" program

Installation of the **„WACO OptoConf"** program can be performed from the „Optoconf.zip" installation pack. Copy the pack to any folder of the computer and unpack it by any "unzip" program. The installation pack contains following files:

- „optoconf.jar" - executable file of the program
- „lib" - folder with „library" files
- „README.TXT" - "readme" file
- „SetupJSerial.msi" - serial port support for Java (installer)
- „ugw3.inf" - driver for USB-IRDA converter

The „WACO OptoConf" program can be started each time by launching of „optoconf.jar" file (clicking on the file name or to the created desktop shortcut to this file).

Check whether the "Java Runtime Environment" (Java Virtual Machine) program in the 8 or higher version is pre-installed in the computer. If after launching of the „optoconf.jar" file a Java-window of the configuration program does not open (or pop-up window „How do you want to open this file?" appears) then the Java support it is not installed (or installed in older version) and it is necessary to perform its installation (32-bit version for Windows, 64-bit version for Linux). The Java Runtime Environment program is available on the official Oracle WEB site for Java support here:

Download Free Java Software

After installation of the Java Runtime Environment install the driver for a serial interface support in Java environment by clicking to **„SetupJSerial.msi"** file. The installer of driver starts running. The installation is very simple - it only requires confirmation of necessary changes in computer configuration („Do you want to allow this app to make changes to your PC?"). After the driver is installed try to start „WACO OptoConf" program again and if everything is all right the program window will be opened. Close the program window.

3.2.2 Connection of „USB-IRDA" optical converter to computer

Before starting of the **„WACO OptoConf"** program connect the **„USB-IRDA"** converter to USB port of the computer. When the converter is connected to computer for the first time an operating system will automatically find and install correct driver for the converter (i.e. generic driver for „USB Serial Device" category of device).

After driver is successfully installed to MS Windows computer, the device should appear in the „Device Manager" in section „Ports (COM and LPT)" as „USB Serial Device (COMx)" (see figure 8).

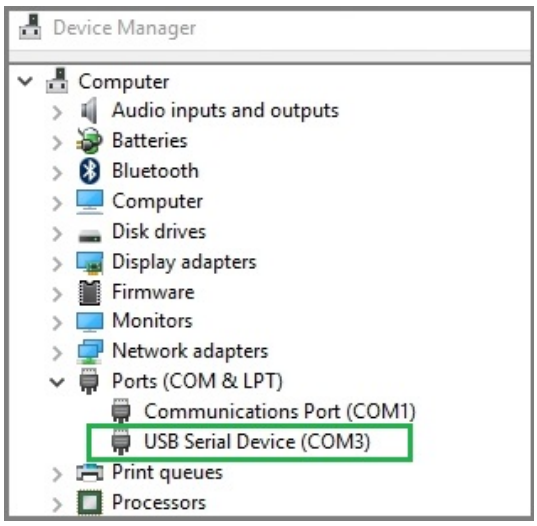


Figure 8: Displaying of the optical converter in the Windows' „Device Manager"

Older versions of MS Windows do not support generic driver for support of serial ports via USB. I this case install the „ugw3.inf" driver from delivered installation pack according to the instructions mentioned in the paragraph 3.5 „USB GateWay" and „USB-IRDA" driver installation" below.

3.2.3 Using of „WACO OptoConf" program for configuration of modules

Start the **„WACO OptoConf"** program by clicking on the **„optoconf.jar"** file name or to the pre-created desktop shortcut to this file. Program window **„WACO configuration"** will open (see figure 9). In **Config/Port** item of menu choose name of serial port assigned to USB-IRDA converter by operating system (see figure 8). The program is thus fully functional and ready for configuring parameters. Menu item **„Config/Look and Feel"** serves only for choice of window color and design by clicking to one of pre-configured options.

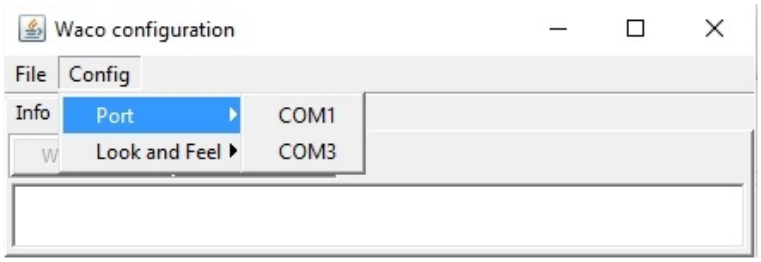


Figure 9: Displaying of „WACO OptoConf" configuration window"

By clicking to **„Walk device"** button the list of all variables that are used for module configuration can be displayed (see figure 10.

Index and description of all variables of the NEP protocol, that is used for coding of data in Softlink's „wacoSystem" communication systems can be found on the producer's WEB site NEP Page.

By clicking to **„Read device"** button the textbfconfiguration table with all the relevant parameters of the module is displayed in the working window. Non-configurable (read only) parameters are displayed as "inactive" (with gray editing fields), while parameters that can be changed by „WACO OptoConf" program are displayed inside white editing fields ("active fields"). Example of configuration table of the module is depicted in the figure 11.

3.2.4 General rules for configuration of the module by optical converter

Connect **USB-IRDA** optical converter to the USB port of the computer. Flashing of green LED signalizes correct function of the converter. By clicking to „optoconf.jar" file (or its shortcut) launch **„WACO OptoConf"** program. If not chosen automatically by previous functioning, choose the name of serial port of the converter („COM XY") in the „Config/port" menu.

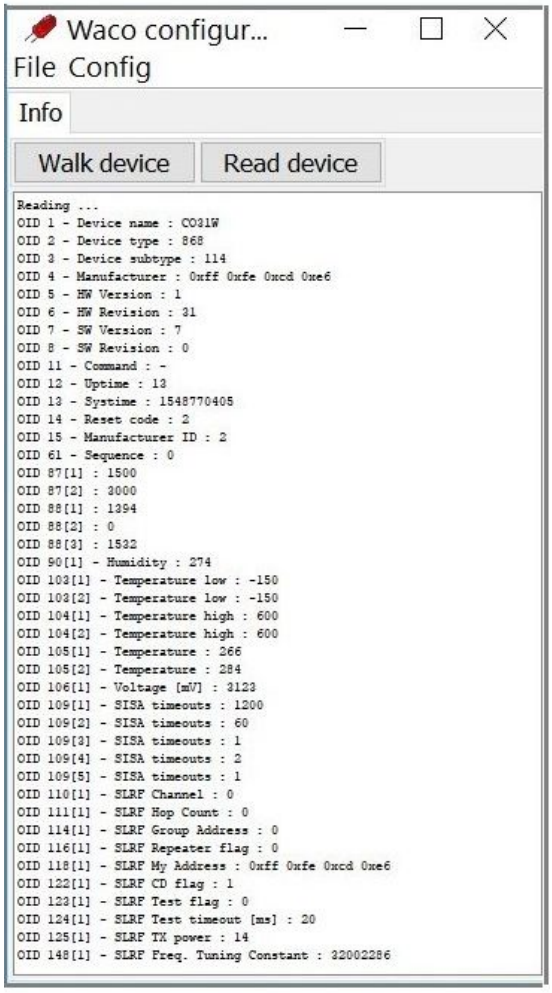


Figure 10: List of variables in the working window of „WACO OptoConf" program

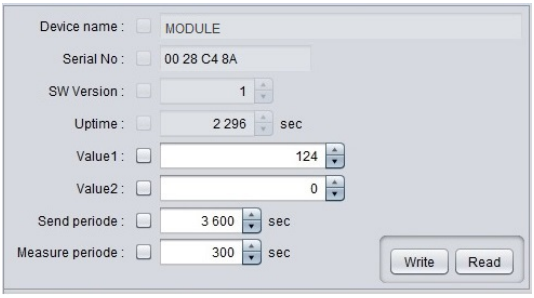


Figure 11: Example of module's configuration table in the „WACO OptoConf" window

Configuration can be performed either on the working desk or directly in the installation site. In both cases it must be arranged such mutual position of the module and optical converter in which the configured module is not more than 15 cm from the tip of converter, module's printed board is facing to converter by its element side and module's optical sensor lies approximately in the converter's axis of symmetry (i.e. in the direction of the infrared beam). Approximate position of the optical sensor of the module is marked in the figure 2 by green arrow. Correctness of mutual position module/converter can be checked by displaying of the current configuration as described below. It is necessary to fix and keep such position in which the communication between module and converter is stable and reliable. Do not move with neither computer nor module during configuration. If current modification of the module is equipped with magnetic attachment for the USB-IRDA converter, it is very easy to use a special modification of converter („MAGNETIC") equipped with circular magnet. In this case just simply put the converter to the circular crater-shaped pit on the module where it is kept by power of magnet, and use USB extension cable.

By clicking to **„Read device"** open a configuration table with all the relevant parameters of the module. Parameters that can be changed are displayed in white colored editing fields. There are four types of editing fields:

- text fields, in which a text can be edited (e.g. "Info-text" field)

- numeric fields, in which a change of number can be done
- selection fields, in which a choice from pre-set options can be done
- hexadecimal fields (marked by "hex"), in which hexadecimal characters can be entered

Text fields can be changed by correcting, erasing, or rewriting of the text inside the field.

Numeric fields can be changed by rewriting number inside the field or by its increasing/decreasing with using of arrows $\triangle$ a $\triangledown$.

Selection fields can be changed by clicking to symbol ∇ and choosing required option from the list-box.

Hexadecimal number fields (e.g. "8B 01") can be changed by clicking on the character and rewriting its value to another hexadecimal character (0 to F).

For editing of individual items keep following rules:

- after making any change in editing field there appears symbol "$\surd$" before the field that is an indication of active change request that will be sent to the module;
- by clicking to **„Write"** button in the lower part of the configuration table the program sends configuration commands through the USB-IRDA converter. During the process of establishing connection converter's LED light stops flashing for approximately 2 seconds and then lights-up;
- after sending data to module the program automatically requests a new status of configuration. Displaying of the new current status of configuration parameters (after requested changes) is signalized by disappearance of symbol "$\surd$" before editing field;
- if requested change of some parameter is out of its range, the change is not accomplished and after disappearance of symbol "$\surd$" there appears an original value in the editing field;
- the program enables making multiple configuration changes at one time. If there are changes in several editing fields of the table, each of them is marked by symbol "$\surd$" and after clicking to „Write" button all the changes are requested/performed;
- if some of the fields was edited unintentionally (by mistake) and the change of this field is not really requested, by clicking to symbol "$\surd$" the field can be „unchecked" and the change request of the parameter is not sent to module;
- current status of all configuration parameters of the module can be requested anytime by clicking to **„Read"** button in lower part of the table;
- ongoing communication between module and USB-IRDA converter may be signaled by flashing of LED on the device;
- if the connection between USB-IRDA and the module was not established until several seconds, error window "Error: Read timeout" will appear in the program window;
- the most common reason of connection failure is either bad position of the module (long distance, wrong orientation, dirty cover, obstacle in the beam), or the module's battery was switched off.

NOTE! „WACO OptoConf" program contains specific data and settings for interworking with certain types of modules. Each version of the program thus supports only the relevant versions of the wacoSystem modules (i.e. actual versions of the modules up to date of the software release). If after reading of data from the module the error window "Error: Unknown device" will appear, the current version of the program does not support configuration of this version of the module. In this case it is necessary to download a new version of the „WACO OptoConf" program from the product WEB site www.wacosystem.com/podpora, or contact manufacturer's technical support by e-mail: support@softlink.cz.

3.3 Configuration of the module via radio

Remote configuration via radio signal is proceeded via special WACO radio messages (queries and commands) that will query the module to get current settings of its individual parameters, or (in case of need) will send a command to change these parameters.

It is possible to configure the module locally from the convenient spot within module radio range (for example from PC with connected gateway WM868-RFU - see figure 12), or to configure the module remotely from a remote computer via local gateway WM868-RFE (WACO Ethernet Gateway) or WM868-RFG (WACO GSM Gateway) as depicted in the figure 13.

In both cases there must be direct radio visibility between the configured module and the communication gateway – it is totally **impossible to configure the WM868-SI2/SI2-H modules via repeater**.

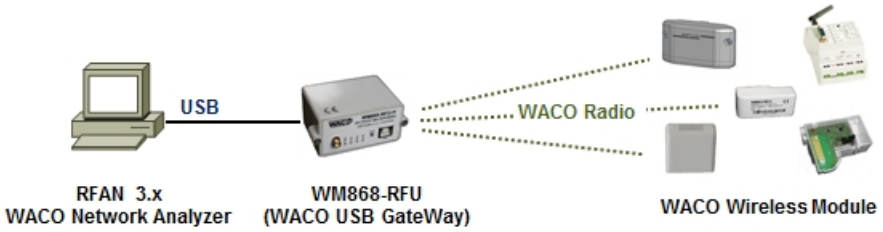


Figure 12: Principle of local configuration via radio

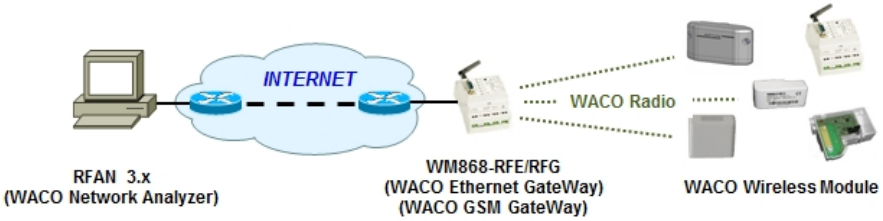


Figure 13: Principle of remote configuration via radio

3.3.1 Using of „RFAN 3.x" program for the module configuration via radio

The universal tool for the configuration of WACO family modules is „WACO Radiofrequency Analyzer RFAN 3.x" (hereinafter „analyzer") that can be used for setting up of all remotely configurable parameters of the module. Analyzer is a computer program written in Java language, which can be installed to any common PC (desktop, laptop, tablet...) with operating system with Java Virtual Machine support. Functionality of RFAN 3.x analyzer is described in detail in the „WACO RFAN 3.x – Software description and configuration" manual, where there are also described in details the steps how to find out current setting of a particular parameter and how to change the setting.

