WIRELESS COMMUNICATION SYSTEM
Wireless M-BUS

WB169-SI4

Revision 4.0

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1 Introduction

This document describes features, parameters and setting possibilities of the WB169-SI4 module, which is used for reading of either consumption meters with pulse output (water meters, electrometers, gas-meters...), or two-state sensors (e.g. door contacts, flood detectors, fire detectors, electronic seals...etc.) and for radio-broadcasting of the data from connected meters/sensors to the superior remote reading system in form of Wireless M-BUS standard messages. The WB169-SI4 module works either in unidirectional communication mode N1, or in the bidirectional N2 mode. In both modes the module regularly broadcasts information messages of „User Data" type intended for superior „master" device. In bidirectional N2 mode it is possible to use a back channel from master device, that can be used for transfer of „Request" type of messages with remote configuration demands. In „alarm' mode" the module sends „User Data" type of messages based on the sensor status changes. These messages are sent immediately, out of regular broadcasting interval.

1.1 Wireless M-BUS Communication Protocol

Wireless M-BUS is the communications protocol described by international standards EN 13757-4 (physical and link layer) and EN 13757-3 (application layer), which is intended primarily for radio transmission of remote reading values from consumption meters and sensors. Protocol Wireless M-BUS (hereinafter „WMBUS") is based on a standard M-BUS definition (uses the same application layer as M-BUS standard), but is adapted for data transfer via radio signals.

Communications via WMBUS protocol works in Master-Slave mode, where „Master" is a collecting data device, „Slave" is a providing data device. Slave device could be integrated or external radio module transmitting data from the meter/sensor. The communications protocol WMBUS defines several communication modes (simplex or duplex). If working in simplex mode a „Slave" device only transmits messages to „Master" that these messages receives. If working in „bidirectional" mode, it is possible to use a back channel from „Master" device to „Slave" device for „Request" type of messages, that can contain e.g. request for the change of slave's configuration.

Wireless M-BUS communications protocol partially supports repeating of the messages. If receiving from some „Slave" device is not possible because of the low level of radio signal, the messages can be re-transmitted (repeated) by appointed element of the radio network (repeater or slave with such functionality). Each repeated message is marked as „repeated message" so as not to be repeated again.

1.2 Module usage

The WB169-SI4 module can be used either for remote reading up to four consumption meters with pulse output, or for transfer of alarm messages from up to four two-state sensors. It is possible to combine both type of usage.

When using for **remote reading of consumption meters** (water meters, gasmeters, electro-meters...), up to four meters with standard pulse ("SI") output can be connected to the module. The meters can be of different kind, with different quantities and units and with different conversion rates. The module continuously registers incoming pulses (generated by meters) into its internal counters, with using of preconfigured multipliers/divisors converts current status of each counter into the required output units (m3, kWh, MJ...) and broadcasts info-messages with current statuses of all connected meters as Wireless M-BUS „User Data" messages.

When using for **remote monitoring of sensor statuses** (door contacts, flood detectors, fire detectors, electronic seals..), up to four two-state sensors with "off/on" ("0/1") outputs can be connected to the module. The sensors can be of different kind, with different type of output and different logic of signaling. The module continuously monitors status of each sensor and records all its changes. If the counter is switched into alarm mode, the module immediately transmits alarm messages according to preselected rule. The module can regularly broadcast in each „User Data" info-message either number of „0-to-1" transitions, or current sensor status ("0" or "1"). If the counter is switched into the alarm mode, the module sends extra „User Data" message immediately at the change of sensor status.

Each regular information message contains following entries:

- module identification
- last values of all four counters at the moment of message sending
- actual statuses of all connected sensors in alarm mode (at the moment of message sending)
- operational entries from embedded sensors (battery voltage, processor temperature...) ...)

Each alarm message contains only WMBUS header with module identification and information about the actual status of that port, on which the status was changed.

Detailed information about the content and format of information and alarm messages can be found in paragraph 3.7. Information and alarm messages are transmitted either in open mode (without encryption), or encrypted by AES-128 encryption key. The messages are transmitted on the 169.4 MHz frequency with data rate from 2.4 kbps to 19.2 kbps (according to used frequency channel). Messages can be received either by WB169-RFE communication gateway (WMBUS Ethernet GateWay produced by SOFTLINK), or any other „Master" device that complies with the Wireless M-BUS EN 13757-3 / EN 13757-4 standard for 169 MHz frequency band.

