WIRELESS COMMUNICATION SYSTEM WACO WM868

WM868-SEA

Revision 1.0

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1 Introduction

This document describes features, parameters and setting possibilities of the WM868-SEA module, which is used for reading of watermeters of the **„Residia-Jet" and „Residia-Jet-C"** series manufactured by **Sensus** (USA), and for radio-broadcasting of the data from the watermeters through the WACO radio-frequency network

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-SEA module can be used for registration of revolving of dry-counter residential watermeters of Sensus „Residia-Jet" or „Residia-Jet-C" series (hereinafter „watermeter") commonly installed in technological shafts of residential buildings. The module is fitted for direct integration with the watermeter (insertion and click-lock into the watermeter slot). The module continuously registers revolving of pivotal wheel (disc) of watermeter mechanical counter with using of two inductive sensors and updates status of internal register (counter) after each turn of the disc. Current status of internal counter is broadcasted in form of WACO standard radio-message („INFO-messages") either automatically (with preset broadcasting period) or on demand (with using of „Wake-On-Radio" function). Using of two inductive sensors enables recognition of revolving direction, what means that when the watermeter rotates in reverse direction (during reverse water flow), status of internal counter decreases (same way as mechanical counter status).

Each INFO-message contains actual watermeter status (reading), as well as module system time, battery voltage, processor temperature and watermeter serial number (if entered into the module configuration). INFO messages are transmitted with general „broadcast" address and with application („port") number 37 („SISA_TX" application), where a confirmation of received message by addressee is not required.

Broadcasted messages are transferred through the WACO RF network to the local **communication gateway** of WM868-RFU (WACO USB GateWay), WM868-RFE (WACO Ethernet GateWay), or WM868-RFG (WACO GSM GateWay), type, where they are converted to the format which is suitable for either serial line transfer (WM868-RFU), or for the transfer through the Ethernet/IP network (WM868-RFE), or transfer through the GSM/GPRS services (WM868-RFG). The messages are transferred to the local or remote computer, where they are decoded and processed. The computer must be equipped by coding/decoding program for processing of WACO protocol (so called „WACO Driver"). In reverse direction (from central computer to meter) the messages are transferred analogously, the communication gateway performs their conversion to the radio-frequency format and broadcasting to the RF network. Principle of data transfer from the WM868-SEA module through the WM868-RFE communication gateway is shown in the upper part of figure 1.

Alternatively, the messages of the WM868-SEA module with watermeter readings can be received by local **„collecting unit"** of the WACO system. The „collecting unit" is a special WACO RF-module intended for collecting

of the data from battery powered WACO modules, conversion of their data into standard M-Bus protocol and their further transfer to the M-Bus master through the physical or virtual bus. Principle of data transfer from the WM868-SEA module through the WACO collection unit of WM868-SJ-MS type is shown in the lower part of the figure 1.
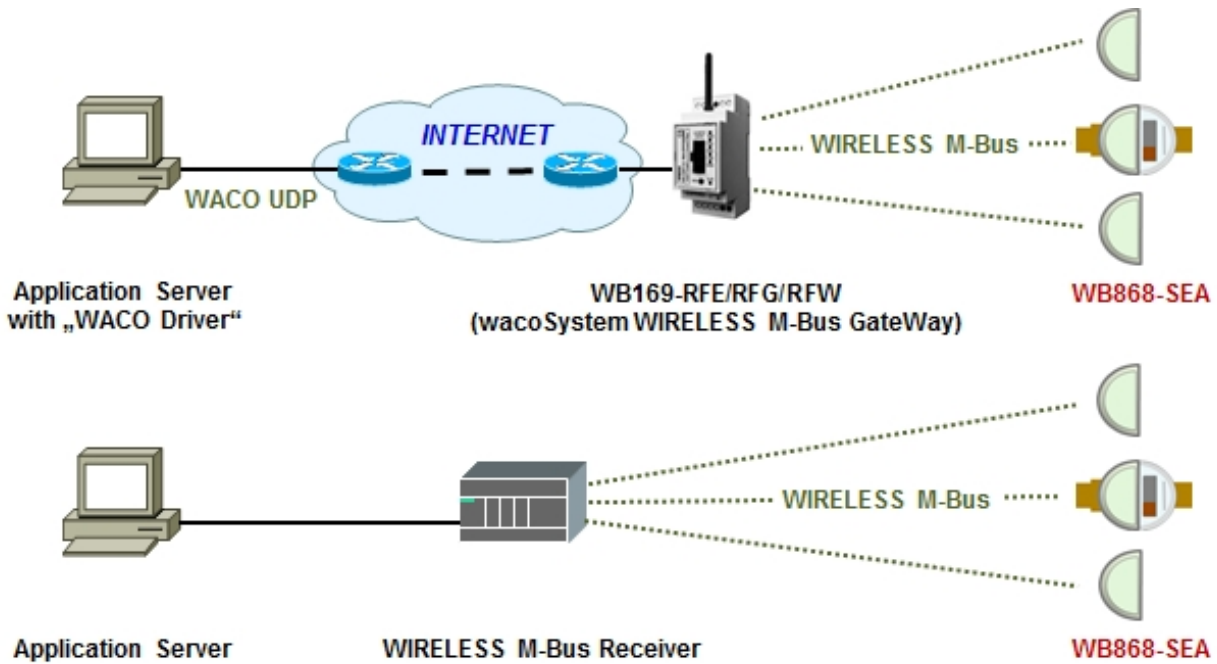
Figure 1: Principle of data transfer from the WM868-SEA module

The WM868-SEA module supports **„Wake-On-Radio" (WOR) function** that enables raising of communication „on demand" even in time of module's „hibernation". The module can be switched to active state by receiving of special radio message („WOR-packet") and by follow-up query the actual readings can be immediately obtained from the module. This function can be used either for immediate gathering of data with using of „walk-by" reading system, or for remote diagnostics and configuration of the module via radio (see chapter 3.2 „Configuration of the module via radio").

The module is enclosed in plastic casing fitted for integration with watermeters of „Residia-Jet" and „Residia-Jet-C" series (Sensus, USA). The module is power supplied by internal battery with lifetime more than 5 years for 60 minutes broadcasting period. Battery lifetime can be negatively influenced by shorter broadcasting period, or by storing and operation in sites with the temperatures exceeding the recommended range, or operation in area with permanent external disturbance or with dense radio-frequency traffic.

External appearance of the WM868-SEA module is shown in the figure 2.

Figure 2: View of the WM868-SEA module

2 Technical parameters overview

Overview of WM868-SEA module technical parameters is shown in the Table1 below.