Purpose and importance of all configuration parameters is described in the next part of the document. Overview of all parameters that can be configured via radio can be found in the section 3.8 „Setting of module parameters via radio". General principles and technique of radio configuration are described in details in section 3.3.3 „General rules of configuration via radio".

3.3.2 Connection of WACO communication GateWay to computer

WACO Communication Gateway is the device intended for communication among a WACO supported software application (e.g. RFAN 3.x) and all subordinate elements of WACO wireless network. The GateWay can be connected to the computer with the RFAN 3.x application directly (through a convenient port of PC) or indirectly through the IP network. „WACO USB GateWay" (with USB support) as well as „WACO Ethernet GateWay" (with etrhernet support) can be connected directly, while „WACO Ethernet GateWay", and „WACO GSM GateWay" can be connected indirectly, what means that the GateWay is not connected to the computer with analyzer, but it is connected to the remote Ethernet/IP port of the IP-network (Internet) anywhere over the world provided that there is an IP-connection between the computer and the GateWay (see figure 13).

Connect WM868-RFU (WACO USB GateWay) to the USB port of computer with RFAN 3.x program. The module is powered from the USB port of computer, so it automatically goes „on" and three virtual serial ports are activated: one for data connection, one for configuration and one for possible firmware upgrade. The device appears in the „Other devices" section of the „Device manager" window and its virtual serial ports appear in the „Ports (COM and LPT)" section as depicted in the figure 14.

If there is no appropriate driver with support of multiple virtual serial ports over USB installed in the computer, it is not possible to select serial port in RFAN 3.x setting (no serial port is available for choice). In this case the virtual serial ports appear in the „Other devices" section of „Device Manager" and it is necessary to install appropriate driver according to the instructions stated in part 3.5"„USB GateWay and USB-IRDA driver installation".

3.3.3 General rules for configuration via radio

RFAN 3.x Analyzer enables remote configuration of WACO radio devices. This function is accessible in folder „Remote Config". The principles of the configuration tools are following:

- select the device to be configured (or read current configuration)

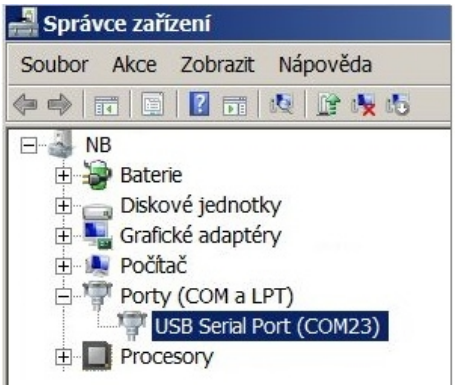


Figure 14: Appearance of WACO USB GateWay in the MS Windows „Device Manager"

- select variable that should be changed (or read)
- launch function „GET" for reading current value, or „SET" for changing of value or „WALK" for reading of all values

When performing of configuration (i. e. making changes or just reading of current settings) keep these general rules:

1. the configuration cannot be made in bulk, there must be always only one device chosen that will be configured;
2. each single variable is set up/queried by a single command/query;
3. there is a possibility to define more configured/queried variables within the tool and run their configuration/query by one click as a sequence, nevertheless, the configuration/querying of each variable is processed individually, one after another, in the order in which the sequence was set up;
4. in case the „WALK" command for querying the current status of all module's variables is used, the analyzer starts dispatching queries that will ask the individual variables step by step;
5. when a „SET" command was sent to device, the device will proceed the command (or not – see rule 6. and 7.) and turns back a value that is really valid after the command execution;
6. if a „SET" command was sent to a variable, that is of „Read Only" character (for example type of the device, or serial number), then the device will not process the command and turns back current value of the variable;
7. if a „SET" command contains such value that is out of the defined range of values of the variable, or that has no sense, then the device either not process the command or change the variable to closest possible value. In any case, the device will send back the value which is really set after proceeding the command;
8. if a „GET"/„SET" command contains variable that is not implemented in the particular device (the device „doesn't recognize" the variable), then the device turns back „null" value which appears in the analyzer as not accomplished command/query.

3.3.4 Remote configuration with using of RFAN 3.x Analyzer in steps

The configuration could be performed in „Remote configuration" mode (fold „Remote Config"). Add the device that should be configured into the left section of the screen by using of „Add RF Address" option of the section context menu (displayed by right-click). The new „Add RF Address" window (form) will open, where there it is necessary to fill in:

- fill device RF address in hexadecimal format marked „0x" (for example „0xffffef6d")
- tick the „Wake On Radio" option for battery powered modules
- write any description into the „Description" field for better module recognition
- by clicking to „Add" button add the device into the configuration list.

Entering of a device into the „RF Address" window is depicted in the left part of the figure 15.

Create the sequence of variables that should be configured (query or set) by clicking on „Add Variable" option in the right section context menu. The new „Add Variable" window (form) will open, where there it is necessary to edit following fields:

- into OID field (Object ID) select a name of variable that should be added in the sequence
- in case the variable has an index, put the index number in (information box „Has Index" is ticked and „Index" box is editable);
- set up required value of the variable into the „Value" field. If the variable will be just read (checked its current value), leave the field blank. Those variables, that have „Read only" status (invariable constants, measured values) will have the „Value" box uneditable;

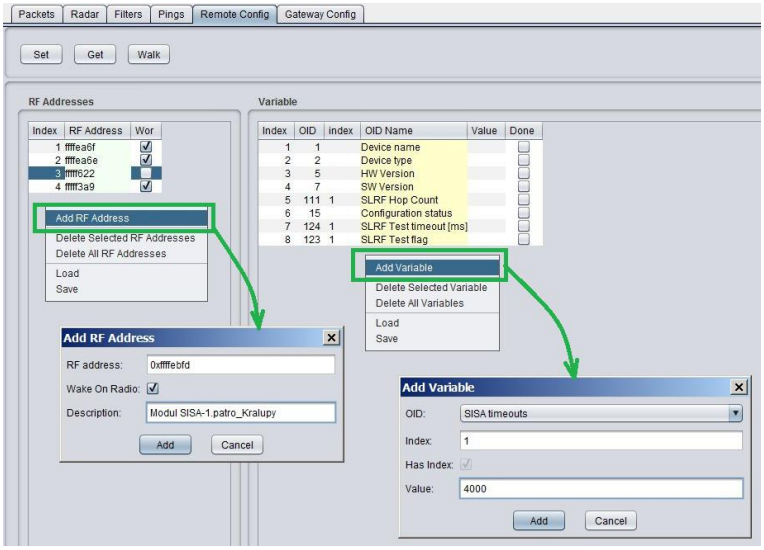


Figure 15: Entering of devices and variables into the remote configuration window

- by clicking on „Add“ button add a variable to the sequence of variables used for configuration.

Entering of a variable into the „Variables” window is depicted in the right part of the figure 15.

Command **GET** (reading the current variable value), **SET** (setting up the required variable value), or **WALK** (reading the current status of all variables) will be done only for one chosen device from the list of devices in **„RF Address“** tab. Run the required command by clicking on relevant button in the top of the screen. After the click, there will appear an information window in which a progress of getting/setting process of will be displayed. As the individual settings are performed, the „tick” symbols in the „Done” box appear item-by-item. The „Getting/Setting” window will disappear after the all commands of the sequence are being accomplished, or after the expiration of the preset time limit (TimeOut). The current variable values are listed in the field „Value” in the relevant row.

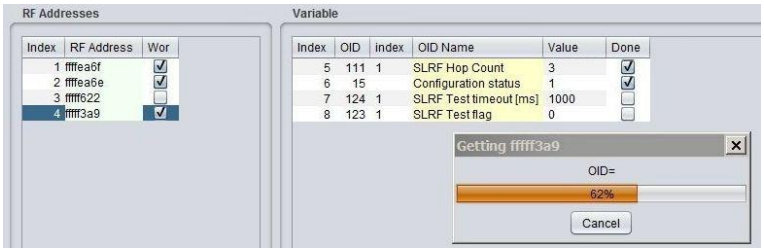


Figure 16: Progress of getting values of preselected variables of the module by using of „GET” command

To avoid serious mistakes that can bring the module into paralyzed condition, numb for further communication, it is necessary to know the meaning of all modified variables of the device, including their mutual relations.

Example: *If value of „SLRF Test Flag” variable is set to ”1”, the module will be preset to send test messages in period which is set up by variable „SLRF Test Timeout [ms]”. In this case the period is just 1 millisecond. The trouble will occur if the test broadcasting would be switch on. It is necessary to set some reasonable period (e.g. 5 second) first and just then switch test broadcasting ”on”, otherwise the module would broadcast permanently and never be able to receive any other command.*

When configuring battery powered modules, always use the „Wake-On-Radio” (WOR) function. The function enables to „wake up” the module with a special „waking” radio signal from „hibernation” mode (that means the mode in which the module is almost permanently) to the mode of active signal reception. Keep in mind that by „waking up” of the particular required module the other modules, that are placed within the GateWay current radio range, will also be activated. Excessive activating of the module can cause the reduction of its battery life. To avoid the excessive „waking” of many modules around the GateWay it is recommended to follow these instructions:

- do not change the parameters if it is not necessary for the module’s functionality; - consider the succession of the configuration commands (or prepare them as a „template”); - do not use command „WALK” if not necessary - (reading of all module variables); - find suitable place for the configuration, that is in a good reach of configured device.

We also recommend keeping the modules in closed boxes, shielded with aluminum foil (or in metal boxes) so the

modules are protected from the excessive „waking up" and their batteries won't be damaged. When you do the preliminary configuration before mounting, always take out from the shielded box only the necessary number of modules. After their configuration, the modules should be placed back in the shielded box.

3.4 USB-CMOS converter driver installation

If the computer operation system failed in automatic installing of the driver for the „USB-CMOS", it is necessary to install the driver manually. The relevant current driver can be found on a chip manufacturer's (FTDI) webpages, namely in the „VCP Drivers" (Virtual COM Ports) section.

www.ftdichip.com/Drivers/VCP.htm

In the „Currently Supported VCP Drivers" table find a link to a driver relevant to your operating system. To download the file, click on a link in the table. After downloading the file (in .ZIP format) into any directory in your computer, unzip the file. It will create a new folder (directory) with a set of files (e.g. „CDM 2.08.24 WHQL Certified").

Connect the converter „USB-CMOS" to your computer and open a „Device Manager" tool. The converter with the disabled driver will be displayed in the top right corner of the window as „Other Devices" (see figure 18 left).

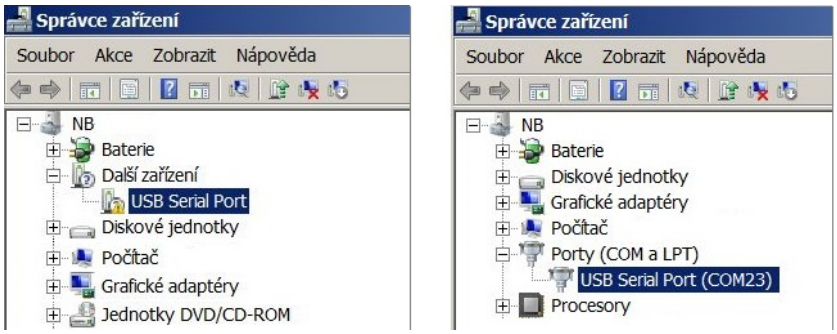


Figure 17: Appearance of converter without driver in the Windows „Device Manager" table

Click by right mouse button on „USB Serial Port" and choose „Update Driver Software" option in the context menu. Choose „Find Driver in this computer" option in the „Update Driver Software" window. Use „Browse" button to set up the path to the driver's folder (directory) and then click on the „Next" button. The driver installation process will launch. After the driver installation is completed, the standard „Installation Completed" message will appear. After the installation the converter will appear in the „Ports (COM and LPT)" section of the „Device Manager" window (see figure 18 right).

3.5 „USB GateWay" and „USB-IRDA" driver installation

The driver „ugw3.inf" intended for support of multiple virtual serial ports through the USB interface of a computer is a part of delivered installation pack. If your version of MS Windows operating system failed in automatic installation of a driver for connected „USB GateWay" or „USB-IRDA" device, make an installation of „ugw3.inf" driver manually.

Connect the device to computer and open a window of „Device Manager" tool. The device appears in the „Other device" section in upper part of the window as „USB Serial port" device (see figure 18 left).

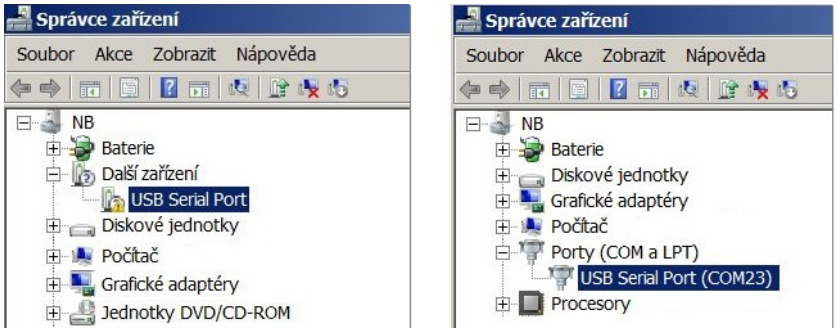


Figure 18: Displaying of the device without driver in "Device Manager" window

By right-clicking to „USB Serial port" open the context menu and choose „Update driver software" item. Click on „Find driver in this computer" in the opened window. Click to „Select driver from the list" and „Next" in next window. After a new „Select device type from the following list" window appears, select „Ports (CPM & LPT)" in the window and click to „Next" button (see figure 19 left). Choose „From disc" in the next „Choose driver which you want to install" window (figure 19 right).