The module is enclosed in humidity-proof plastic casing and can be used in interiors as well as in exteriors. Newest modifications of the module (labeled as "Rev. 2" and higher) are enclosed in transparent casings that enables their wireless configuration with using of optical USB-IRDA converter. External appearance of the WB169-SI4 module is shown in the Figure 1.

Figure 1: Appearance of the WB169-SI4 module in transparent and non-transparent casing

The module is power supplied by internal battery with 5.8 Ah or 13 Ah. capacity (see ordering options). If using of 13 Ah battery, the module lifetime for 60 minutes broadcasting period is more than 8 years. If using of 5.8 Ah battery, the lifetime is up to 8 years for 120 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 for module storage and operation. Operation in bi-directional mode (N2) with using of back channel decreases the battery lifetime by 5 %.

1.3 External synchronization and alarm functions

TheWB169-SI4 module can be used in a wide variety of applications within different industries. The **external synchronization** function is intended especially for measurement of electrical energy and gas. When using this function, broadcasting of the module is synchronized from external source of synchronization pulses. It can be used for measuring of energy consumption in standardized 15-minutes intervals synchronized with parallel measurement of superior energy/gas distributor. Detailed description of this function can be found in paragraph 3.5.4 „WMBUS' group commands for setting of messages".

The WB169-SI4 module enables also monitoring of operational parameters of objects by reading of **sensor statuses**. Typical example of this usage is monitoring of opening/closing of overhead doors of halls, where the module can provide information about current status of each door and also measure number of open/close cycles of the doors. Another example is monitoring of current statuses of circuit breakers or closing valves, or monitoring of safety-loops („electronic seals"). Detailed description of special settings for sensor monitoring purposes can be found in paragraph i 3.5.8 „Setting of sensor inputs".

The special **alarm functions „Leak" and „Burst"** are intended for measuring of water and gas. The „Leak" function serves for detection of permanent minor leaks in water/gas distribution systems. The „Burst" function serves for detection of breakdowns in water/gas distribution systems, when some kind of accident (e.g. broken pipe) causes huge overconsumption. Each of these functions can be configured for any port of the module. Corresponding „Leak" and „Broken Pipe" alarm messages are transmitted immediately after detection of the alarm status. Coding of these alarm messages complies with M-Bus standard. Detailed description of alarm messages can be found in paragraph refsection:struktura-zpravy „Structure of module data messages".

Detailed description of „Leak" function can be found in paragraph 3.5.6 „Description and setting of „Leak" alarm function". Detailed description of „Burst" function can be found in paragraph 3.5.7 „Description and setting of „Burst" alarm function".

1.4 Bi-directional communication mode

If the WB169-SI4 module is preset for working in **bi-directional communication mode N2**, it could receive the **„Request" type of messages** according to the Wireless M-BUS standard. These messages can be originated by superior system or by superior „Master" device and can contain commands for remote configuration of following parameters:

- setting of transmitting power;
- setting of info-messages broadcasting period;
- correction of initial statuses of pulse counters in form of relative corrections („add NN"), or absolute corrections („set NN").

Receiving of „Request" type message take place always during the 500 ms long time window that starts immediately after transmitting of regular „User Data" info-message. During this interval the WB169-SI4 module opens its receiver so as to be able to receive possible „Request" message. The module confirms receiving of „Request" by sending of „Acknowledgment" type of message.

Management of „Request" type of messages must be implemented into the central application software or into the superior „Master" device. The messages are coded by M-Bus standard principles with short Wireless M-BUS header with special indication of „Request" type messages (C-byte ="53", CI-byte = "5A"). The message contains one data block (with appropriate DIFE/VIFE code and required value) for each parameter, that should be remotely changed. More detailed description of „Request" type of message can be provided by producer of the WB169-SI4 module on request.

1.5 Variants and ordering codes

The WB169-SI4 module is delivered i four variants with different capacity of internal battery and with different degree of protection. There are four ordering codes for delivery of required hardware configuration of the module:

- **WB169-SI4-B13** - ordering code for variant with **13 Ah battery** and **IP65** degree of protection;
- **WB169-SI4-B13/IP68** - ordering code for variant with **13 Ah battery** and **IP68** degree of protection;
- **WB169-SI4-B5** - ordering code for variant with **5.8 Ah battery** and **IP65** degree of protection;
- **WB169-SI4-B5/IP68** - ordering code for variant with **5.8 Ah battery** and **IP68** degree of protection.