Table 1: Overview of WM868-SEA module technical parameters

RF subsystem parameters		
Frequency band	868,0 až 868,6	MHz
Modulation	FSK	
Number of channels	3	
Bandwidth	200	kHz
Transmitting power	5	mW
Receiver sensitivity	106	dBm
Communication protocol	WACO	
Transmission speed	38400	Baud
Antenna	integrated	
Configuration interface RS232		
Transmission speed	4800	Baud
Operation mode	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, none parity	
Signal level	TTL/CMOS	
Revolution counter sensor		
Maximum rotation frequency	1,4 Hz	(84 rpm)
Recognition of direction	yes	
Power supplying		
Lithium battery voltage	3,6	V
Lithium battery capacity	1,2	Ah
Weight and dimensions		
Length	62	mm
Width	30	mm
Height	26	mm
Weight	cca 35	g
Storage and installation conditions		
Installation environment (by ČSN 33 2000-3)	normal AA6, AB4, A4	
Operation temperature range	(-10 ÷ 50)	°C
Storage temperature range	(0 ÷ 70)	°C
Relative humidity	95	% (w/o condensation)
Degree of protection	IP20	

3 Configuration of the WM868-SEA module

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

- with using of **„USB-CMOS"** converter and configuration cable connected to the module
- wireless, with using of radio-frequency communication gateway

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 3.5 „Setting of WM868-SEA parameters via configuration cable". Description of interconnection of the radio-communication gateway with computer and general rules of configuration **via radio** are described in the section 3.2 „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 3.6 „Setting of WM868-SEA parameters via radio".

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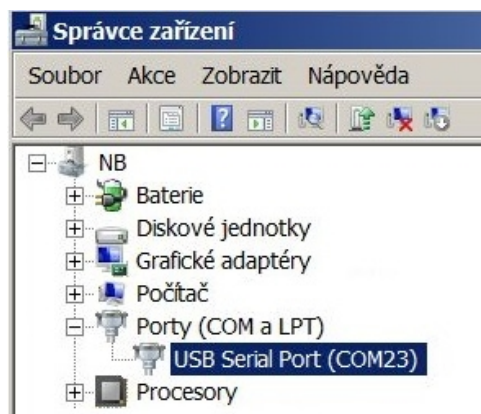
Figure 3: Appearance of the USB-CMOS converter in Windows „Device Manager"

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 3.3 „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-SEA 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.
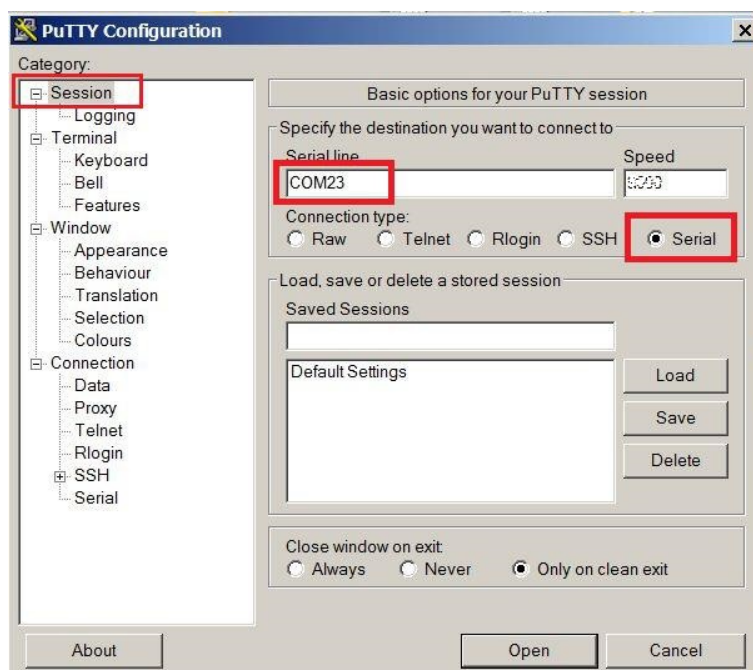
Figure 5: Terminal setting for serial line communication

„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 **„sensus3"** which announces that the module is ready to be configured (see figure 6).
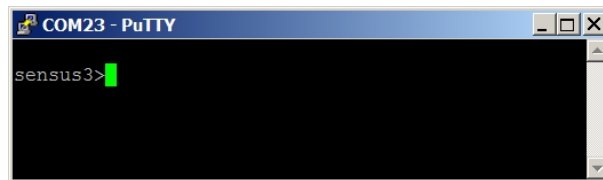
Figure 6: Open terminal window for module configuration via serial line

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 „sensus3" or „mon" format (see figure 6);
- it is possible to enter only one command each time;
- 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 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 7), 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 8.
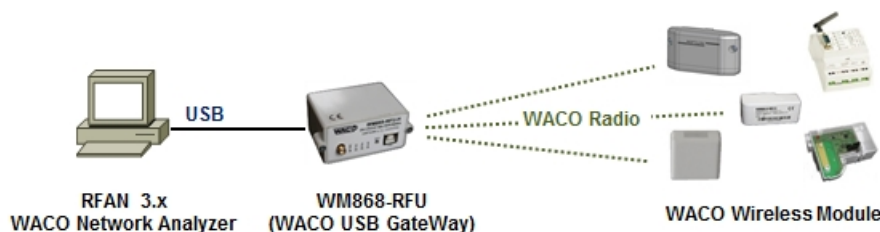
Figure 7: Principle of local configuration via radio

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**.

3.2.1 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,
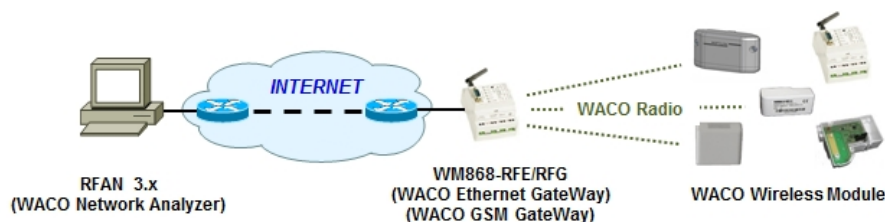
Figure 8: Principle of remote configuration via radio

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 3.6 „Setting of module parameters via radio". General principles and technique of radio configuration are described in details in section 3.2.3 „General rules of configuration via radio".

3.2.2 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 8).

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 9.
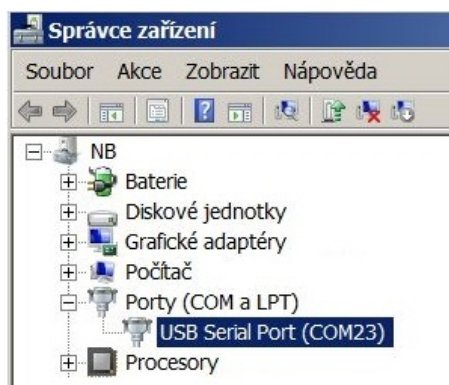
Figure 9: Appearance of WACO USB GateWay in the MS Windows „Device Manager"

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 3.4"„USB GateWay and USB-IRDA driver installation".