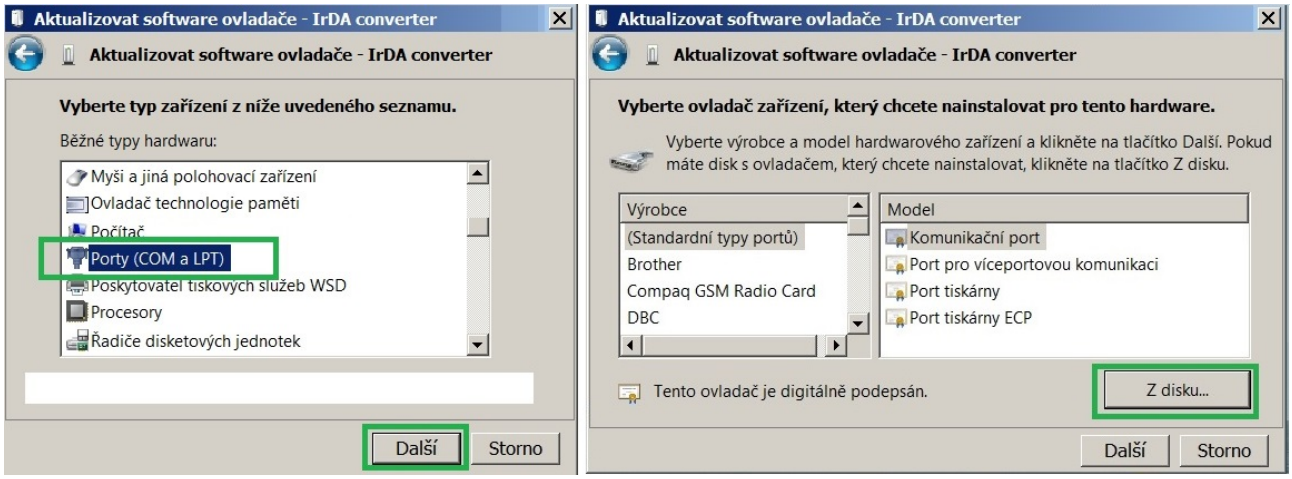


Figure 19: Manual selection of the driver file from a folder

After that a new „Find file" window appears. Set the folder with driver file in the „Browse" tool, select „ugw3.inf" file name that will appear in the window and click to „Open" button (see figure 20 left). A new „Choose driver to be installed for the hardware" window will appear, select „RFU Gateway Serial port" item and click to „Next" button (see figure 20 right).

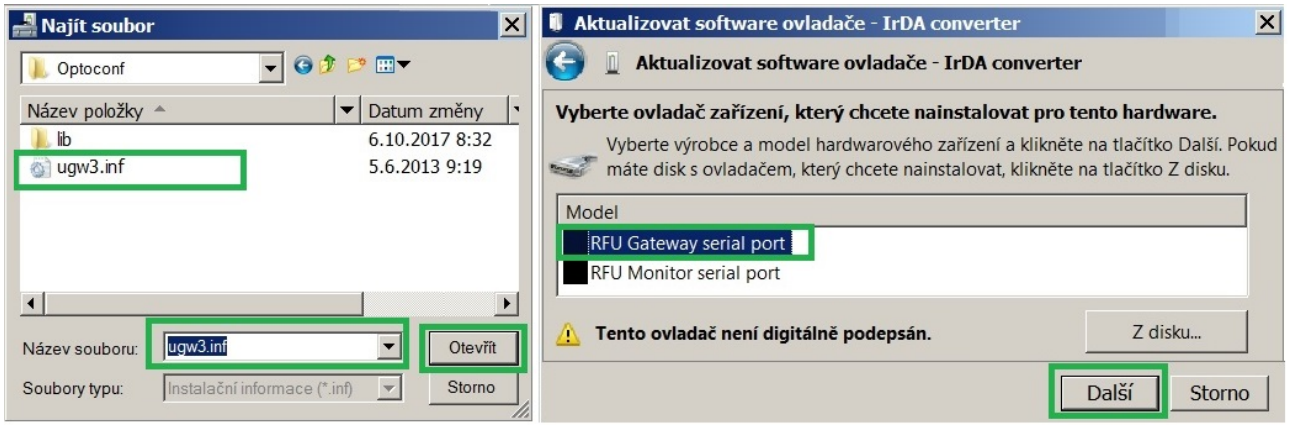


Figure 20: USB driver installation

A new „Driver software installation" window will appear with standard red „unknown driver producer" Windows system warning. Click to „Install the software anyway" option and the installation process will launch (*). After the process is completed the system shows positive message „The driver was successfully installed" (or similar). The device will move to the „Ports (COM & LPT)" section of the „Device Manager" window (see figure 18 right).

(*) If installing the driver into the Windows 8 or Windows 10 OS computer, it could be a security problem with the installation because the driver doesn't have a digital signature („unsigned driver"). In this case follow the instructions below.

3.5.1 How to disable driver signature enforcement in Windows 8 system

Enforcement of signed driver installation in Windows 8 can be disabled by following procedure:

- by pressing the „Windows + R" keys open the „Run" window;
- write a restart command "shutdown.exe /r /o /f /t 00" into the „Open" editable field;
- choose „Troubleshoot" option in the „Choose an option" window that will pop-up;
- choose „Advanced options" in opened „Troubleshoot" window;

- choose „Windows Startup Settings" in opened „Advanced options" window and run „Restart";
- during the system restart process a window „Advanced Boot Options" appears, choose „Disable Driver Signature Enforcement" option in this window;
- after launching the system install the driver according the above mentioned instructions.

Deactivation of the enforcement of signed driver function of the Windows 8 operating system is functional only until the next restart of the system.

3.5.2 How to disable driver signature enforcement in Windows 10 system

Enforcement of signed driver installation in Windows 10 can be switched-off by following procedure:

- click to „Windows" icon in left the bottom left corner of the screen and choose „Settings" icon;
- select „Update and security" in „Settings" window;
- select „Recovery" in next window';
- select „Advanced startup" section in „Recovery" window and click to „Restart" button in the section;
- in a few seconds the new „Choose an option" screen appears; select „Troubleshoot" option;
- in next steps select „Advanced options" and „Startup repair" options and click to „Restart" button;
- in this step an instruction for entering of „BitLocker" recovery key could appear (depends on the system settings). This is a 64-character access key for data section of the user that can be used in case of loss of OS Windows password. The key can be found in the „Microsoft Account Settings" page, that can be displayed by clicking to „Windows" icon and „User" item of main Windows menu. To get to the account it is necessary to click to „Change account setting" and „Manage my Microsoft account" and log into the account by using of Microsoft user login/password. Select „Device" in main menu of the user account page and click to „Obtain BitLocker recovery key" in „Desktop" section and „Bitlocker" subsection. The new screen with recovery keys will open. Copy down the key that is valid for the required unit (according to the required unit identifier);
- after entering of the key the new screen with startup options will appear, select „Disable Driver Signature Enforcement" option from the list. The selection can be done with using of F1 - F10 keys, for selected option with order number „7" press key „F7";
- after OS Windows restart perform the driver installation according to the above described procedure.

Deactivation of the enforcement of signed driver function of the Windows 10 operating system is functional only until the next restart of the system.

3.5.3 Support of older OS Windows versions and OS Linux support

Earlier MS Windows versions (Vista, Windows XP and older ones) do not support sufficiently the installation of multiple virtual serial ports onto one physical USB port and the current versions of „USB GateWay" and „USB-IRDA" devices cannot be connected to the computers with these operating systems.

There is no need to install any drivers with serial port support to the computer with Linux OS as the Linux system will automatically use its own generic drivers.

3.6 Setting parameters of the WM868-CO2 module using a configuration cable

The following part of the manual describes those parameters of the WM868-CO2 module whose current value can be determined by directly connecting the module to a PC using a configuration cable and possibly changed using configuration commands (configuration "from the command line") as described in section 3.1 of this document.

3.6.1 Listing of configuration parameters and commands of the WM868-CO2 module

The configuration parameters can be displayed by entering the command **"/"** (forward slash) into the command line and pressing the "ENTER" key.

The following output will appear in the terminal window:

```
co31w>/
CONFIGURATION: OK
RF Address: 0xfffecde6
hop count: 0
group: 0
SLRF flags:
test timeout: 20
channel: 0
TX Power: 14
RF Driver flags: C
RX timeout: 1
SISA master: 0x010000fe
Sending time: 120
Repeat: 1
Repeat timeout: 2
ADC sampling: 60
Crypt Keys for:
Run test: 0
Debug level: 0
CO2 alarm threshold: 1480
co31w>
```

An overview of the configuration parameters with a brief description of their meaning is given in Table 2 on page 34.

A summary of configuration commands ("HELP") and their parameters can be displayed by entering the command **"/?"** into the command line and pressing the "ENTER" key.

The following output will appear in the terminal window:

```
co31w>/?
/W - write configuration
/# - erase configuration
/x - RESET
/@@@ RF address - (in hexadecimal)
/h number - hop count (0-15)
/g number - group address (0-65535)
/f[+-] flags - e-extender, Z-AZRA algorithm
/T number - test timeout (in 1/20 sec.)
/c number - channel
/P number - TX power in dBm
/F[+-] flags - C-CD detect, R-RX only, W-WOR active, G-high gain
/X time - RX timeout (50ms)
/!!! (f freq_in_khz | freq_const)
/m RF_address - master address
/s number - sending time in sec.
/R number - # of attempts to deliver data
/A number - repeat timeout in 50 ms steps
/a number - sampling timeout in sec.
/K port d - delete key
 port key- add/change key

/E number - run test
/w - send empty WOR packet
/D number - debug level
/C number - set CO2 threshold (default 1500)
co31w>
```

The procedure for setting individual parameters and a more detailed explanation of their meaning is described in the following parts of section 3.6.

3.6.2 „Configuration" group of commands for writing of configuration and reset

The module contains two sets of configuration: 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 the 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:

```
co31w>/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:

```
co31w>#
```

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:

```
co31w>/x
```

After entering the command the module goes to software restart.

Change of some configuration parameters has an effect only after module reset (e.g. retuning of module radio by changing of „SLRF Channel" parameter). In this case it is recommended to create a configuration sequence containing commands for change of parameter, saving the change to Flash, as well as command for performing of module reset (..and exactly in this order).

3.6.3 Commands for settings of radio-frequency subsystem

This group of commands enables setting of transmitting, receiving, repeating and addressing system. There are following commands:

/c number	*frequency channel setting (SLRF Channel)*
/h count	*maximum number of re-transmissions (SLRF Hop Count)*
/f[+-] flags	*repeating mode setting (SLRF flags)*
/F[+-] flags	*transceiver mode setting (RF Driver flags)*
/g group	*setting of group address (SLRF Group Address)*

Names of parameters that are configured by individual commands are stated in the brackets.

The **„SLRF Channel"** parameter is a number of module frequency channel. RF modules of WACO communication system can be tuned to any of three separate frequency channels that don't influence each other.

Frequency channel of the module can be set by **"/c [number]"** command, where value 0, 1, or 2 means number of frequency channel to be tuned. Change of frequency channel is effective only after module reset. Example of sequence of commands for module setting to the frequency channel "1":

```
co31w>/c 1
co31w>/W
co31w>/x
```

The **„SLRF Hop Count"** parameter is a maximum number of re-transmissions of the messages, broadcasted by the module. If, as an example, the parameter is set to value "3", each message originated by the module will be discarded after three re-transmissions (it is repeated no more than 3 times). This mechanism prevents the system from uncontrolled circulation of the message within the network. It is recommended to set the parameter to "n" or n+1" value, where "n" is the least number of re-transmissions which is necessary to get the massage to its destination. If the „SLRF Hop Count" value is too low, the message is discarded before reaching of its destination. If the „SLRF Hop Count" value is too high, capacity of the network is loaded by useless repeating of the messages.

The „SLRF Hop Count" parameter can be set by **"/h [number]"** command, where the value from 0 - 15 interval means the maximum number of re-transmissions ("hops") of the messages, broadcasted by the module. Example of command for setting of „SLRF Hop Count" parameter to value of 3 "hops":

```
co31w>/h 3
```

The **„SLRF Repeater flags"** parameter is intended for setting of repeating (re-transmission) mode. Repeating mode can be set by using of **"/f[+-] [flags]"** command, where the required mode is chosen by entering of one of following pre-defined symbols („flags"):

- value **" "** (without flag) - none of below mentioned functions is involved
- value **"e"** - setting of basic repeating mode (without back transfer suppression)
- value **"Z"** - setting of advanced repeating mode with back transfer suppression (AZRA)

During normal operation the WM868-CO2 module stays mostly in „hibernated" state and it is switched to active receiving/transmitting state only for the very short time interval, when the message is transmitted. For that reason the possibility of repeating messages from other modules is so limited, that it is practically unusable. It is recommended to leave the parameter in default setting (SLRF flags: " ") with repeating function switched off.

The **„RF Driver flags"** parameter is intended for setting of module transceiver mode. The mode can be set by using of **"/F[+-] [flags]"** command, where the required transceiver mode is chosen by entering of one or more of following pre-defined symbols („flags"):

- value **"C"** - full anti-collision protection (carrier and frame transmission detect) enabled
- value **"R"** - limited anti-collision protection (carrier detect) enabled
- value **"W"** - „Wake On Radio" (WOR) function of the receiver enabled
- value **"G"** - „High Gain" function enabled (it has no effect for WM868-CO2 module)

Important note:

The **"C"** and **"R"** functions are alternative options and their setting works as a **change-over switch** (when one of them is enabled, second one is automatically switched off). The **"W"** and **"G"** functions are independent. Their flags can be added or removed **individually** by using of +/- symbol before the flag.

Example of command for common setting of „Full anti-collision protection" and „Wake On Radio" functions and corresponding record in the module configuration summary:

```
RF Driver flags:  R
co31w>/F C +W
RF Driver flags:  CW
```

Example of command for switching of protection to „Limited anti-collision protection" mode and corresponding record in the module configuration summary:

```
RF Driver flags:  CW
co31w>/F R
RF Driver flags:  RW
```

As seen in the example, by enabling of "R" function the original "C" function was automatically switched off and it had no influence on the "W" function.

Example of disabling of "W" function and corresponding record in the module configuration summary:

```
RF Driver flags:  RW
co31w>/F -W
RF Driver flags:  R
```

As seen in the example, disabling of "W" function had no influence on the "R" function.

Example of command for common setting of "W" and "G" functions and corresponding record in the module configuration summary:

```
RF Driver flags:  R
co31w>/F +W +G
RF Driver flags:  RWG
```

Example of command for switching of anti-collision protection to "C" mode together with disabling of "G" function and corresponding record in the module configuration summary:

```
RF Driver flags:  RWG
co31w>/F C -G
RF Driver flags:  CW
```

*When the **„Full anti-collision protection"** function is switched on, the module opens its receiver for an instant before broadcasting and „listens" whether the frequency channel is clear. If a carrier frequency is detected or transmission of a frame is underway, the module postpones broadcasting of the message for a moment and then tries again. This procedure protects transmission of the message from interference with disturbing signal on the same frequency as well as from collision with broadcasting of other modules.*

*When the **„Limited anti-collision protection"** function is switched on, the module goes to transmission if there is no other frame underway (but, unlike the full protection, detection of carrier is not performed). This procedure does not protect broadcasting against disturbing signal, but protects transmission of the message from collision with broadcasting of other modules. This setting is recommended in this case when the module works in the environment with permanent disturbance of carrier frequency and it has no sense to waste time (and battery power) by waiting for clear channel.*

Important note! Even the functions of anti-collision protection are identical for all modifications of the WM868-CO2 module, older version of the module can have a**different way of switching between full and limited protection**:

- for switching to full anti-collision protection use flag **"C"**
- for switching to limited anti-collision protection use „empty flag" (**" "**).

Switching from factory preset full anti-collision protection mode ("RF Driver flags: C") to the limited anti-collision protection mode can be performed this way:

```
RF Driver flags:  C
co31w>/F
RF Driver flags:
```

By using of "/F" command without flag all current flags will be removed. After that required flag (e.g. "W') can be added by "/F +W" command.

*When the **„Wake On Radio"** (WOR) function is enabled, the module can be anytime remotely activated from hibernated state with using of a special „wake-up" radio signal. This function is quite essential for the module, because it enables reading of data on demand (in „walk-by" mode) as well as performing of remote diagnostics and configuration via radio as described in the section 3.8.*

The **„SLRF Group Address"** parameter can be used for setting of module group address. Practically unlimited number (65536) of groups can be created within each WACO RF network and these addresses can be also used for addressing (besides individual addresses). If a group address is used, the message is delivered to all modules of that group. As the WM868-CO2 module's current applications use „broadcast" type of addressing, setting of group address is not required. But it is possible, that some of the applications could use group addressing in future.

Setting of **module group address** („SLRF Group Address") can be performed by using of **"/g [number]"** command, where the number from 0 - 65535 interval is the module group address. Example of setting of the group address to the "21" value and corresponding record in the module configuration summary:

```
co31w>/g 21
...
group:  21
```

3.6.4 Time constants and number of repetitions

This group of commands enables setting of measurement and transceiver time constants and setting a number of the message repetitions. There are following commands:

/X time	*receiving time interval (50 ms)*
/s number	*spontaneous messages broadcasting period (sec)*
/R number	*maximum number of repetitions of unconfirmed message*
/A number	*time interval between message repetitions (50 ms)*
/a number	*A/D converter measurement interval (sec)*

The **„/X time"** command is intended for setting of „receiving time interval", what is the interval immediately after sending a message in which the module's receiver is active. This interval enables unbroken wireless communication with the module in case of using of Wake-on-Radio (WOR) system. As the module does not switch to hibernation immediately after transmitting of data, it is possible to send another query subsequently. The interval is set in „system units" of 50 ms (20 units = 1 second). Example of setting of receiving time interval parameter to 200 ms (4 units) value:

```
co31w>/X 4
```

WARNING! *When using Wake On Radio (WOR) system in the module operation, it is necessary to set the /X parameter to* ***at least 150 ms (3 units) value****. Recommended value for reliable working of WOR system is 200 ms (4 units).*

The **„/a number"** command can be used for setting of the time interval for Analog-to-Digital (A/D) converter measurement. The module is equipped with A/D converters for measurement of some operational parameters (e.g. temperature, voltage...) and the measurement is performed in the preset intervals (set in seconds). As the latest values of measured quantity are broadcasted in INFO-messages, measurement interval should be always significantly shorter than broadcasting period. Example of setting of A/D converter measurement interval to 5 minutes (300 seconds) value:

```
co31w>/a 300
```

The **„/s number"** command can be used for setting of the module **broadcasting period**. The period is set in seconds and the module broadcasts its INFO-messages spontaneously with this period. Example of setting of broadcasting period to 1 hour (3600 seconds):

```
co31w>/s 3600
```

Following two commands are intended for setting of **repetitions of unconfirmed message**. The module supports also the applications that require confirmation of delivered message by its addressee. If the sender does not receive a confirmation message („acknowledgement"), repeats the message again after some time interval. If the module does not use any application with confirmation of the messages, setting of following parameters has no practical meaning and it is recommended to leave them in the factory setting.

The **„/R number"** command can be used for setting of maximum number of message repetitions if the delivery is not confirmed. Factory setting is "1" (without repetition). Example of setting of maximum number of message repetitions to 1 value:

```
co31w>/R 1
```

The **„/A number"** command can be used for setting of the time interval between repetitions of unconfirmed message. The interval is set in „system units" of 50 ms (20 units = 1 second), factory setting is 50 ms (1 unit). Example of setting of the time interval between repetitions to 50 ms (1 unit) value:

```
co31w>/A 1
```

As the main application of the WM868-CO2 module („SISA_TX") does not support confirming of messages, setting of message repetitions has no practical meaning.

3.6.5 Setting of test broadcasting

These commands can be used for setting of **test broadcasting function** of the module, that can be used for evaluation of radio signal in the installation site. When this function is switched on, the module broadcasts test messages in regular intervals and a quality of their reception can be evaluated around the module with using of WACO RF analyzer or any similar device.

The **"/T"** command can be used for setting of **period of the test broadcasting**. Length of the period is entered in „system units", where the value of one system unit is 50 ms (value of „100 units" means 5 second period). Example of setting of the testing period to 10 second (200 system units):

```
co31w>/T 200
```

By using of the **"/E [0/1]"** command the function of **test broadcasting can be switched "on" and "off"**. Test broadcasting is switched on with using of "/E 1" command, and it is disabled by using of "/E 0" command. Example of test broadcasting switching "on" command:

```
co31w>/E 1
```

WARNING! *Do not set "T" parameter to less than "50" value, otherwise the module buffers could be overloaded.*

3.6.6 Special 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. It is strongly recommended using of these commands only by users with a very good knowledge of the system, or only after consulting with manufacturer. There are following commands:

/@@@ RF address	*insertion of module RF address (it can be done only once, not editable)*
/K port key	*insertion of AS128 encryption key for the particular application („port")**
/K port d	*removal of AS128 encryption key for the particular application („port")**
/P number	*transmitting power setting (Do not use! Only for factory setting!)*
/!!! f num.	*correction constant setting (Do not use! Only for factory setting!)*
/w	*send empty WOR packet (Do not use! Only for factory setting!)*
/D number	*„debug" statement switch-on (Do not use! Only for factory setting!)*

** none of the WM868-CO2 module applications currently use the data encryption with AS128 key*

3.6.7 Setting the CO2 threshold value and system time

Using the command **"/C [number]"** the **threshold value of CO2 concentration** at which the module triggers acoustic and optical signaling can be set (see section 3.9. The threshold value is set in units of "ppm", the default setting is 1500 ppm. The module is in the state of signaling excess ("alarm") until the measured CO2 concentration value falls below the set threshold value. Example of a command to set the threshold value to 1200 ppm:

```
co31w>/C 1200
```

The threshold value setting is displayed in the module configuration listing using the "/" command in the "CO2 alarm threshold" line as follows:

```
CO2 alarm threshold: 1200
```

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

```
co31w>r 12 19 00 02 01 2019
12:19:0  2.1.2019  (49)
co31w>
```

The circuit for maintaining the system time value is backed up by a built-in battery, so the system time is maintained even after disconnecting power from the module. Setting the system time is not necessary for the module's functionality.

3.6.8 Display of current module status

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