Together with the WB169-SI4 module also some time-tested sensors for industrial use can be ordered directly from module's producer (e.g. magnetic position sensor, security loop, flood detector...). Actual list of offered sensors is available at producer's e-shop: www.softlink.cz/obchod.

Optical configuration of the module is available from the version marked on the product label as „Rev. 7" and higher.

„External synchronization", „Leak" and „Burst" functions are available from the version marked on the product label as „Rev. 7" and higher and with software version „SW Revision: 3" and higher.

„Alarm mode" functions are available from the version marked on the product label as „Rev. 7" and higher and with software version „SW Revision: 4" and higher.

2 Technical parameters overview

Overview of WB169-SI4 module technical parameters is shown in the Table1 below.

Table 1: Overview of WB169-SI4 module technical parameters

RF subsystem parameters		
Frequency band *	169.40625 to 169.46875	MHz
Modulation *	2-GFSK, 4-GFSK	
Bandwidth *	12.5 or 50	kHz
Transmitting power	500	mW
Sensitivity of back-channel receiver	-109	dBm
Communication protocol	Wireless M-BUS	
Communication mode (by EN 13757-4)	N1, N2	
Transmission speed *	2400, 4800, or 19200	Baud
Configuration interface RS232		
Transmission speed	9600	Baud
Operation mode	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, none parity	
Signal level	TTL/CMOS	
Optical configuration interface		
Transmission speed	115 200	Baud
Optical I/F specification	complies with IrPHY 1.4 standard	
Pulse/sensor inputs		
Resistance of released contact	more than 10	MΩ
Resistance of short-circuited contact	less than 1	kΩ
Maximum frequency of input pulses	10	Hz
Minimum pulse length	40	ms
Power supplying		
3,6 V lithium battery capacity	5.8 or 13	Ah
Weight and dimensions		
Length	145	mm
Width	45	mm
Height	100	mm
Weight	cca 300	g
Storage and installation conditions		
Installation environment (by ČSN 33 2000-3)	normal AA6, AB4, A4	
Operation temperature range	(-20 ÷ 40)	°C
Storage temperature range	(0 ÷ 40)	°C
Relative humidity **	95	% (w/o condensation)
Degree of protection **	IP65 or IP68	

* in reliance on selected frequency channel - see EN 13757-4, Mode N, Physical link parameters (Table 18).

** modules with additional silicon filling are waterproof with IP68 degree of protection.

3 Configuration of the WB169-SI4 module

Configuration parameters of the WB169-SI4 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 **„USB-IRDA"** converter

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 WB169-SI4 parameters via configuration cable".

Description of interconnection of the "USB-IRDA" converter with PC and general rules of configuration with using of this **optical converter** are described in the section 3.2 „Configuration of the WB169-SI4 module with using of optical converter". The description and meaning of the parameters that can be changed by optical converter can be found in the section 3.6 „Setting of parameters by using of optical „IRDA" converter".

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 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 an manufacturer's original configuration cable with „USB-CMOS" converter (see Figure 3). 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 2).

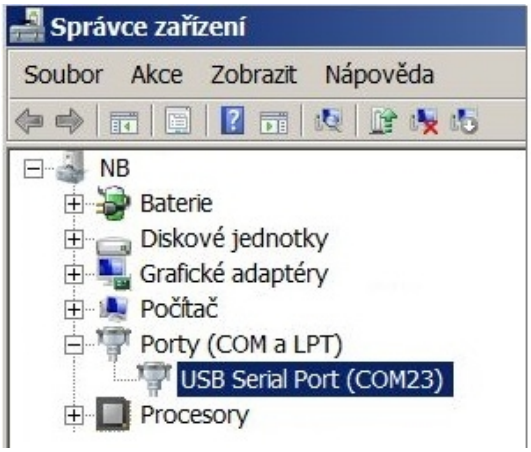


Figure 2: Appearance of the USB-CMOS converter in Windows „Device Manager"

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 module's printed circuit board. Thus the computer is connected with the module and ready for performing any changes in configuration (see figure 3 „Configuration via USB port of computer").

Figure 3: 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.