3.2.3 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)

- 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.

3.2.4   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 10.

Figure 10: Entering of devices and variables into the remote configuration window

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
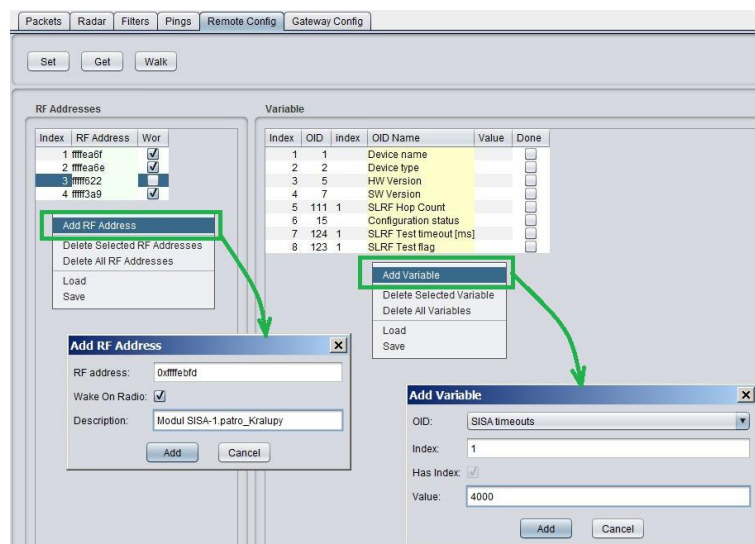
- in case the variable has an index, put the index number in (information box „Has Index" is ticked and „Index" box is editable);
- set up required value of the variable into the „Value" field. If the variable will be just read (checked its current value), leave the field blank. Those variables, that have „Read only" status (invariable constants, measured values) will have the „Value" box uneditable;
- 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 10.

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 11: 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.

3.3 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 13 left).
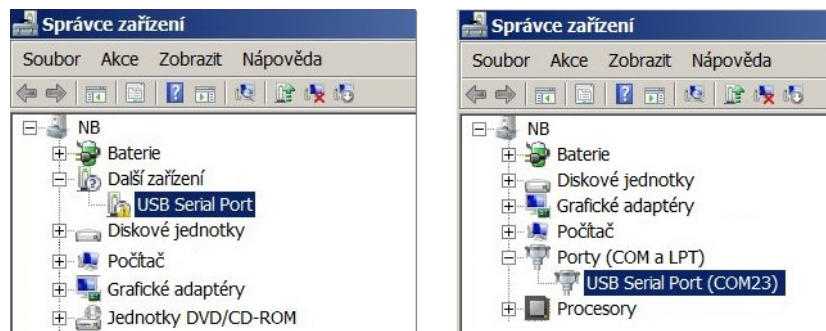
Figure 12: Appearance of converter without driver in the Windows „Device Manager" table

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 13 right).

3.4   „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 13 left).
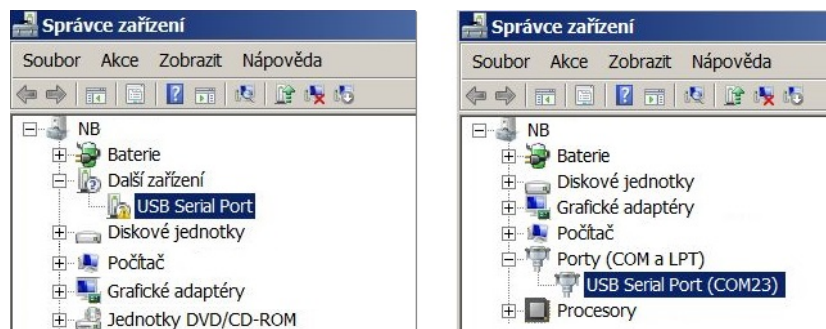
Figure 13: Displaying of the device without driver in "Device Manager" window

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 14 left). Choose „From disc" in the next „Choose driver which you want to install" window (figure 14 right).

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 15 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 15 right).
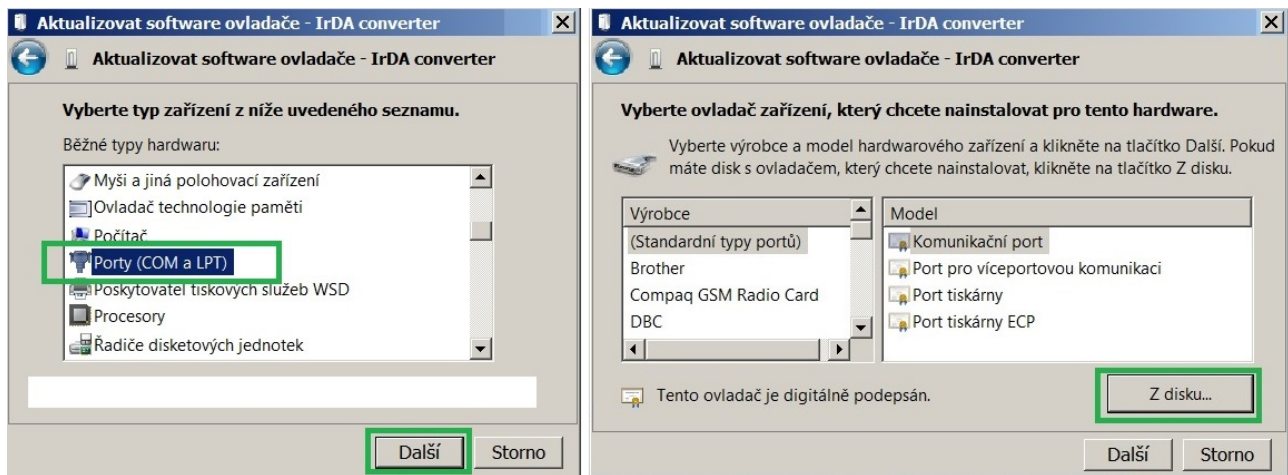
Figure 14: Manual selection of the driver file from a folder
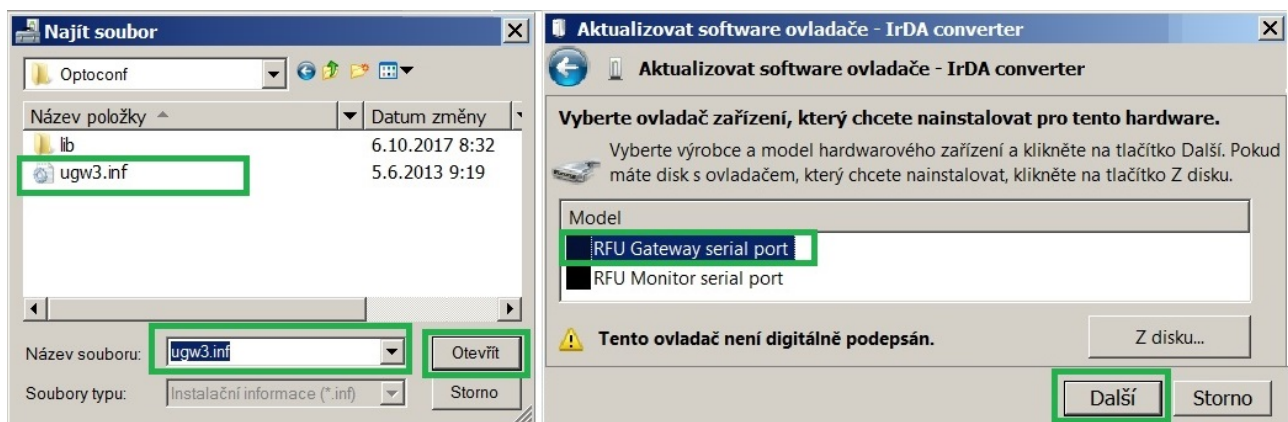
Figure 15: USB driver installation