```
co31w>i
CO31W   HW 1.31  SW: 7.0
Reset cause=0 (0004)  Uptime=183
temperature[1]: +26.5
temperature[2]: +28.4
humidity[1]: 24
voltage[1]: 3162
CO2eq: 785
CO2eq: 761
CO2eq: 987
CO2 sum: 24624  cnt: 28  average: 879
Buzzer const: 0
12:26:49   13.12.2018
State  TXIE  RXIE
---------------------------
   0    0     0  0/128
edgeCounter 0
co31w>
```

The first line of the output shows the **device name**, **hardware version/revision** (HW version.revision) and **software version/revision** (SW version.revision). The second line shows the value of **"Reset cause"** and **"Uptime"**.

The following lines show the **current temperature value** measured by the CO2 measurement sensor (temperature [1]), **current processor temperature** (temperature [2]), **current relative humidity value** (humidity [1]) and **current supply voltage value** (voltage [1]).

The next lines contain the measured CO2 concentration values in the set measurement interval (last, lowest and highest value) and summary data on the number of measurements. Other output data (except for the module's **system time** in the usual time format) are only for module diagnostics.

The value of the **"Uptime"** variable shows the time since the last power-on or reset of the device in seconds. The variable is of "read only" type.

The value of the **"Reset cause"** variable informs about how the device was last reset. For this type of device, the following reset types are relevant:

- **"0"** is the reset code for "Cold start" (module reset by external "RESET" command)
- **"1"** is the reset code for "Warm start" (reset after specific cases of "suspension"
- **"2"** is the reset code for "Watchdog reset", (reset by the "watchdog" system when "frozen")
- **"3"** is the reset code for "Error reset" (reset due to incorrect instruction, inconsistent data...)
- **"4"** is the reset code for "Power reset" (reset due to decreased supply voltage)

The variable is of "read only" type and is mainly used for diagnostic purposes.

3.7 Setting module parameters using an optical converter

Using an optical converter, all parameters necessary for normal operation of the module can be set. The advantage of setting via optical converter is the possibility of configuration through the module's ventilation slot, without the need to open the module cover. The optical converter sensor is located on the module's printed circuit board next to the power connector, its position is marked in purple in Figure 29.

The principles of configuration, method of connection to a computer and general configuration procedure using the **"WACO OptoConf"** program are described in detail in section 3.2 "Configuring the WM868-CO2 module using an optical converter".

The configuration changes can be performed in the **Module Configuration Table**, which can be displayed by clicking the "Read" button in the "WACO OptoConf" program window. The configuration table of the WM868-CO2 module is shown in Figure 21.

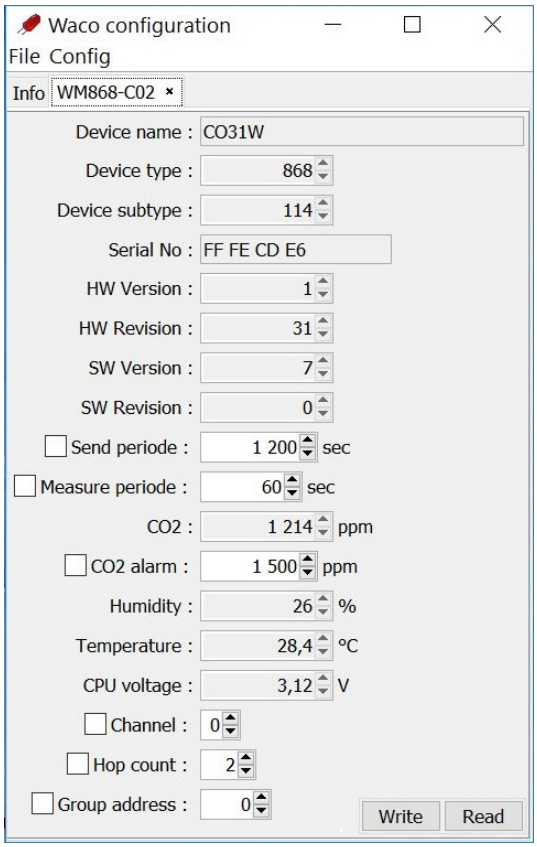


Figure 21: Configuration table of the WM868-CO2 module

In the **upper part of the table** are parameters set by the manufacturer (read only), which relate to the identification of the module and its components. These are the following parameters:

Device name	*device type designation according to manufacturer's documentation*
Device type	*specification of type designation according to manufacturer's documentation*
Device subtype	*specification of type designation according to manufacturer's documentation*
Serial No.	*radio address of the module*
HW Version	*hardware version according to manufacturer's documentation*
HW Revision	*specification of hardware version according to manufacturer's documentation*
SW Version	*software version according to manufacturer*
SW Revision	*specification of software version according to manufacturer's documentation*

All data contain precise identification of the product, production series and software version and are intended for the needs of the device manufacturer.

In the **middle part of the table** is a group of configurable parameters of the WM868-CO2 module. These are the following parameters:

Send periode	*setting the period for sending information messages*
Measure periode	*setting the period for measuring analog values*
CO2 alarm	*setting the threshold value for CO2 signaling*

The **"Send periode"** field is used to set the period for spontaneous sending of information messages. The parameter value is set in minutes. A more detailed description and options for setting this parameter are given in section 3.6.4 "Commands for setting time intervals for measurement, transmission and reception".

The **"Measure periode"** field is used to set the period for measuring analog values (temperature, battery voltage) in seconds. A more detailed description and options for setting this parameter are given in section 3.6.4 "Commands for setting time intervals for measurement, transmission and reception".

The **"CO2 alarm"** field is used to set the threshold value for acoustic signaling of CO2 concentration. A more detailed description and options for setting this parameter are given in section 3.6.7 "Setting the CO2 threshold value and system time".

Setting of all above parameters can be performed by overwriting the current value in the appropriate editing field of the configuration window to the desired value and clicking the "Write" button. When writing the value, the green LED on the USB-IRDA converter flashes and the yellow LED on the module lights up. After each write, the "WACO OptoConf" program automatically reloads the current values, so if the configuration was successful, the desired data will remain in the configuration window even after the process is completed (i.e., after the yellow LED on the module goes out);

In the **lower part of the table** are the current values of internal CO2 sensors, humidity, temperature and supply voltage. These are the following parameters:

CO2	*current CO2 concentration value (read only)*
Humidity	*current relative humidity value (read only)*
Temperature 1	*current temperature value (read only)*
Voltage	*current supply voltage (read only)*

The current **CO2 concentration** value is measured by the CO2 sensor. The value is given in "ppm" units, the meaning of which is described in more detail in section 3.9 "Display, control buttons and alarm signaling".

The current temperature value **Temperature** indicates the temperature of the CO2 measurement sensor. This value is only relevant for module diagnostics (*).

The current relative humidity value **Humidity** is measured by the CO2 sensor itself and can be used for indicative measurement and monitoring of air humidity around the module with limited accuracy (*).

(*) The CO2 measurement sensor produces a significant amount of heat during its operation, which can affect the accuracy of temperature and humidity measurements. The degree of influence is mainly determined by the intensity of air flow through the sensor, which depends mainly on the position and placement of the module.

The current voltage value **"Voltage"** shows the current value of the supply voltage in Volts. The supply voltage value is used for module diagnostics.

All of the above variables are of the **"read only"** type. The current data of the module's internal sensors are sent in each information message of the module (see description of information messages in section 3.11 "Structure of data messages of the module").

The last three lines display the **basic parameters of the radio part of the module**. These are the following parameters:

Channel	*frequency channel number of the transmitter/receiver (0 - 2)*
Hop count	*maximum number of radio message retransmissions (0 - 15)*
Group address	*group address of the module (0 - 65535)*

All these parameters are editable by entering a numerical value from the range given in the table. The meaning of these parameters is described in detail in section 3.6.3 "Commands for configuring the radio part of the module".

3.8 Setting of the WM868-CO2 module parameters via radio

In following part of the document there is a description of these parameters of the WM868-CO2 module, that can be checked via radio (by using of GET or WALK command) as described in the chapter 3.3 „Configuration of

the WM868-CO2 module via radio". Some of the parameters can be also changed via radio by using of "SET" command.

3.8.1 Module description and identification parameters

The first group of variables of the module serves for the device identification and description. These variables are load up into the module configuration by the manufacturer and are „Read Only". There are following variables:

OID	Index	OID Name	Description	Example
1	N/A	Device name	device name by manufacturer	T40
2	N/A	Device type	device type by manufacturer	868
3	N/A	Device subtype	device subtype by manufacturer	101
4	N/A	Manufacturer #	device RF address	0xff 0xff 0xea 0xb5
5	N/A	HW Version	hardware version by manufacturer	1
6	N/A	HW Revision	hardware revision by manufacturer	5
7	N/A	SW Version	software version by manufacturer	4
8	N/A	SW Revision	software revision by manufacturer	2

As it is evident from the table, these variables enable identification of the module by individual RF address and provide an additional information about its production series, software version etc.

Variables **„Device Name"** and **„Manufacturer #"** are very important for the device identification in case of re-configuration, repair or service maintenance. The rest of the variables are relevant mainly to the manufacturer for monitoring and evaluating the system operation and the malfunction diagnostics.

3.8.2 Setting of the module System Time

The **„Systime"** variable serves for setting of module real time. This parameter can be configured only via radio, but its setting is not required for any common application of the module. System time is kept in the same format as in computer operating systems, i.e. in seconds, starting from 1.1.1970 („UNIX Epoch time"). The module can be synchronized with the real time by the **"SET"** command of the WACO RFAN analyzer, where the **"Systime (s)"** variable is selected in the "OID" field and an actual time in the "UNIX time" format is entered into the "Value" field of the "Add variable" form (see figure 22).

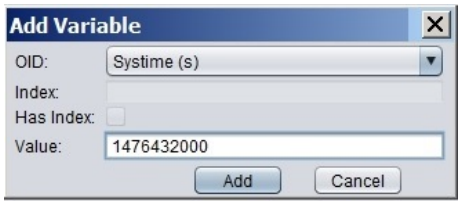


Figure 22: Setting of module System Time via radio

3.8.3 Uptime, configuration status and reset cause parameters

This group of variables is used mainly as an additional information about the device status within its diagnostics. There are following variables:

OID	Index	OID Name	Description	Example
12	N/A	Uptime (s)	working time from the last reset in seconds	335962
14	N/A	Reset code	recent reset type (reason)	0
15	N/A	Configuration status	storing of configuration parameters	2

The **„Uptime"** variable shows the time interval passed from the last device reset in seconds. The exact moment of the last module reset can be recognized by this parameter and together with the „Reset Code" parameter (see below) it is also possible to recognize the cause of the reset. The parameter is of „read only" type.

The **„Reset Code"** variable 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)

Reset code is used mainly for the diagnostics purposes. Setting of this variable to any value except „0” by SET command will cause an immediate **reset of the module**.

The **„Configuration status”** variable gives an information about the storing of configuration parameters into the device's FLASH memory. The variable can have following values: - **„0”** - empty (erased) FLASH, operating configuration is loaded by default values

- **„1”** - configuration not saved in FLASH (FLASH content is different than operating configuration)
- **„2”** - configuration saved in FLASH (FLASH content is same as operating configuration)

Setting of this variable to „2” value by SET command will cause immediate **saving of current operating configuration** into FLASH memory.

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 the user changes configuration parameters, it does so only in operating configuration.

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. Change of some configuration parameters has an effect only after module reset (e.g. retuning of module radio by changing of „SLRF Channel” parameter). In this case it is recommended to create a configuration sequence containing commands for change of parameter, saving the change to Flash, as well as command for performing of module reset (..and exactly in this order).

3.8.4 Parameters ”CO2”, ”Humidity”, „Temperature” and „Voltage”

This group of variables can be used for displaying of user data measured by the module. Current status of these variables is regularly broadcasted in the module „INFO” messages.

There are following variables:

OID	Index	OID Name	Description	Example
87	1	CO2 high alarm threshold	Threshold CO2 value	1500
88	1	CO2 measurement in ppm	Current CO2 value	1687
88	2	CO2 measurement in ppm	Minimum measured CO2 value	1028
88	3	CO2 measurement in ppm	Maximem measured CO2 value	1740
90	1	Humidity	Measured relative humidity in tenth of %	270
103	1	Temperature low	Minimum sensor temperature in 0,1 °C	-150
103	2	Temperature low	Minimum processor temperature in 0,1 °C	-150
104	1	Temperature high	Maximum sensor temperature in 0,1 °C	600
104	2	Temperature high	Maximum processor temperature in 0,1 °C	600
105	1	Temperature	Current sensor temperature in 0,1 °C	246
105	2	Temperature	Current processor temperature in 0,1 °C	203
106	1	Voltage (mV)	Current power voltage in mV	3765

The CO2 signaling threshold determines the concentration of CO2 in ppm, upon exceeding which the module triggers acoustic and optical signaling. The threshold value can also be set using the LCD display and buttons as described in the paragraph 3.9 ”Display, control buttons and alarm signaling”.

Values of the ”Temperature” variable with the index ”1” refer to the temperature of the CO2 measurement sensor. These values are only relevant for module diagnostics. The values of the ”Temperature” variable with the index ”1” refer to the temperature of the CO2 measurement sensor. These values indirectly and with limited accuracy (*) indicate the ambient temperature. Temperature values are given in tenths of a degree Celsius, where the ”203” value means a temperature of 20.3 °C.

The **Relative humidity** value is measured by the CO2 sensor itself and can be used for indicative measurement and monitoring of air humidity around the module with limited accuracy (*). The value is given in tenths of a percent.

(*) The CO2 measurement sensor produces a non-negligible amount of heat during its operation, which can affect the accuracy of temperature and humidity measurements. The degree of influence is mainly determined by the intensity of the air flow through the sensor, which depends mainly on the position and location of the module.

Value of **„Voltage"** variable shows the current value of module battery voltage in mV (value „3765" means battery voltage of 3,765 V). This parameter can be used for module diagnostics.

All the above variables (with the exception of the CO2 signaling threshold) are of **"read only"** type.

3.8.5 „SISA TimeOuts" Parameters

The **„SISA TimeOuts"** variable can be used for setting of module internal timers, that control measurement of useful data („Input value", „Temperature", „Voltage") and broadcasting of the measured values in form of radio messages. The different types of timers are distinguished by different indexes of the „SISA TimeOuts" variable. The variable can use indexes with following meaning:

OID	Index	OID Name	Description	Example
109	1	SISA timeouts	spontaneous messages broadcasting period (sec)	1200
109	2	SISA timeouts	A/D converter measurement interval (sec)	60
109	3	SISA timeouts	receiving time interval (50 ms)	4
109	4	SISA timeouts	time interval between repetitions (50 ms)	3
109	5	SISA timeouts	maximum number of repetitions	1