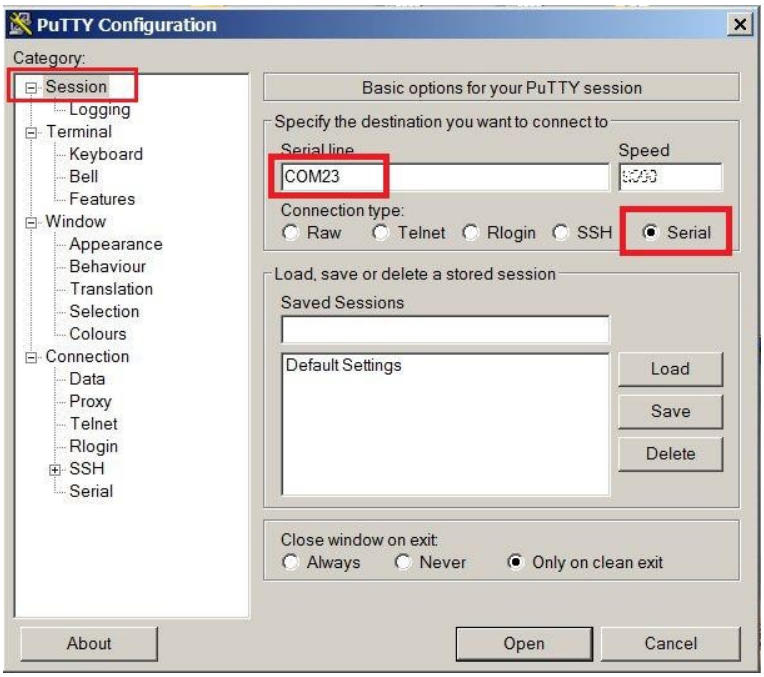


Figure 4: Terminal setting for serial line communication

„PuTTY" software runs after clicking on the downloaded file „putty.exe". There will open a window of the terminal communication (see Figure 4). 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 9600 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 2).

Click on „Open" button in „PuTTY" program and open the terminal window. After pressing of „ENTER" key there will appear a command prompt **„mon"** which announces that the module is ready to be configured (see figure 5).

Figure 5: 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 „mon" or „mon" format (see figure 5);
- 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 with using of optical converter"

The module is equipped with an InfraRed interface that is intended for configuration with using of **„USB-IRDA"** converter. This converter serves for wireless transfer of configuration data (commands and values) between module and configuration computer via modulated beam of light in infrared band. By using of this kind of configuration there is possible to make all common settings through the transparent casing without necessity to open the module's cover (see figure 6). Optical beam goes through the transparent casing and it is decoded by the infrared modem placed on the module's printed board (PCB). A special software application program **„WACO OptoConf"** written in Java language can be used for required settings. This program can be installed to the computers with MS Windows as well as Linux operating systems.