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 13 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.

3.4.1 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.

3.4.2   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.

3.4.3   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.

3.5   Setting of WM868-SEA module parameters by configuration cable

In following part of the document there is a description of these parameters of the WM868-SEA module, that can be displayed and examined from PC connected to the module by configuration cable. Some of the parameters can be changed by configuration commands entered „from the console" as described in paragraph 3.1.

3.5.1   List of WM868-SEA module configuration parameters and commands

List of all configuration parameters of the module can be displayed by entering of "/" command and pressing of „ENTER" key.

The following list of parameters will display in the terminal window:

```
sensus3>/
CONFIGURATION: OK
RF Address: 0xFFFEE1F1
hop count: 3
group: 0
SLRF flags: eZ
test timeout: 1000
channel: 0
PA table: 0xC6
RF Driver flags: CW
RX timeout: 4
SISA master: 0x010000FE
Sending time: 3600
Repeat: 0
Repeat timeout: 1
ADC sampling: 60
Water meter: 124
VC1=66  VC2=58
Crypt Keys for:
Manuf ID: 12AB34cd
Run test: 0
Debug level: 0
sensus3>
```

Overview and short description of configuration parameters can be also found in table 2 on the page 26.

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

```
sensus3>/?
/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 - PA table
/F[+-] flags - C-CD detect, 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.
/i [value]  get/set input value
/C - start calibration

/K port d - delete key
 port key- add/change key

/M ID - save manufacturer ID
/E number - run test
/w - send empty WOR packet
/D number - debug level
```

The meaning of individual parameters and detailed description of their usage can be found in the following part of chapter 3.5.

3.5.2 „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:

```
sensus3>/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:

```
sensus3>#
```

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:

```
sensus3>/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).

3.5.3 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":

```
sensus3>/c 1
sensus3>/W
sensus3>/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":

```
sensus3>/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-SEA 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-SEA 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
sensus3>/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
sensus3>/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
sensus3>/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
sensus3>/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
sensus3>/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-SEA 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
sensus3>/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 3.6.*

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-SEA 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:

```
sensus3>/g 21
...
group:  21
```

3.5.4 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:

```
sensus3>/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:

```
sensus3>/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):

```
sensus3>/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:

```
sensus3>/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:

```
sensus3>/A 1
```

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

3.5.5 Commands for setting of input counters

For easy identification of reading values the module broadcasts in each INFO-message also a serial number of „its" watermeter. This serial number can be entered to module configuration by using of **/M ID** command, where

"ID" is a serial number of watermeter in form of maximum 16 alphanumeric characters. Example of setting of the watermeter serial number to „12AB34cd" value and check of corresponding record in the module configuration summary:

```
sensus3>/M 12AB34cd
...
Manuf ID: 12AB34cd
```

The WM868-SEA module is equipped with an inductive sensor of watermeter mechanical counter revolution that also registers the direction of motion. Each turning in forward direction increases the module counter by one, while each turning in reverse direction has inverse effect - the counter value is decreased.

When installing the module to watermeter, it is necessary to set current status of watermeter mechanical counter into the module configuration by using of **„/i value"** command, where „value" is required initial value of the register.

Example of setting of the module counter to „124" initial value and check of corresponding record in the module configuration summary:

```
sensus3>/i 124
...
Water meter: 124
```

Important notes

*Setting of register initial value should be always performed **after installation of the module to the watermeter**. Until the module is separated from the watermeter, its sensor can be accidentally activated by any near metallic object during transportation, installation or other handling. This could cause discrepancy between mechanical counter values and remote reading data.*

*The module is primarily intended for using with watermeter with unit volume of **one liter (0,001 m^3) per one turn** of pivotal wheel of watermeter. When using with different model of watermeter with different unit volume per one turn it is necessary to make appropriate correction of reading data in the remote reading system.*

After installation of the module to watermeter the **„Water meter"** value in the configuration summary will increase/decrease with each turn of watermeter.

3.5.6 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):

```
sensus3>/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:

```
sensus3>/E 1
```

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

3.5.7 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-SEA module applications currently use the data encryption with AS128 key

The **"/C"** command is a special command for calibration of module inductive sensors. When performing calibration, the WM868-SEA module must be placed on the wooden or plastic pad (without metallic elements) and the calibration process is started by entering of "/C" command. As a result of calibration, the two calibration constants are processed and stored into the module configuration. They appear in the module configuration summary as "VC1" and "VC2" values (e.g. "VC1=66 VC2=58").

Calibration of inductive sensors is performed in factory during manufacturing process and it is strogly recommended not tu use this command during normal operation.

3.5.8   Module current status statement

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