By using of variable with **index „1"** the period of broadcasting of spontaneous INFO-messages can be configured. The INFO-message carries useful data (values of counters, physical quantities..). If, as an example, value „1200" is preset, the module automatically sends INFO message (see paragraph 1.2) every 1200 seconds (3-times per hour).

By using of variable with **index „2"** the time interval for Analog-to-Digital (A/D) converter measurement can be configured. As the latest values of measured quantity are broadcasted in INFO-messages (see paragraph 1.2), the time interval should be always significantly shorter than broadcasting period. Recommended value is in range of few minutes (value „60" means 1 minute).

By using of variable with **index „3"** the „receiving time interval" can be configured. Receiving time interval is the time interval immediately after sending a message in which the module's receiver is active. This interval enables unbroken wireless communication with the module in case of using of Wake-on-Radio (WOR) system. The module does not switch to hibernation immediately after transmitting of data and it is not necessary to wake it up again before each query. The interval is set in „system units", where one unit means 50 ms.

WARNING! *When using Wake On Radio (WOR) system in the module operation, it is necessary to set the „receiving time interval' parameter to* ***at least 150 ms*** *(3 units). Recommended value for reliable working of WOR system is 200 ms (4 units).*

By using of variable with **index „4"** the time interval between repetitions of unconfirmed message can be configured. Some types of messages require confirmation of delivered message by its addressee. If the sender does not receive a confirmation, repeats the message again after preset interval. The interval is set in „system units", where one unit means 50 ms. Maximum number of repetitions is set by same variable with index „5".

By using of variable with **index „5"** the maximum number of message repetitions can be configured. If the parameter is set to „1" value, the message will be sent only once (without repetition).

There are only some applications that require confirmation of message delivery. As the main application of the module („SISA_TX") does not support confirming of messages, setting of message repetitions has no practical meaning.

3.8.6 Radio-frequency subsystem parameters

This group of variables contains parameters of transmitting, receiving, repeating and addressing system. There are following parameters:

OID	Index	OID Name	Description	Example
110	1	SLRF Channel	frequency channel setting	0
111	1	SLRF Hop Count	maximum number of re-transmissions	3
114	1	SLRF Group Address	setting of group address	2
116	1	SLRF Repeater Flag	repeating mode setting	0
118	1	SLRF My Address	module RF address	0xff 0xff 0x1a 0xf1
122	1	SLRF CD Flag	anti-collision mode setting)	1

The **„SLRF Channel"** variable can be used for setting of module frequency channel. RF modules of WACO communication system can be tuned to any of three separate frequency channels that don't influence each other.

Value of the „SLRF Channel" variable means a number of frequency channel to which the module is tuned (0, 1, or 2). **Change of frequency channel** can be performed by setting of variable to required value by using of SET command. As the change of frequency channel is effective only after module reset, it is always necessary to send a sequence of commands for change of channel (SLRF Channel), saving of configuration (Configuration status) and module reset (Reset Code).

The **„SLRF Hop Count"** variable can be used for setting of the maximum number of re-transmissions of the messages, broadcasted by the module. If, as an example, the parameter is set to value "3", each message originated by the module will be discarded after three re-transmissions (it is repeated no more than 3 times). It is recommended to set the parameter to "n" or n+1" value, where "n" is the least number of re-transmissions which is necessary to get the massage to its destination. If the „SLRF Hop Count" value is too low, the message is discarded before reaching of its destination. If the „SLRF Hop Count" value is too high, capacity of the network is loaded by useless repeating of the messages.

The **„SLRF Repeater flag"** variable can be used for setting of repeating (re-transmission) mode. Each RF module of WACO communication system can be used also for re-transmission of messages from other modules. Repeating function can be switched or disabled by setting of different values of „SLRF Repeater flag" variable, where following values can be used:

- **„0"** - repeating mode disabled, module does not repeat messages
- **„1"** - basic repeating mode enabled (w/o back transfer suppression)
- **„3"** - advanced repeating mode with back transfer suppression (AZRA) enabled

During normal operation the module stays mostly in „hibernated" state and it is switched to active receiving/transmitting status only for the very short time interval, when the message is transmitted. For that reason the possibility of repeating messages from other modules is so limited, that it is practically unusable. It is recommended to leave the parameter in factory setting (SLRF Repeater flag = 0) with repeating function switched off.

The **„SLRF Group Address"** variable can be used for setting of module group address. Practically unlimited number (65536) of groups can be created within each WACO RF network and these addresses can be also used for addressing (besides individual addresses). If a group address is used, the message is delivered to all modules of that group. The address can be entered as natural number from the range of 0 to 65535. The address appears in same form in the current statement obtained by command GET or WALK (see figure 23). As the module's current applications use „broadcast" type of addressing, setting of group address is not required.

The **„SLRF My Address"** variable can be used for displaying of the module individual RF address. The individual RF address is unique 32-bit long number assigned to the module in factory that cannot be changed by user („read only" variable). Each RF message originated by the module contains the module's individual RF address in the „Source Address" field of the message header. If a WACO RF message should be delivered to the particular module (e.g. query for its parameter), the individual RF address of addressee should be inserted to the „Destination Address" field of the message header. The address should be entered in hexadecimal form with „0x" sign at the beginning (e.g. „0xffffea72"). The address appears in the statement obtained by GET or WALK commands in the hexadecimal form of individual Bytes: „0xff 0xff 0xea 0x72" (see figure 23).

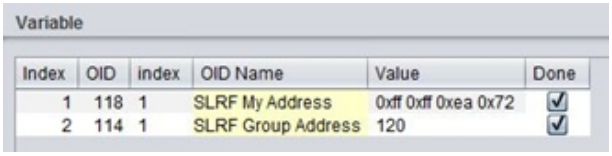


Figure 23: Current status of „SLRF My Address" and „SLRF Group Address"

The **„SLRF CD flag"** variable can be used for switching of anti-collision functions. When **full anti-collision protection** („Carrier Detect" - CD) function is switched on, the module opens its receiver for an instant before broadcasting and „listens" whether the frequency channel is not occupied by disturbing signal or whether the channel is not occupied by transmission of another WACO module. When **limited anti-collision protection** function is switched on, the module goes to transmission if there is no other transmission underway (but, unlike the full protection, detection of carrier is not performed). If anti-collision system (by using of one of above described methods) detects using of frequency channel, the module postpones broadcasting of the message for a moment and tries again, until the message is successfully transmitted.

This function is switched to the full anti-collision protection mode by factory setting (SLRF CD flag=1), switching to the limited protection mode (SLRF CD flag=0) is recommended when the module works in the environment with permanent disturbance of carrier frequency and it has no sense to waste time (and battery power) by waiting for clear channel.

As the WM868-CO2 module is equipped with just one radio-frequency subsystem (transceiver), all configurations

of RF subsystem should be performed with using of **index 1**.

3.8.7 „SLRF Test flag" and „SLRF Test timeout" parameters

These commands can be used for setting of **test broadcasting function** of the module, when the module broadcasts test messages in regular intervals. This function can be used for evaluation of the module installation site (range verification), as well as for RF network maintenance, re-design or diagnostics. There are following variables:

OID	Index	OID Name	Popis	Příklad
123	1	SLRF Test flag	switching of test broadcasting function	0
124	1	SLRF Test timeout	setting of test broadcasting period (50 ms)	20

Test broadcasting can be switched "on" and "off" by using of the **„SLRF Test flag"** variable. By setting of „SLRF Test flag" value the function can be switched on/off as follows:

- **„0"** - test broadcasting is disabled
- **„1"** - test broadcasting is enabled, test messages are broadcasted with „SLRF Test timeout" period

During normal operation the test broadcasting function is switched off (SLRF Test flag = 0, what is the factory setting). **Before activation of this function** it is necessary to setup period of test broadcasting by **setting of „SLRF Test timeout"** variable to appropriate value (recommended range of value is 50 - 100). Too short period could cause permanent broadcasting of the module, when the module buffers are overloaded and the communicate with the device could become difficult.

The test broadcasting function should be switched off immediately after testing!

The **„SLRF Test timeout"** variable can be used for setting of the test broadcasting period when the test broadcasting function is on. Length of the period is entered in „system units", where the value of one system unit is 50 ms, so that the value of „100 units" (example) means 5 second period.

As the module is equipped with just one radio-frequency subsystem (transceiver), setting of test broadcasting should be performed with using of **index 1**.

3.8.8 „Sequence #" parameter

The **„Sequence #"** variable is generally intended for identification (pairing) of „query-answer" sequences. None of current module applications use this function, so it has no practical use so far. It is recommended to leave the variable in default setting.

3.8.9 List of all module variables displayed by "WALK" command

List of all variables of the WM868-CO2 module, that are accessible via radio, as displayed by the RFAN 3.x analyzer after using of „WALK" command, is shown in the figure 24.

Variable

Index	OID	index	OID Name	Value	Done
1	1		Device name	CO31W	
2	2		Device type	868	
3	3		Device subtype	114	
4	4		Manufacturer #	0xff 0xfe 0xcd 0xe6	
5	5		HW Version	1	
6	6		HW Revision	31	
7	7		SW Version	7	
8	8		SW Revision	0	
9	11		Command	-	
10	12		Uptime (s)	2821	
11	13		Systime (s)	2254527546	
12	14		Reset code	0	
13	15		Configuration status	1	
14	61		Sequence #	0	
15	87	1	CO2 high alarm threshold	1480	
17	88	1	CO2 measurement in ppm	1687	
18	88	2	CO2 measurement in ppm	1028	
19	88	3	CO2 measurement in ppm	1740	
20	90	1	Humidity	270	
21	103	1	Temperature low	-150	
22	103	2	Temperature low	-150	
23	104	1	Temperature high	600	
24	104	2	Temperature high	600	
25	105	1	Temperature	276	
26	105	2	Temperature	300	
27	106	1	Voltage [mV]	3162	
28	109	1	SISA timeouts	1800	
29	109	2	SISA timeouts	60	
30	109	3	SISA timeouts	4	
31	109	4	SISA timeouts	2	
32	109	5	SISA timeouts	1	
33	110	1	SLRF Channel	0	
34	111	1	SLRF Hop Count	1	
35	114	1	SLRF Group Address	0	
36	116	1	SLRF Repeater flag	0	
37	118	1	SLRF My Address	0xff 0xfe 0xcd 0xe6	
38	122	1	SLRF CD flag	1	
39	123	1	SLRF Test flag	0	
40	124	1	SLRF Test timeout [ms]	60	
41	125	1	SLRF TX power	14	
42	148	1	RF frequency tuning constant	32002286	

Figure 24: Table of all WM868-CO2 module variables displayed by RFAN 3.x analyzer

3.9 Display, control buttons and alarm signaling

The **LCD display** is used to show current measured values of the WM868-CO2 module. Together with the **control buttons**, it is also used to set several basic parameters of the module.

An **LED indicator** and **sound generator** are used to signal when the set threshold value is exceeded.

3.9.1 Displaying current data

Displaying current data is the basic operating mode of the module, which it enters automatically when powered on. From the settings mode, you can always return to the current data display mode by pressing the "ESC" button.

In the current data display mode, the **top line** of the LCD display always shows the current **CO2 concentration**, while the **bottom line** alternates (cyclically) between the following values at approximately 5-second intervals:

- **current time** in the format "hh:mm"
- current **relative humidity** in percent

An example of displaying this data on the LCD display in the basic data display mode is shown in the following figure:

The left part of the image shows the display of the current time. The right part of the image shows the display of relative air humidity measured by the module. This value is only indicative, as the indicated relative humidity value may be affected by the heating of the CO2 sensor.

3.9.2 Setting selected parameters using buttons

To switch the module to the mode for setting selected parameters using the "ESC", "ENT", "+" and "-" buttons, press and hold the **"ENT"** button for about 3 seconds. The display in the top line of the display will not change, while in the bottom line the current time value will appear in the format hh:mm with the hours ("HH") flashing. We can **change** the number of hours using the "+" and "-" buttons, we can move to editing **other values** by pressing the "ENT" button, and we can exit the settings mode using the "ESC" button. When sequentially switching the edit mode using the "ENT" button, the following data is displayed:

- current time in the format **hh**:mm (editing hours)
- current time in the format hh:**mm** (editing minutes)
- current date in the format **DD**:MM (editing day of the month)
- current date in the format DD:**MM** (editing month of the year)
- current year in the format **YYYY** (editing year)
- setting the **threshold value** for CO2 concentration
- setting the **transmission period** of radio messages in minutes

An example of displaying this data on the LCD display in the mode for setting selected data is shown in the following figure:

The left part of the image shows the setting of the current time (in three steps - time/day/year). The middle part of the image shows the setting of the alarm threshold value. When this value is exceeded, the module signals an alarm acoustically and visually. The right part of the image shows the setting of the radio message transmission period in minutes. When set to "30", the module will transmit an information message with measured data every 30 minutes.

The following general rules apply to editing data:

- the **flashing value** is always being set;
- the value is increased with the **"+"** button and decreased with the **"-"** button;
- the value can be increased/decreased either **gradually**, by short presses of the button, or **quickly**, by holding the button;
- moving to edit the next value is done by briefly pressing the **"ENT"** button;
- exiting the data editing mode can be done from any step by briefly pressing the **"ESC"** button.

3.9.3 Signaling when the set CO2 concentration level is exceeded

The module signals exceeding the set threshold value of CO2 concentration both **acoustically** (intermittent beeping) and **visually** (flashing red LED). At the same time, a **spinning fan symbol** is displayed on the right side of the LCD display. The threshold value for CO2 concentration can be set by using the display and buttons as described in the previous paragraph, or using the **"/C"** command entered from the console using the configuration cable (see section 3.6). The threshold value can be set also wirelessly, using an optical converter (see section 3.7), or via radio (see section 3.8). The set value is displayed in the configuration parameters listing (see section) as follows:

```
CO2 alarm threshold: 1450
```

*The module reports CO2 concentration in **"ppm"** units, which express the number of CO2 particles per million air particles. It is recommended setting the threshold value to a value between 1000 - 1500 ppm, where 1000 ppm is the acceptable CO2 concentration value in interiors (the so-called Pettenkofer number), exceeding which initial symptoms of fatigue may occur. When CO2 concentration increases above 1500 ppm, the air is considered stale and needs to be replaced. When exceeding the 5,000 ppm limit, acute health risks are possible.* When the set threshold value is exceeded, the acoustic signal generator starts and the red signal LED above the LCD display begins to flash. The acoustic signal can be switched off by briefly pressing the **"ESC"** button. The signal LED flashes until the CO2 concentration drops below the set threshold value. Throughout the period when the threshold value is exceeded, a spinning fan symbol is displayed on the display.

3.10 Overview of Module Configuration Parameters

An overview of configuration parameters used for user settings of the WM868-CO2 module is provided in Table 2. The parameters are listed in the table in the same order as they are loaded when using the "WALK" command when setting module parameters via radio (see Section 3.8.9).

In the **"Default"** column, default values set during module production are listed. The color marking of this field has the following meaning:

- green color - most frequently changed parameters, we set them depending on the specific application
- red color - parameters that we do not recommend changing
- gray color - values that cannot be changed ("read only")

In the complete variable listing, some variables with OID from 142 to 148 are also displayed. These variables are only for initialization and diagnostic purposes, and it is strongly recommended against using them during normal module operation.

Table 2: Overview of configuration parameters for the WM868-CO2module

OID	Index	OID Name	Description	Default
1		Device name	Device name	read only
2		Device type	Device type	read only
3		Device subtype	Device subtype	read only
4		Manufacturer #	Device radio address	read only
5		HW Version	Device hardware version	read only
6		HW Revision	Device hardware revision	read only
7		SW Version	Device software version	read only
8		SW Revision	Device software revision	read only
12		Uptime	System runtime since reset (s)	read only
13		Systime	System time in seconds	read only
14		Reset code	Last reset code	read only
15		Configuration status	Configuration status	read only
61		Sequence #	Transaction sequence number	0
87	1	CO2 threshold	CO2 signaling threshold value	1500
88	1	CO2 measurement	Last measured CO2 value in ppm	read only
88	2	CO2 measurement	Lowest measured CO2 value in ppm	read only
88	3	CO2 measurement	Highest measured CO2 value in ppm	read only
90	1	Humidity	Measured relative humidity in tenths of %	read only
105	1	Temperature	Current sensor temperature in 0.1 °C	read only
105	2	Temperature	Current processor temperature in 0.1 °C	read only
106	1	Voltage (mV)	Current supply voltage in mV	read only
105	1	Temperature	Measured temperature in tenths of Celsius	read only
105	2	Temperature	Processor temperature in tenths of Celsius	read only
106	1	Voltage (mV)	Battery voltage in mV	read only
109	1	SISA timeouts	TimeOut for spontaneous message sending (sec)	1800
109	2	SISA timeouts	TimeOut for A/D converter measurement (sec)	60
109	3	SISA timeouts	TimeOut for receiver opening after message sending (50 ms)	4
109	4	SISA timeouts	TimeOut for repetition of unconfirmed messages (50 ms)	1
109	5	SISA timeouts	Maximum number of unconfirmed message repetitions	1
110	1	SLRF Channel	Radio channel number	0
111	1	SLRF Hop Count	Maximum number of allowed hops (retransmissions)	3
114	1	SLRF Group Address	Module group (multicast) address	0
116	1	SLRF Repeater Flag	Turning on the module in repeater mode	0
118	1	SLRF My Address	Module radio address (RF address)	read only
122	1	SLRF CD Flag	Carrier Detect enabled	1
123	1	SLRF Test flag	Enabling periodic test transmission	0
124	1	SLRF Test timeout	Test transmission period (50 ms)	20
125	1	SLRF Tx Power	Module transmission power in mW	10

3.11 Structure of the module's data message

The module communicates with other elements of the WACO RF network by data messages of the WACO SLRF communication protocol, which observes ISO/OSI communication model, its typical features are high effectivity and reliability, and enables huge variability of supported applications. A structure of individual layers of the WACO SLRF protocol is shown in the figure 25.

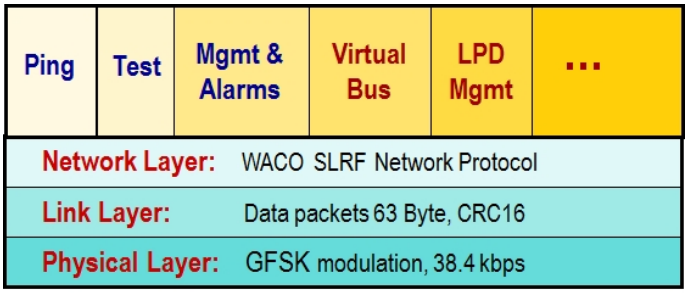


Figure 25: WACO SLRF protocol structure

Maximum total length of WACO SLRF data packet („packet") is 63 Byte. The packets are bordered by preamble code and synchro-bits (6 Byte in total) at the beginning and by 16-bit checksum code (CRC) at the end.

Each data message contains 11 Byte long fixed header and data content („Payload") with maximum length of 52 Byte. Packet header is very simple and contains only information that are necessary for routing of the packet (source and destination address, hop count, transaction ID) and a type of respective application („port number"). Payload data coding method is determined by application type. WACO SLRF data packet structure is shown in the figure 26.

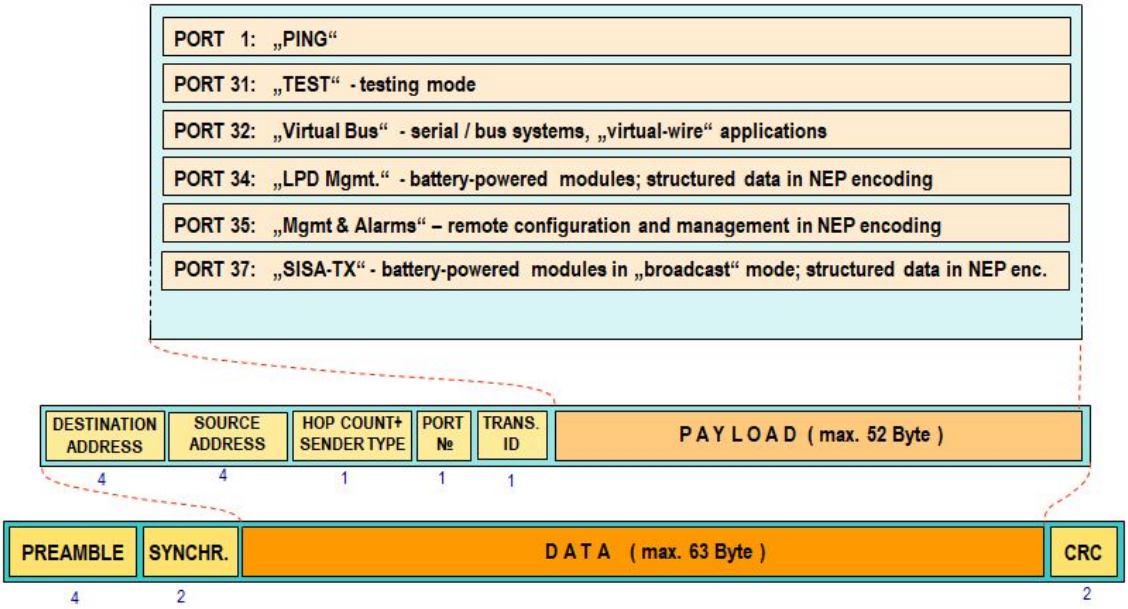


Figure 26: Structure of WACO system data packet

The WM868-CO2 module is used for measuring carbon dioxide (CO2) concentration in interiors and sending CO2 concentration data to the WACO radio network through "INFO" type messages. The transmission of "INFO" messages takes place in the "SISA_TX" type application (port number 37) of the "LPD Management" group (LPD=Low Power Devices), used for data collection from battery-powered devices. These devices communicate in the so-called "active mode", where the device actively sends data at adjustable intervals and does not wait for confirmation of message receipt.

The WM868-CO2 module sends current data about the state of connected meter counters and accompanying operational data in **two** consecutive "INFO" type messages. The content of the **first** "INFO" message includes these variables:

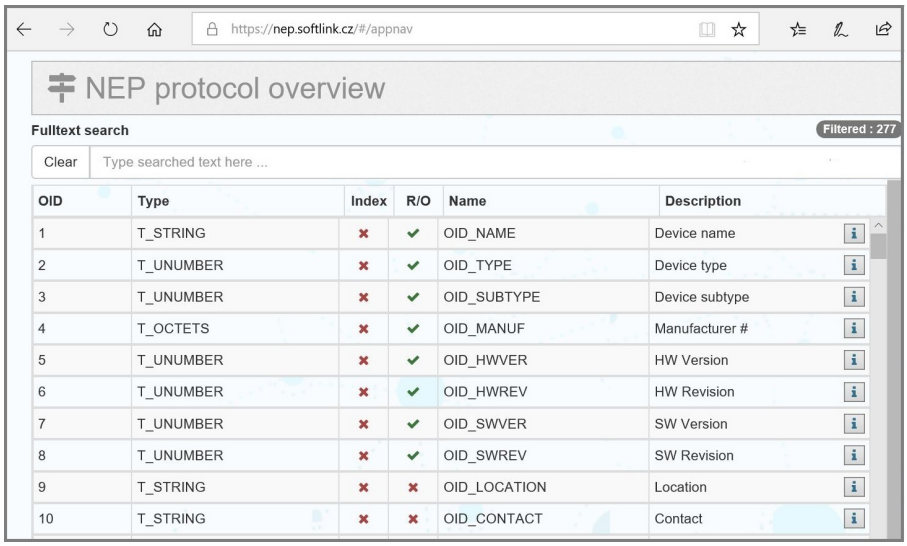
- designation of the device **"subtype"** (modification) (OID=3)
- measured **last CO2 value** (OID=88/1)
- measured **minimum CO2 value** (OID=88/2)

- measured **maximum CO2 value** (OID=88/3)

The content of the **second** "INFO" message includes these variables:

- current value of the module's **system time** in seconds (OID=13)
- **system runtime** (Uptime) in seconds (OID=12)
- **supply voltage** value in millivolts (OID=106/1)
- **CO2 sensor temperature** value in tenths of a degree Celsius (OID=105/1)
- module **processor temperature** value in tenths of a degree Celsius (OID=105/2)
- **relative air humidity** value in tenths of a percent (OID=90/1)

Individual variables are coded into the data content of the message by using of "NEP" proprietary coding system invented by SOFTLINK. In this system each type of variable has its own designation called "OID" (Object ID), which determines meaning, character and data type of the variable. These variables, that could be used multiple times (as multiple inputs, temperatures, voltages...) must be used jointly with order number of the variable called "Index". „NEP coding table" is centrally maintained by SOFTLINK and it is available on the public WEB address NEP Page. Preview of „NEP coding table" for coding of variables in the WACO system is shown in the figure 27.



OID	Type	Index	R/O	Name	Description
1	T_STRING	✖	✔	OID_NAME	Device name
2	T_UNUMBER	✖	✔	OID_TYPE	Device type
3	T_UNUMBER	✖	✔	OID_SUBTYPE	Device subtype
4	T_OCTETS	✖	✔	OID_MANUF	Manufacturer #
5	T_UNUMBER	✖	✔	OID_HWVER	HW Version
6	T_UNUMBER	✖	✔	OID_HWREV	HW Revision
7	T_UNUMBER	✖	✔	OID_SWVER	SW Version
8	T_UNUMBER	✖	✔	OID_SWREV	SW Revision
9	T_STRING	✖	✖	OID_LOCATION	Location
10	T_STRING	✖	✖	OID_CONTACT	Contact

Figure 27: Preview of „NEP coding table" for coding of variables in WACO system

If a receiver of "INFO" messages from the module is „WACO collection unit" (see paragraph 1.2 „Module usage"), decoding of variables and their conversion into M-Bus system coding is performed by the collection unit.

If a receiver of "INFO" messages from the module is any other application, it must be equipped with a decoding program for working with WACO communication protocol („WACO Driver") that includes also NEP-decoder. Fixed general rules of NEP coding system enable decoding of any variable even if decoding system on the receiving side does not have all of them implemented. In this case the decoder extracts OID, index and value of the variable, but is not able to specify its meaning and measuring unit. WACO RFAN 3.x radio network analyzer has implemented a table of variables in the "oids.xml" file. If the table is not up to date, it could receive messages with „unknown" variables that appear in the table of variables as records with incomplete description. In this case it is recommended to replace "oids.xml" file by newest version that is available at producer of the analyzer. A preview of the WM868-CO2 module's "INFO" message display in the "Packets" table of the RFAN 3.x analyzer is shown in Figure 28. The current values of the variables contained in the message are displayed in the "tooltip" window when the cursor is placed over the "Data" area of the given message.

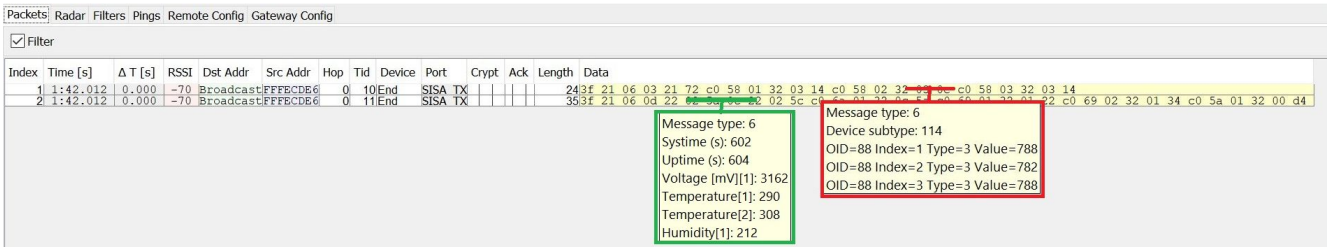


Figure 28: Display of the WM868-CO2 module's "INFO" message in the RFAN 3.x analyzer

4 Operating conditions

This section of the document provides basic recommendations for the transport, storage, installation, and operation of WM868-CO2 radio modules.

4.1 General operating risks

WM868-CO2 radio modules are electronic devices powered by an external DC voltage source, which measure and display CO2 concentration in the surrounding air at short intervals and send radio messages with current CO2 concentration data at set intervals. The following risks are particularly associated with the operation of the device:

4.1.1 Risk of mechanical and electrical damage

The devices are enclosed in plastic boxes with small ventilation slots, allowing air flow around the measuring sensor. The slots, measuring 35 mm x 2 mm, prevent direct damage to electronic components by touch and static electricity, but do not prevent mechanical and electrical damage caused by thin tools. Another potential risk of module damage is the possibility of water damage. The module is designed for use in dry indoor environments and can be used as a portable device placed on a table (desktop), or as a permanently installed device mounted on a wall. Under normal use, no special precautions are necessary, except for preventing mechanical damage from strong pressure and shocks and preventing water from entering the module.

Special protection against mechanical damage is required for the antenna, power supply, and cable. During operation, care must be taken to prevent mechanical damage to the power supply or power cable. The power cable must not be subjected to tension or bending, and if its insulation is damaged, we recommend replacing the cable immediately. If the module is equipped with a remote antenna on a coaxial cable, great attention should also be paid to the antenna and antenna cable. The minimum bending radius for an antenna cable with a diameter of 6 mm is 4 cm, for an antenna cable with a diameter of 2.5 mm, the minimum bending radius is 2 cm. Failure to comply with these bending parameters may result in disruption of the coaxial cable's homogeneity and thus reduce the radio range of the device. Furthermore, care should be taken to ensure that the connected antenna cable does not excessively strain or twist the device's antenna connector. Excessive load may result in damage or destruction of the antenna connectors.

The module is designed for installation in normal indoor spaces with a temperature range (-10 ÷ +50)°C, with humidity up to 90% without condensation. Direct installation of the device in outdoor spaces is not possible.

4.1.2 Risk of electrical damage

The electrical installation of the module may only be carried out by a person trained to install this device. The device is powered by a safe DC voltage of 5 V with minimal current consumption (up to 100 mA). The delivery includes an approved power supply (AC 230V / DC 5V/1000 mA mains adapter), and another suitable type of mains adapter with the same characteristics, approved for operation in the given country, can also be used for power supply. The device can also be powered from a standard USB port of a computer, but the module manufacturer does not guarantee this functionality and it needs to be verified in advance. The power supply can be interrupted by unplugging the adapter from the socket or unplugging the power cable.

4.2 State of modules at delivery

The modules are supplied in standard cardboard boxes. The antenna, power adapter, and USB cable are standard parts of the delivery.

4.3 Storage of modules

We recommend storing the modules in dry rooms with temperatures ranging from (0 ÷ 30) °C.

4.4 Safety warnings

Warning! Permanent installation and removal of the WM868-CO2 module must be carried out by a person with the necessary electrical qualifications.

4.5 Environmental protection and recycling

The device contains a non-rechargeable lithium battery. When disposing of the device, the battery must be removed and disposed of separately from the rest of the device in accordance with hazardous waste regulations. Damaged, destroyed, or discarded devices cannot be disposed of as household waste. The device must be disposed of through collection yards that handle electronic waste. Information about the nearest collection yard can be obtained from the relevant administrative office.

4.6 Installation of modules

WM868-CO2 radio modules are enclosed in plastic boxes with IP20 protection. The box consists of two parts:

- module box with LCD, buttons, and printed circuit board. There are ventilation slots on two sides of the box;
- box lid with mouldings indicating the place for drilling holes for screws used to mount the module.

A view of both parts of the WM868-CO2 module is shown in Figure 29 on the left. On the left side of the image, the position of the backup battery is marked in red on the printed circuit board, the position of the antenna connector in green, the position of the configuration connector in yellow, the position of the power connector in blue, and the position of the optical configuration sensor in purple.

Figure 29: Detailed view of the WM868-CO2 module

Permanent installation of the module is performed as follows:

- remove the box lid from the WM868-CO2 module box by pulling with your fingers or using a suitable tool (such as a thin screwdriver);
- attach the box lid to the wall of the room using one or two screws (*). The places for drilling holes for screws are marked by mouldings on the inside of the box lid. First, drill holes for screws in the box lid, then mark the places for drilling holes for wall plugs on the wall accordingly. Use common screws of appropriate dimensions (according to the properties and material of the base, for example 2.5 x 30 mm, or a 6 mm diameter hammer-in wall plug). Firmly screw the box lid to the wall or ceiling;
- bring the power cable to the module and connect the power supply to the module by inserting the power connector. The standard "miniUSB" type power connector is located on the side of the module (marked in blue in Figure 29);
- perform basic diagnostics of the module and, if necessary (if the module was not configured in the preparatory phase of installation), configure it using the IRDA optical adapter, cable, or WM868-RFU radio adapter, according to the procedures described in Section 3 "Module Configuration".
- place the module box on the attached lid. When attaching, rotate the box so that the LCD display is in the correct position;
- if the installation procedure or internal customer rules require sealing of the module (as protection against possible influence), seal the module by sticking an adhesive seal across the joint between the two parts of the box.