3.2.1 Installation of the „WACO OptoConf" program

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

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

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

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

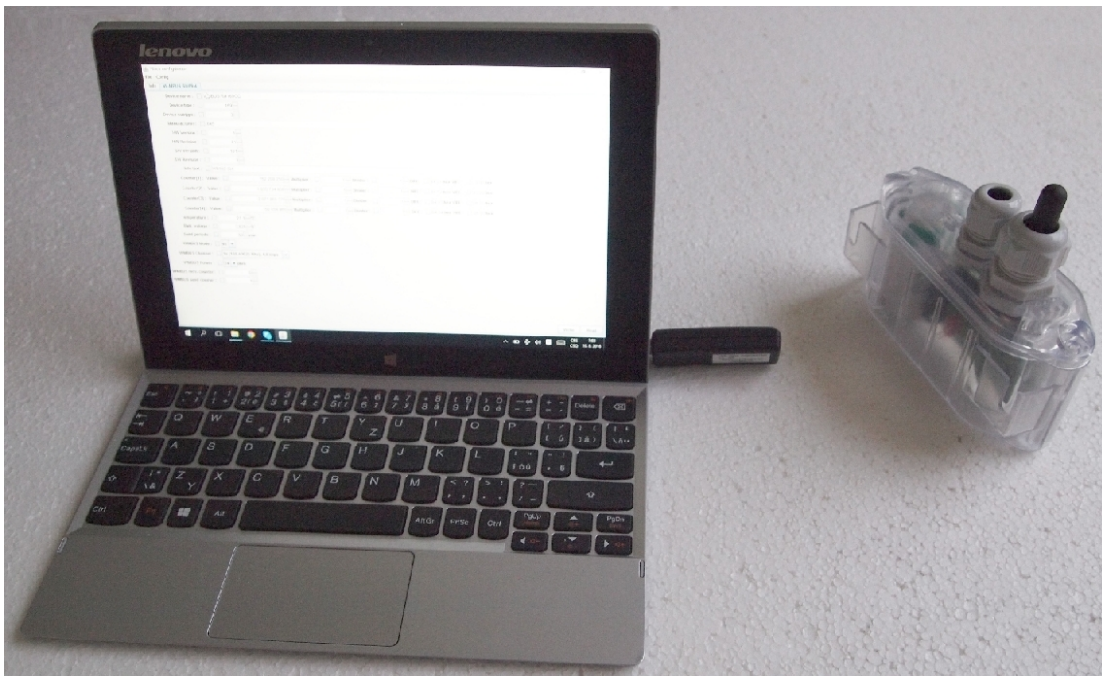


Figure 6: Configuration of the module with using of optical converter

64-bit version for Linux). The Java Runtime Environment program is available on the official Oracle WEB site for Java support here:

Download Free Java Software

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

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

Before starting of the **„WACO OptoConf"** program connect the **„USB-IRDA"** converter to USB port of the computer. When the converter is connected to computer for the first time an operating system will automatically find and install correct driver for the converter (i.e. generic driver for „USB Serial Device" category of device). After driver is successfully installed to MS Windows computer, the device should appear in the „Device Manager" in section „Ports (COM and LPT)" as „USB Serial Device (COMx)" (see figure 7).

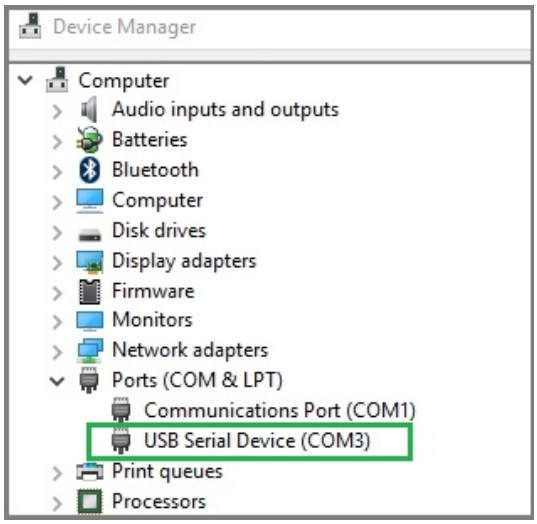


Figure 7: Displaying of the optical converter in the Windows' „Device Manager"

Older versions of MS Windows do not support generic driver for support of serial ports via USB. I this case install the „ugw3.inf" driver from delivered installation pack according to the instructions mentioned in the paragraph 3.4 „USB GateWay" and „USB-IRDA" driver installation" below.

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

Start the **„WACO OptoConf"** program by clicking on the **„optoconf.jar"** file name or to the pre-created desktop shortcut to this file. Program window **„WACO configuration"** will open (see figure 8). In **Config/Port** item of menu choose name of serial port assigned to USB-IRDA converter by operating system (see figure 7). The program is thus fully functional and ready for configuring parameters. Menu item **„Config/Look and Feel"** serves only for choice of window color and design by clicking to one of pre-configured options.

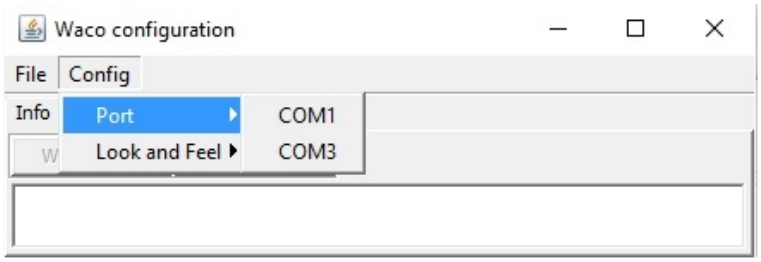


Figure 8: Displaying of „WACO OptoConf" configuration window"

By clicking to **„Walk device"** button the list of all variables that are used for module configuration can be displayed (see figure 9.