```
sensus3>i
Sensus Water Meter   HW 1.5  SW: 4.4
0:31:47  1.1.1970  Reset cause=0004 Uptime=1907
state=0  cnt=15
temperature[1]: +0.0
temperature[2]: +38.6
voltage[1]: 3623
TA1R: 71  0
v1=80  v2=71
sensus3>
```

In the first row there are displayed following device specifications: **manufacturer type** (Device name), **hardware version/revision** (HW version.revision) and **software version/revision** (SW vesion.revision). In the second row there are values of module **system time** in common time format, **reset cause** of module last reset and value of module **"Uptime"**. In next rows there are values of **current temperature** measured by sensor (Temperature [1]), **current processor temperature** (Temperature [2]) and **current voltage of internal battery** (Voltage [1]). As the module is not equipped by temperature sensor, the "Temperature [1]" value is a random number with no practical meaning. In the last two rows there are some diagnostic statements intended only for manufacturer use.

The **"Systime"** parameter value shows setting of module real time. 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"). In default status (after battery switch-on) there is zero value in the counter and it increases by one every second. The module can be synchronized with the real time only via radio, by using of the **"SET"** command of the WACO RFAN analyzer (see paragraph 3.6.2). Setting of this parameter is not required for any common application of the module.

The **"Uptime"** parameter value shows the time interval passed from the last device reset in seconds so that the exact moment of the last module reset can be recognized by this parameter. The parameter cannot be changed by user („read only" type).

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

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

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

3.6 Setting of WM868-SEA module parameters via radio

In following part of the document there is a description of these parameters of the WM868-SEA module, that can be checked via radio (by using of GET or WALK command) as described in the chapter 3.2 „Configuration of the module via radio". Some of the parameters can be also changed via radio by using of "SET" command.

3.6.1 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.

3.6.2 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 16).

Figure 16: Setting of module System Time via radio

3.6.3 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).

3.6.4 Parameters „Manufacturer ID", „Input value", „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
16	n/a	Manufacturer ID	Watermeter S/N (configurable)	0
100	1	Input value	Current status of internal counter	0
105	1	Temperature	Measured temperature (not used)	0
105	2	Temperature	Processor temperature in tenths of Celsius	203
106	1	Voltage (mV)	Battery voltage in mV	3765

Value of **„Manufacturer ID"** variable shows preset serial number of connected watermeter (if entered). The value can be set by SET command as any string of alphanumeric characters with maximum length of 16 characters. This variable is broadcasted in every INFO-message.

Value of **„Input value"** variable (index 1) shows the current status of module internal counter. The variable can be set to required value by using of SET command. This setting can be used for setting of counter initial value after module installation (or anytime after that) to synchronize broadcasted data with the real status of watermeter mechanical counter.

Value of **„Temperature"** variable with **index 1** shows the current value of temperature sensor. As the module is not equipped with the sensor, this variable has no relevance and its value is „0".

Value of **„Temperature"** variable with **index 2** shows the current value of module processor temperature in tenths of Celsius (value „206" means temperature of 20,6 °C). As the input power of the module is extremely low (in range of μW), autogenous heating of the processor is negligible and the value is very close to the ambient air temperature.

The „Temperature" variable is of **„read only"** type.

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 is important for module diagnostics, where too low value (under 3,2 V) indicates upcoming battery discharge. This variable is of **„read only"** type.

3.6.5 „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.

3.6.6 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 17). 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 17).

Variable					
Index	OID	index	OID Name	Value	Done
1	118	1	SLRF My Address	0xff 0xff 0xea 0x72	✓
2	114	1	SLRF Group Address	120	✓

Figure 17: 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-SEA module is equipped with just one radio-frequency subsystem (transceiver), all configurations of RF subsystem should be performed with using of **index 1**.

3.6.7 „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**.

3.6.8 „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.

3.6.9 List of all variables displayed by "WALK" command

List of all variables of the WM868-SEA module that are accessible via radio, as displayed by the RFAN 3.x analyzer after using of „WALK" command, is shown in the figure 18.

Index	OID	index	OID Name	Value	Done
1	1		Device name	Sensus Water Meter	
2	2		Device type	868	
3	3		Device subtype	108	
4	4		Manufacturer #	0xff 0xfe 0xe1 0xf1	
5	5		HW Version	1	
6	6		HW Revision	5	
7	7		SW Version	4	
8	8		SW Revision	4	
9	12		Uptime (s)	409	
10	13		Systime (s)	19311	
11	14		Reset code	1	
12	15		Configuration status	2	
13	16		Manufacturer ID, configurable	12AB34cd	
14	61		Sequence #	0	
15	100	1	Input value	124	
16	105	1	Temperature	0	
17	105	2	Temperature	319	
18	106	1	Voltage [mV]	3616	
19	109	1	SISA timeouts	3600	
20	109	2	SISA timeouts	60	
21	109	3	SISA timeouts	4	
22	109	4	SISA timeouts	1	
23	109	5	SISA timeouts	0	
24	110	1	SLRF Channel	2	
25	111	1	SLRF Hop Count	3	
26	114	1	SLRF Group Address	0	
27	116	1	SLRF Repeater flag	1	
28	118	1	SLRF My Address	0xff 0xfe 0xe1 0xf1	
29	122	1	SLRF CD flag	1	
30	123	1	SLRF Test flag	0	
31	124	1	SLRF Test timeout [ms]	10000	

Figure 18: List of all WM868-SEA module variables displayed by RFAN 3.x analyzer

Overview of all WM868-SEA module configuration parameters accessible via radio is shown in the Table 2 that can be found in paragraph 4.1.2. The individual items of the table are ordered by OID number same way as they display in the analyzer window after using of „WALK" command.

3.6.10   Overview of module configuration parameters

Overview of configuration parameters that can be used for user settings of the WM868-SEA module is shown in the Table 2 below. The parameters are presented in the same order as they appear in the List of configuration parameters obtained by „WALK" command of wireless configuration via radio (see paragraph 3.6.9).