(*) Due to its minimal weight, the module can also be attached using a single screw (preferably in the center of the box), or using a suitable mounting adhesive. For short-term installation, the module can also be attached with double-sided adhesive tape.

After installation, fill out the prescribed documentation (installation protocol), or make sure that you have installed the correct module according to the installation label or project documentation. If necessary, verify the functionality of the module once again using an analyzer or by performing a test reading using the "Walk-By" system, or by displaying temperature and humidity data in the remote data collection system.

When selecting the installation location for the module, consider the purpose of measurement (distribution of CO2 concentration in the room, air flow...), protection of the module against possible mechanical damage (installation away from operationally exposed areas, out of reach of children, etc.), as well as conditions for radio signal propagation between the module installation location and the communication gateway, repeater, or suitable reading position of the Walk-By system. These conditions can either be estimated based on previous experience or measured using the WACO RFAN 3.x signal strength analyzer. The minimum received signal level (RSSI) value for WACO WM868 series modules is -106 dBm, but at this level, there is no reserve for temporary signal "fades" and it is almost certain that the radio connection with the module will occasionally fail. The optimal received signal level (RSSI) is in the range of -(80 ÷ 85) dBm.

When using the module as a portable device (desktop), place the module in a suitable location so that the measurement is not directly affected by external influences (*), insert the power cable plug into the module and plug the power adapter into the mains socket.

(*) For measuring CO2 concentration, placing the module on a regular work desk is suitable. We recommend placing the module as far as possible from the person sitting at the desk and to the side so that the stream of exhaled air does not directly hit the module.

***Important note!** The function of the CO2 sensor is partially influenced by direct sunlight. To increase the accuracy and stability of CO2 concentration measurements, we recommend placing the module so that it is not exposed to direct sunlight.*

4.7 Replacement of the WM868-CO2 module

When replacing a permanently installed WM868-CO2 module due to a malfunction, proceed as follows:

- if the module was sealed, check if the adhesive seal is intact before dismantling the module. Handle seal violation according to the internal rules applicable to the given customer/project;
- turn off the module by disconnecting the power cable;
- remove the original WM868-CO2 module from the box lid by pulling with your fingers or using a suitable tool (such as a thin screwdriver) and visibly mark it as "defective". If applicable, fill out the appropriate form (installation sheet) or other prescribed documentation for module replacement;
- open the new module and (unless there is a reason to replace the original lid as well) place the box with the new module on the original lid in place of the original module;
- connect the power supply to the module and perform basic diagnostics and module setup according to the procedure described in Section 4.9 "Checking Module Functionality". Check and set especially these configuration parameters:
  - frequency channel and "hop-count" according to Section 3.6.3
  - transmission time constants according to Section 3.6.4
- write down the RF address of the new module and, if possible, immediately overwrite (or ensure overwriting of) the original RF address with the new address in the online system database or in the Walk-By system configuration data table;
- reassemble the original faulty module by attaching the remaining lid.

When replacing a portable WM868-CO2 module due to a malfunction, physically exchange the device for a new one, and if the module is also connected to a remote reading system, make the appropriate change in this system (change the RF address in the online system database or in the Walk-By system configuration data table).

4.8 Dismantling the module

When dismantling a permanently installed module, turn off the device, open it, and remove the box lid. Reassemble the dismantled module (place the lid on the box), properly mark it as dismantled, and fill out the appropriate documentation prescribed for this case by internal regulations. If necessary, ensure deactivation of the module in the remote reading system or in the Walk-By system.

When ending the operation of a portable device that is also connected to a remote reading system, don't forget to deactivate the device in this system.

4.9 Checking module functionality

After putting the module into operation (or after each repair and replacement of the module), we recommend checking its basic functions:

- check the functionality of the measurement system according to the data displayed on the LCD display (see Section 3.9);
- check the transmission functionality of the module using the RFAN 3.x analyzer in "Packets" or "Radar" mode (according to the procedure described in the analyzer documentation), preferably using the module's "test transmission" function described in Section 3.6.5 "Turning on Test Transmission";
- perform a general check of the functionality of the WM868-CO2 module's transmitter and receiver using the RFAN 3.x network traffic analyzer, for example by downloading any configuration parameter of the module using the "GET" command as described in Section 3.3 "Configuring the WM868-CO2 Module via Radio";
- perform a comprehensive check of the module's implementation into the data collection system by verifying the correctness and up-to-dateness of the obtained data directly in the data collection system.

4.10 Operating the WM868-CO2 Module

Remote reading of CO2 concentration using WM868-CO2 modules in an automatic reading system works completely automatically. The greatest risks here are associated with the activities of the facility user, especially the risk of mechanical damage to the modules when handling objects at the installation site, the risk of relocating the radio module to another location, or the risk of signal shading by a metal object. A typical consequence of damage is a complete loss of connection with the module. Relocating the module may manifest as a change in the received signal level from the module, which may result in reduced reliability of reading CO2 sensors, temperatures and humidity, or interruption of connection with the module.

To eliminate these risks, we recommend regularly monitoring the functionality of sensor readings and, in case of detecting outages or non-standard values, contacting the facility user or performing a physical check at the installation site.

For remote reading with the "Walk-By" system, the risks of mechanical damage are the same as for the "online" system. Risks can be eliminated in the same way as in the online system, but only at the time of reading when we have the read data available. If an inconsistency or anomaly is detected during the reading, we recommend immediately performing a physical check at the installation site and, if necessary, comparing the measured values with the values of a reference thermometer and hygrometer at the installation site.

The module can also be operated outside the remote reading system, only for local monitoring of CO2 concentration. In this case, it is necessary to protect the device (including the antenna, power adapter, and cable) from mechanical and electrical damage and regularly monitor the consistency of data on the LCD display. In case of doubts about functionality, we recommend replacing the device or verifying its functionality by comparing the indicated data with the data of a reference device. To increase the accuracy and stability of CO2 concentration measurements, we recommend selecting a location for the module where it is **not exposed to direct sunlight**.

5 Troubleshooting

5.1 Possible causes of system failures

During operation of the WM868-CO2 device, failures, functionality outages, or other operational problems may occur, which can be divided into the following categories according to their cause:

5.1.1 Power supply failures

The module requires DC power from an external AC/DC adapter according to the specification given in section 2 "Overview of technical parameters". Alternatively, the module can be powered directly from a computer's USB port, but this functionality is not guaranteed and needs to be verified in advance for a specific computer. The presence of supply voltage is indicated by the presence of data on the module's LCD display. If the device becomes completely non-functional, the cause may be a power supply failure. The correctness of the power supply can be verified using this procedure:

- check whether there has been a power outage in the building;
- check whether the power adapter is not switched off (unplugged from the socket);

- verify the functionality of the power adapter by replacing it with a definitely functional unit;
- in case of doubt, measure the value of the supply voltage.

If the power adapter is faulty, replace it. If the power adapter is functional with the correct supply voltage value and still no values are shown on the module's LCD display, the module is most likely faulty. Replace the device according to section 4.7 and then perform the setup and functional check of the new (replaced) device. If the new device functions normally, mark the original module as "defective" and record the replacement details in the operational documentation according to internal rules.

5.1.2 System failures

System failures are considered to be mainly processor failures, memory failures, internal power supply failures, or other fatal failures that cause complete device malfunction. If the device is in a state where the LCD display shows some values, but the device shows incorrect values, does not respond to buttons, does not communicate through the communication port, etc., and this state does not change even after disconnecting and reconnecting the power supply (i.e., after a restart), it is probably a system failure. Replace the device according to section 4.7 and then perform the setup and functional check of the new (replaced) device. If the new device functions normally, mark the original module as "defective" and record the replacement details in the operational documentation according to internal rules.

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, that have following external signs:

- the module transfers data only from certain elements of the radio-network, data from other elements are not transferred;
- certain elements of the network do not receive data from the module;
- data from certain elements of the network are incorrect or incomplete;
- there are numerous breakdowns in the data communication (sometimes the data pass through the module, sometimes not).

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

- incorrect setting of transmitter parameters, mainly frequency channel, maximum number of re-translations, or transmitting power;
- permanent or occasional blocking 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 wrong setting or failure of transmitter;
- low level of receiving signal caused by wrong setting or failure of receiver;
- 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 redesign of radio network;
- 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, especially setting of radio parameters as described in paragraph 3.6.3 and perform the check of module overall functionality as described in paragraph 4.9;
- if there are breakdowns in communication with some specific element of the network, check functionality of that element according to the respective documentation;

- replace the module according to the paragraph 4.7 and perform the setting and check of overall functionality off the new module after that;
- if the module is not properly working even after its replacement for proven device and equipment, the trouble can be caused by local interference (jamming) from external source. Another possible reason could be an unsuitable setting of some configuration parameter that has not been discovered. In this case ask for your supplier, producer, or other experienced person for some form of assistance.

Appropriate level of transmitting power can be checked by comparing of its signal strength with the reference signal from another module (modules) under comparable circumstances, for example with using of signal analyzer or testing receiver placed to the suitable spot. If the signal strength is similar to the signal of reference transmitter, then the module's transmitting power is adequate, and the reason of troubles could be in insufficient signal strength on the receiving side. Attenuation of the signal can be caused by making of some change in module installation site (e.g. turning of antenna or placing of some object nearby, installation of iron bars, rack or shelfs...) or similar changes in the installation site of receiver (GateWay). This kind of troubles can be solved by redesign of the radio network in order to secure sufficient signal reception (that means changing of antenna for better type, moving of antenna or whole device etc.).

5.1.4 Sensor failures

A typical sign of a CO2 sensor failure is the reading of incorrect CO2 concentration values, that is a state where data arrives regularly from the module, but the values differ from reality or are obviously nonsensical. In this case, visually check whether there have been any changes in the installation circumstances (module relocation, installation/uninstallation of a heat source near the module...). If there is no natural explanation for the change in indicated CO2 concentration, check the module identification in the reading system (whether there has been a device mix-up). If the module is set correctly in the reading system database, it is most likely a sensor failure. In this case replace the module according to section 4.7.

5.2 Procedure for determining the cause of a failure

When determining the probable cause of a failure, we proceed as follows:

1. The module shows values on the display, responds to buttons, communicates normally (data can be read by the remote reading system), but the CO2 sensor gives an obviously incorrect or suspicious value, either under certain circumstances or permanently. In this case check the functionality of the sensor according to section 5.1.4 "Sensor failures".
2. The module shows values on the display, responds to buttons, but data arrives irregularly, there are periodic outages in receiving data from the module. In this case , check the functionality of individual module subsystems in this order:
   - check the functionality of data transmission and reception according to section 5.1.3 "Transmitter and receiver failures";
   - check the functionality of the device that receives data from the WM868-CO2 module according to the documentation for that device;
   - if no data is coming from the module, check the correctness of the address setting for that module in the collection system.
3. The module does not show values on the display, does not respond to buttons or configuration commands, no data is coming from the module. In this case it is recommended checking the functionality of individual module subsystems in this order:
   - check the functionality of the power supply according to section 5.1.1 "Power supply failures",
   - check the functionality of the system according to section 5.1.2 "System failures".

WARNING: The WM868-CO2 module is a reliable device of relatively simple and durable construction, so there is a high probability that any failure is caused by external installation circumstances, especially mechanical damage, incorrect power supply, or excessive moisture ingress. With each module replacement due to failure it is recommended verifying whether the cause of the failure was not one of these circumstances and, if necessary, take measures to eliminate it.

6 Additional information

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

www.wacosystem.com
www.softlink.cz

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

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