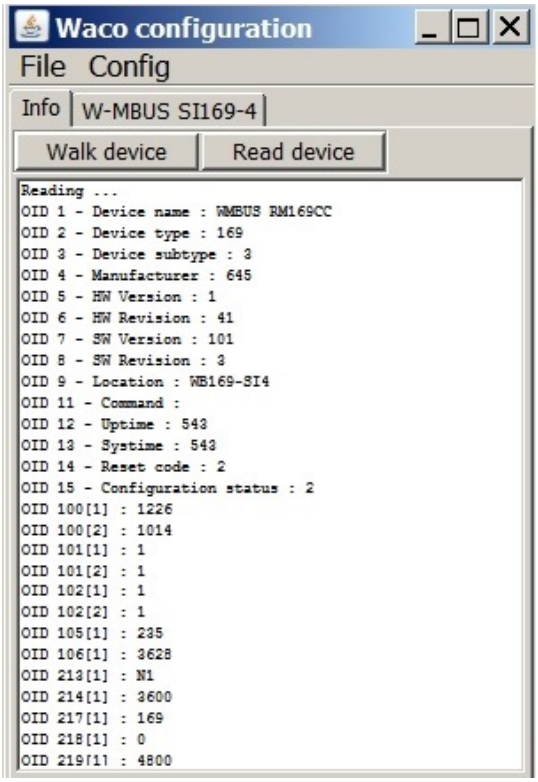


Figure 9: List of variables in the working window of „WACO OptoConf" program

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

By clicking to **„Read device"** button the textbfconfiguration table with all the relevant parameters of the module is displayed in the working window. Non-configurable (read only) parameters are displayed as "inactive" (with gray editing fields), while parameters that can be changed by „WACO OptoConf" program are displayed inside white editing fields ("active fields"). Example of configuration table of the module is depicted in the figure 10.

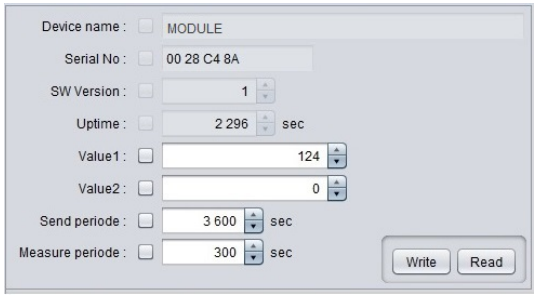


Figure 10: Example of module's configuration table in the „WACO OptoConf" window

3.2.4 General rules for configuration of the module by optical converter

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

Configuration can be performed either on the working desk or with using of a special holder for attaching of optical converter to the module.

Configuration on the **working desk** means that computer as well as the module are placed on the any convenient work surface (e.g. on the desk - see figure 6). In this case the module should be placed not more than 15 cm from the tip of converter, the module's printed board must be facing to converter by its element side, and module's optical sensor should be lying approximately in the converter's axis of symmetry (i.e. in the direction of the infrared beam). Approximate position of the optical sensor of the module is marked in the figure 1 by green arrow. Correctness of mutual position module/converter can be checked by displaying of the current configuration as described below. It is necessary to fix and keep such position in which the communication between module and converter is reliable.

When working directly at the installation site always use **a special holder** that is designed for attaching of converter to the module. Put the holder to the WB169-SI4 module as shown in the figure 11.

Figure 11: Attaching of optical converter to the holder

Put holder to the module from the element side and shift it to that side where the optical sensor is placed (approximate position of the optical sensor is marked in the figure 1 by green arrow). Connect the converter with laptop by using of extension USB cable and insert the converter to the slot in the holder as shown in the picture. Check correctness of converter's position by displaying of the current configuration as described below. If the connection is not reliable shift the holder along the module's cover. The best position is if the converter is right opposite to sensor.

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

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

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

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

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

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

For editing of individual items keep following rules:

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

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

3.3 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).

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).

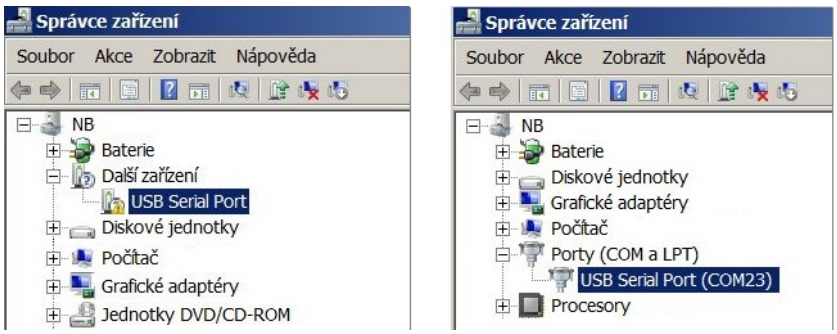


Figure 12: Appearance of converter without driver in the Windows „Device Manager" table

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).