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

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

Table 2: Overview of WM868-SEA module configuration parameters

OID	Index	OID Name	Description	Default
1		Device name	Manufacturer device name	read only
2		Device type	Manufacturer device type	read only
3		Device subtype	Manufacturer device subtype	read only
4		Manufacturer #	Device serial number (RF 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	Device uptime from reset (s)	read only
13		Systime	System time in seconds	read only
14		Reset code	Las reset code	read only
15		Configuration status	Configuration saving status	read only
16		Manufacturer ID	Watermeter serial number	
61		Sequence #	Transaction sequence number	0
100	1	Input value	Current counter status	0
105	1	Temperature	Sensor temperature (not used)	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	Regular broadcasting period (sec)	1800
109	2	SISA timeouts	Period of A/D measurement (sec)	300
109	3	SISA timeouts	Receiving interval after transmission (50 ms)	4
109	4	SISA timeouts	Re-transmission period (50 ms)	1
109	5	SISA timeouts	Maximum number of re-transmissions	1
110	1	SLRF Channel	Frequency channel number	0
111	1	SLRF Hop Count	Maximum number of repeating message	3
114	1	SLRF Group Address	Module group (multicast) address	0
116	1	SLRF Repeater Flag	Switching of repeating mode	0
118	1	SLRF My Address	Module RF address	read only
122	1	SLRF CD Flag	Module transceiver mode (Carrier Detect)	1
123	1	SLRF Test flag	Switching of test broadcasting	0
124	1	SLRF Test timeout	Period of test broadcasting (50 ms)	20

3.7 Structure of module data messages

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 19.
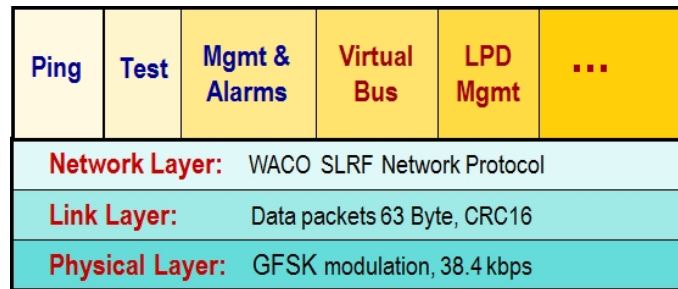

Figure 19: WACO SLRF protocol structure

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 20.
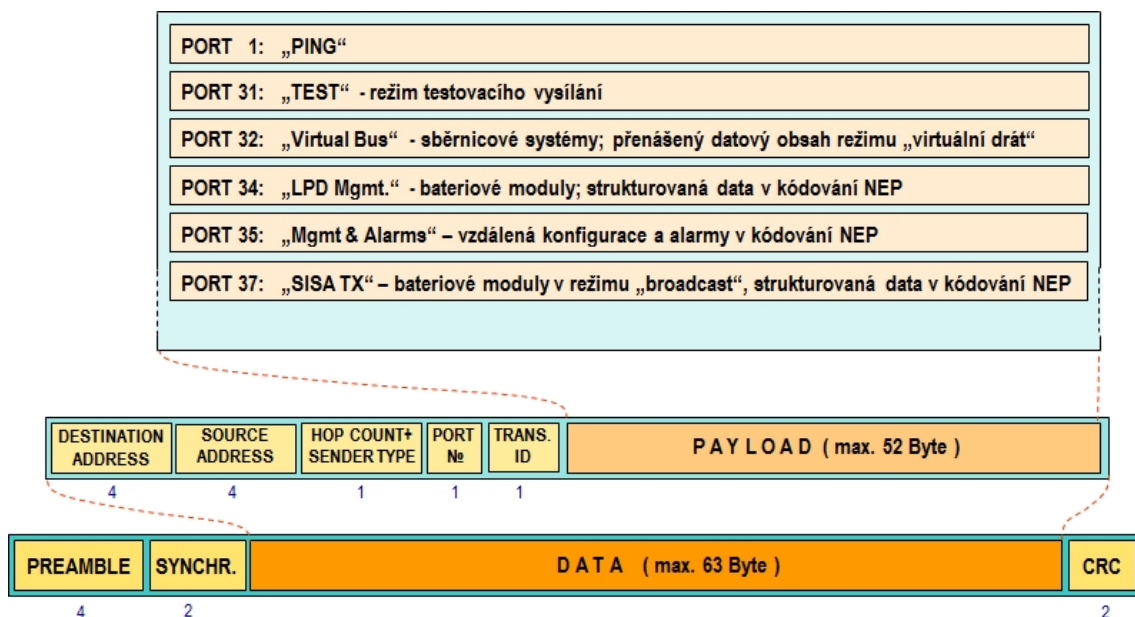

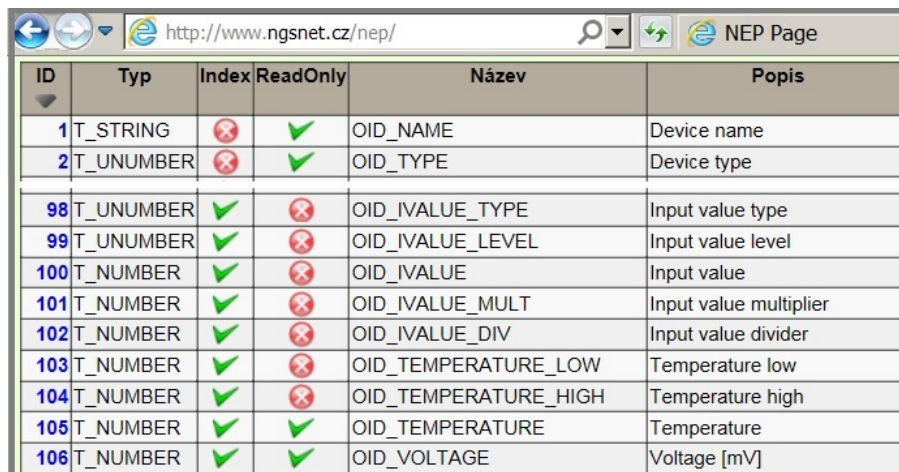Figure 20: Structure of WACO system data packet

The WM868-SEA module is intended for reading of residential watermeters of the **„Residia-Jet" and „Residia-Jet-C"** series and broadcasting of current status („reading") of connected watermeter into the local WACO RF network in form of RF messages of „INFO" type. Transfer of INFO-messages is carried out by „SISA_TX" application (port number 37), that is one of „LPD Management" group of applications (LPD=Low Power Devices) used for data collection from battery powered modules. Battery powered „LPD devices" typically work in „active mode", when the devices actively broadcast INFO-messages with preset broadcasting period and don't expect confirmation of their receiving.

The INFO-message of WM868-SEA module contains following variables:

- current status of module **system time** in seconds (OID=13)
- current status of module **battery voltage** in millivolts (OID=106/1)
- current status of module **processor temperature** in tenths of Celsius (OID=105/2)
- current **watermeter (counter) status** (OID=100/1)

- preset **watermeter serial number** (OID=16)

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 21.

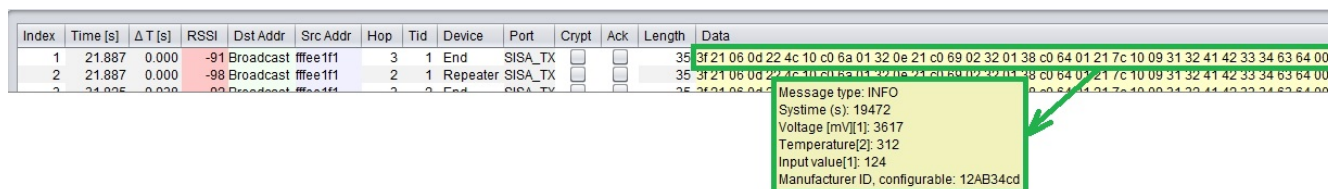Figure 21: Preview of „NEP coding table" for coding of variables in WACO system

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.

View of WM868-SEA module INFO message, as seen in „Packets" table of RFAN 3.x analyzer, is shown in the figure 22. Decoded values of message variables can be displayed in „tooltip" window by placing of cursor over the „Data" field of the message.

Figure 22: View of WM868-SEA module INFO message received by RFAN 3.x analyzer

4 Operational conditions

This section of the document describes basic recommendations for transportation, storing, installation and operation of WM868-SEA radio modules.

4.1 General Operation Risks

The WM868-SEA modules are electronic devices power-supplied by internal batteries that detect revolving of watermeter mechanical counter and register water consumption.

During their operation be aware mainly of the following risks:

4.1.1 Risk of mechanical and/or electric damage

The devices are enclosed in plastic boxes, so that the electrical components are protected from the direct damage by human touch, tools or static electricity.

The device is intended for using in normal internal environment with mounting on the top of watermeter by clicking into watermeter locks. In normal operation no special precautions are needed, besides avoiding of the mechanical damage from strong pressure or shocks and protection against water inundation.

Installation of the module can be performed only by a person with necessary qualification in electrical engineering and at the same time trained for this device installation.

4.1.2 Risk of premature battery discharge

The devices are equipped with the long duration batteries. Battery life can be influenced by these factors:
- storage and operation temperature – in high temperatures the spontaneous discharging current increases, in low temperature the battery capacity reduces;
- frequency of radio-transmitting.

Modules are delivered with preset period of regular transmitting of info-messages as stated in the configuration table in section of this document and the battery life cycle is quoted for this period. If the transmitting period is significantly reduced, battery life will be proportionally shortened. One cycle of reading by walk-by system spends approximately same capacity of battery as 5 - 6 days of on-line operation with 30 minutes period.

The battery life shortens also when the radio network is overloaded by the heavy radio traffic which causes the situation when each module has to wait in the active mode to catch the moment of „radio silence" to be able to send its message. Such situation can happen when the installation contains hundreds of WACO radio modules in the same frequency channel, or when there is a high number of repeaters installed, or when the traffic is loaded by external disturbing signal. However, these factors can be eliminated by the professional design of the WACO network topology and setting up of correct parameters (especially „Repeat", „Repeat TimeOut", „Rx TimeOut" and „WOR") in accordance with producer's recommendation.

4.2 The condition of modules on delivery

Modules are delivered in standard cardboard boxes. The modules are commonly delivered with battery switched off. There is an exception in case the modules are delivered with additional sealing by silicon filling - in this case the modules are switched on.

4.3 Modules storage

It is strongly recommended to store the modules in dry rooms or halls, in the temperature interval $(0 \div 30)$ °C. To prevent the unwanted discharging of internal battery it is recommended storing the modules with batteries disconnected and activate the battery during mounting (with exception of modules with additional sealing by silicon filling - see paragraph 4.2).

4.4 Safety precautions

Warning! Mechanical and electrical installation of the WM868-SEA module can be provided only by a person with necessary qualification in electrical engineering.

4.5 Environmental protection and recycling

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

4.6 WM868-SEA module installation

The WM868-SEA modules are enclosed in plastic casings with an IP20 degree of protection. The casing consists of two parts:
- the module base with the printed circuit board;
- transparent cap of the box.

Both parts are equipped with plastic locks for fitting of cap on the base and for locking the module to the watermeter.

Detailed view of the module without cap (left) and assembled with cap (right) can be seen in the figure 23. Position of configuration connector on the module printed circuit board is marked by green colour, module battery switch (jumper) is marked by red colour.
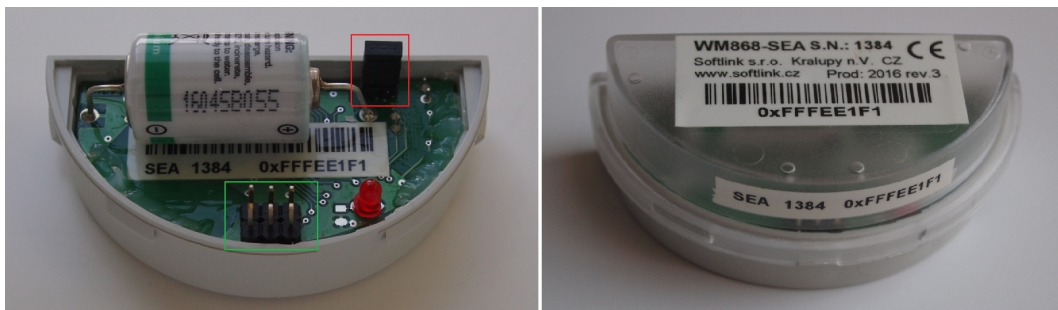

Figure 23: Detailed view of WM868-SEA module

When mounting the device follow these instructions:

- remove the cap from the module (by fingers tug, or thin screwdriver...);
- insert the module base into the watermeter slot and press until both plastic locks click and catch the module in position;
- switch-on battery by short-circuiting of shortening pins (insert „jumper" to shortening connector on the PCB - see figure 23);
- connect configuration cable to the module configuration connector as described in the paragraph 3.1.1 and complete module diagnostics and configuration as described in chapter 3 „Module configuration". If the module was pre-configured in preliminary phase of installation, it is necessary to set-up at least watermeter serial number and counter initial value as described in the paragraph 3.5.5 „Setting of watermeter number and counter initial value". Alternatively, this setting can be performed via radio as described in paragraph 3.6.4. After setting is completed, save configuration to memory.
- if possible, check functioning of the module by turning the tap and running some quantity of water. „Water meter" value in the configuration parameters overview should adequately change;
- insert the cap on the module base and press until all the plastic locks click and catch the cap in position. Appearance of the WM868-SEA module attached to the watermeter can be seen in the figure 2;
- if the internal rules or the mounting process needs the antifraud seal to be installed (as the protection from the unwanted influencing), stick the antifraud seal across the joint between the module and watermeter and also between the two parts of the module.

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

4.7 Module replacement

When there is necessary to replace the WM868-SEA module due to the module failure or due to battery discharging follow this procedure:

- check the antifraud seal before dismantling – the antifraud seal damage must be solved according to the internal rules of the customer/project;
- very carefully remove the module from watermeter (by fingers tug, or thin screwdriver...);
- by pulling of fingers and levering with using of thin screwdriver around the cap carefully remove the transparent cap from the module base. Switch off battery by removing of „jumper" from shortening connector on the PCB and mark the module visibly as „defective". Alternatively, just mark the module as defective, the module can be opened and switched off later (in workshop);
- put the new module to the watermeter and switch its battery on by inserting of „jumper" to shortening connector. Perform module diagnostics and configuration as described in paragraph 4.9 „Functional check of the module". Check especially these parameters:
    - frequency channel, hop-count and WOR function (see paragraph 3.6)
    - watermeter serial number and counter initial value (see paragraph 3.5.5)
    - RF-subsystem timers (see paragraph 3.5.4)
- insert the cap on the module base and stick the antifraud seal;
- fill the prescribed documentation, primarily write down the RF-address and seal number of the module and current status of watermeter counter. If possible, arrange making of all appropriate changes in the database of the remote reading system immediately;

4.8 Module dismantling

When dismantling, remove carefully the module from watermeter (by fingers tug, or thin screwdriver...). Remove transparent cap and switch off battery by removing of „jumper" from shortening connector on the PCB (this operation can be performed afterwards in workshop). Mark the module visibly as „dismantled" and fill in the relevant documentation, prescribed for this situation by the internal rules. If possible, arrange deactivation of the module in the database of remote reading system immediately.

4.9 Functional check of the module

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

- check broadcasting functionality by RFAN 3.x analyzer in "Packets" or "Radar" mode (according to the analyzer documentation) with using of „test broadcasting" function described in the paragraph 3.5.6 „Setting of test broadcasting".
- perform overall check of transmitter and receiver functioning by testing of remote configuration via radio with using of RFAN 3.x analyzer (i.e. reading of any module's parameter by "GET" command as described in chapter 3.2 „Configuration of the module via radio");
- check implementation of the module within remote reading system (including correctness of setting of the central database) by checking of correctness of the data rendered by the module.

4.10 Operation of the WM868-SEA module

When working in the **automatic reading system** the WM868-SEA module performs remote reading of watermeter status and broadcasts measured values fully automatically. The greatest risks of module service breakdown are commonly caused by human activities within the installation site, especially risk of mechanical damage of the module by improper handling around the installation site, or by temporary or permanent shading of radio signal by metal object (e.g. due to building operations). The typical result of the damage is full loss of connection with the module. Shading of the module can cause decreasing of radio signal strength with negative influence on the reliability of remote reading, or full interruption of radio connection.

To prevent an unexpected breakdown, it is recommended to perform regular monitoring of all broadcasting data, i.e. readings, processor temperature and battery voltage. If some of the parameters goes beyond the common steady value, it is recommended to contact the installation site caretaker and ask for the potential cause of the anomaly or perform the physical check on the installation site.