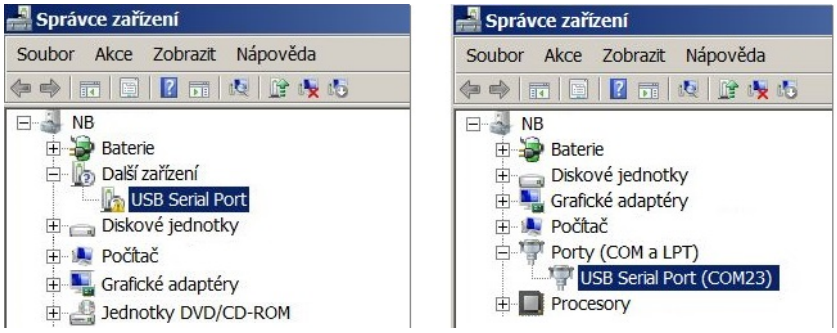


Figure 13: Displaying of the device without driver in "Device Manager" window

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).

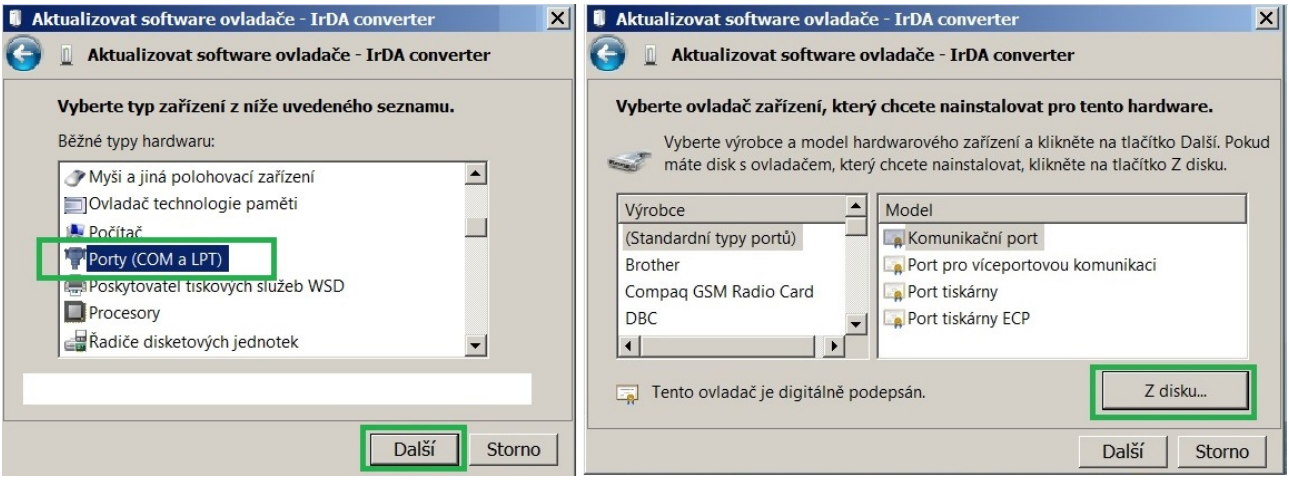


Figure 14: Manual selection of the driver file from a folder

After that a new „Find file" window appears. Set the folder with driver file in the „Browse" tool, select „ugw3.inf" file name that will appear in the window and click to „Open" button (see figure 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).