When working in the „**Walk-By" reading system** the risks of the mechanical damages are the same as for the on-line reading system and can be eliminated in the same way. Correctness of read data can be checked only during the walk-by reading, when the data are available. If there is any anomaly in the data, it is recommended to perform a visual inspection of installation site immediately and check correctness of read data by comparing with mechanical counter value.

The risk of **premature battery discharge** could be eliminated by respecting the instructions described in paragraph 4.1.2.

5 Troubleshooting

5.1 Possible causes of module failures

If during operation of WM868-SEA module some anomaly, malfunctions or other troubles are recognized, the possible causes of the failures can be classified by following categories:

5.1.1 Power supplying failures

The module is supplied by electrical power from the long-life internal battery. Approximate battery life is specified in paragraph 1.2 „Modul usage". Battery life can be negatively influenced by circumstances that are described in detail in paragraph 4.1.2 „Risk of premature battery discharge".

Low battery power becomes evident as irregular drop-outs of signal reception from the module, finally the radio connection with the module completely fails.

Battery is soldered into the printed circuit board of the module and the module has to be disassembled for its replacement. Battery replacement can be performed only by qualified and experienced person. Soldering of battery by unskilled person can cause irretrievable damage of the module. There are only top-quality batteries used in the wacoSystem modules, that have been carefully selected and properly tested. In case of battery replacement by user the new battery parameters should meet same technical requirements (type, capacity, voltage, current load, auto-discharging current...) as the original battery. It is strongly recommended to use for replacement same type of battery as used in production.

5.1.2 System failures

As „system failure" are considered mainly failures of module's processor, memory, internal supplying or any other failures that cause a complete breakdown of the device. If module's battery has correct voltage with no signs of discharging and the device still does not communicate through its configuration port and does not respond to any commands and this status will not change even after module's restart (by switching off and switching on its battery), the system failure probably occur. Perform the replacement of the module according to the instructions in paragraph 4.7 and check functionality of the new module. If the new device works properly, label the original module as „defective" and fill in the appropriate documentation prescribed by internal rules for this case.

5.1.3 Failures of sensing

Failures of registration of watermeter revolution typically appear as „zero consumption" of the meter even though the consumption of the meter is evident, or generally, meter status from remote reading is different than meter status shown in meter's mechanical counter. In this case try to proceed with troubleshooting of the connection with meters in following steps:

1. visually check the watermeter-module composition, especially whether the module is correctly mounted on the watermeter, and whether the meter or module are not damaged;

2. if the module is correctly placed and fixed to the supported type/modification of watermeter and there are no signs of damage, remove the module from watermeter and visually check pivotal wheel (disc) of watermeter. If there is no damage on the disc, the problem is the most probably in the malfunction of the WM868-SEAmodule. Replace the module following the instructions in the paragraph 4.7.

3. if registration of watermeter revolution does not work properly even after module replacement, the problem is the most probably in the malfunction of the watermeter.

5.1.4 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 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.).

5.2 Troubleshooting procedure

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

1. The module communicates normally, readings from meters/sensors are available (in on-line or in walk-by mode), but data from some meters/sensors are apparently incorrect. In this case it is recommended to check functionality of the module subsystems in following order:
   - check correctness of central application configuration related to the watermeter, especially correctness of its ID, address and association of the watermeter with right reading module.
   - check setting of counter initial value;
   - check functionality of registration of watermeter revolution as described in paragraph 5.1.3 „Failures of sensing".

2. Data from the module are coming irregularly, with periodical breakdowns. In this case it is recommended to check functionality of the module subsystems in following order:
   - check functionality of the transmitting and receiving of the radio-signal as described in the paragraph 5.1.4 „Transmitter and receiver failures";
   - check functionality of internal battery as described in the paragraph 5.1.1 „Power supplying failures";
   - check functionality of the device that receives messages from the WM868-SEA module (local gateway, master, collection unit...) according to the appropriate documentation.

3. No data are available from the WM868-SEA module. In this case it is recommended to check functionality of the module subsystems in following order:
   - check correctness of setting of the module in the central system database;
   - check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures";
   - check functionality of the system as described in the paragraph 5.1.2 „System failures";
   - check functionality of the transmitting and receiving of the radio-signal as described in the paragraph 5.1.4 „Transmitter and receiver failures".

NOTE: The WM868-SEA module is a reliable device with relatively simple and resilient construction, so that any possible failure of the device is very likely caused by external circumstances, especially mechanical damage, excessive humidity, or discharging of internal battery. After each replacement of the module caused by its failure it is recommended to check the root cause of the failure and take necessary measures to eliminate any persisting troubles.

6   Additional information

This manual is focused on description, parameters and configuration options of radio modules WM868-SEA 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 and WB868 (Wireless M-BUS), or WS868 (Sigfox) series of the modules can be found on the manufacturer website:

<p align="center">www.wacosystem.com
www.softlink.cz</p>

If interested in any additional information related to application of radio modules of WM868, WB169, WB868, or WS868 series or other manufacturer's equipment for telemetry and remote reading of consumption meters, feel free to contact the manufacturer:

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