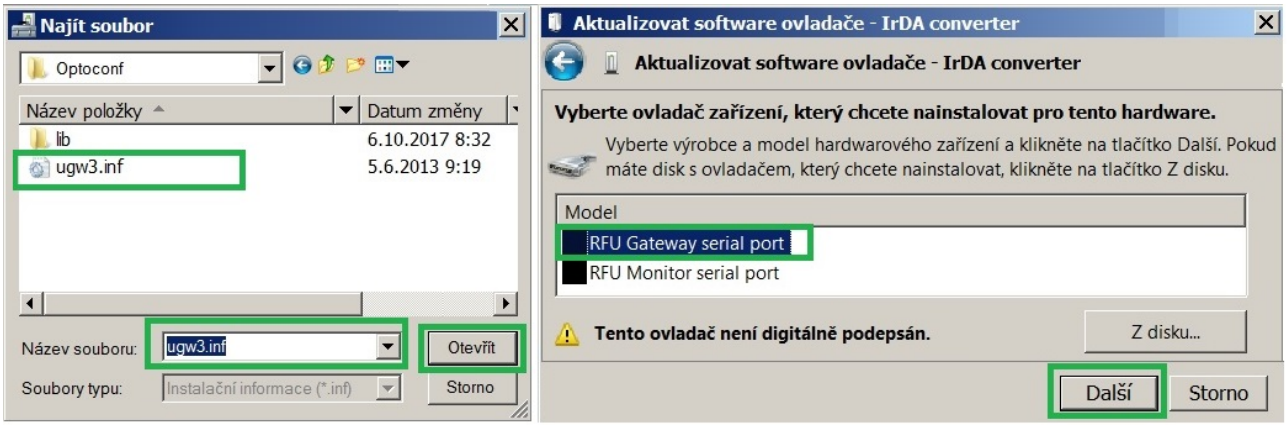


Figure 15: USB driver installation

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 WB169-SI4 module parameters by configuration cable

3.5.1 List of module configuration parameters

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

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

```
mon#show
Show configuration :
 MBUS ID : 00000588
 MBUS version : 3
 MBUS manufacturer : SFT
 MBUS medium : 7
 MBUS manuf info : SI4N3
  MBUS value[0] DIB: 04, VIB: 13 00, multiplier 1, divider 1, mode falling, quick, alr: none
  Leak detection periode 24 hour(s), zero periode 90 minutes
  Broken pipe min. 50 pulse/10 min. during 30 minutes
  MBUS value[1] DIB:44, VIB: 13 00, multiplier 1, divider 1, mode falling, quick, alr: none
  Broken pipe min. 25 pulse/10 min. during 60 minutes
  MBUS value[2] DIB: 84 01, VIB:13 00, multiplier 1, divider 1, mode falling, quick, alr:none
  MBUS value[3] DIB: 04, VIB: fd 3a, multiplier 1, divider 1, mode falling, slow, alr: both
 MBUS power : 5 (27 dbm)
 MBUS mode    : N2
 WMBUS channel : 3 - chan 2a (169,43125 Mhz), 2,4 kbps
 Send periode : 60 min.
 Data will be unencrypted
 Next send : 42 min.
  No. sent : 3 msg(s)
 Configuration version 14
 SW version 1.06, date Jan 10 2018
mon#
```

The meaning of individual parameters and detailed description of their usage can be found in the following part of chapter 3.

Overview of configuration parameters with short description of their meaning can be also found in table 2 on the page 29.

3.5.2 Displaying the List of configuration commands („HELP")

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

```
mon#?
 Help :
 ---  System commands ---
deb              : Show or set debug level
ta               : Show tasks
mb               : Show mail boxes
du addr          : Dump memory
rw addr          : Read byte from addr
rb addr          : Read word from addr
sw addr val      : Set word on addr
sb addr val      : Set byte on addr
uptime           : Show uptime
reset            : Reset device
sens             : Show ADC, vcc and temperature values
?                : Show this help
 ---  WMBUS commands ---
mid              : Show or set MBUS ID (0 - 99999999)
power            : Show or set MBUS power (1 - 5)
manuf            : Show or set MBUS manufacture code (AAA)
info             : Show or set MBUS info string (0-30 chars)
vers             : Show or set MBUS version (0 - 255)
medium           : Show or set MBUS medium (0 - 255)
periode          : Change periode of send  0 - disable, >0 periode in minutes, <0 from input
mode             : Set WMBUS mode 1 - N1, 2 - N2
chan             : Set WMBUS channel, type ? for help
ekey             : Set encrypt key, point '.' no eccrypt
 ---  Inputs[0-3] ---
val              : Show or set counters values[0-3]
mul              : Set multiplier of value[0-3]
div              : Set divider of value[0-3]
dib              : Set DIF and DIFE for value[0-3]
vib              : Set VIF and VIFE for value[0-3]
det              : Detection 0 - falling, 1 - rising
dmode            : 0 - quick, 1 - slow
alr              : Send alarm : 0 - none, 1 - falling, 2 - rising, 3 - both
leakp            : Leak detection periode in hours - 0 disabled
leakz            : Leak zero periode in minutes (rounded up to ten minutes)
burstp           : Burst min puls in 10 minutes
burstt           : Burst check time in minutes (rounded up to ten minutes)
pullup           : Set pull up 0 - off, 1 - on
 ---  Configuration ---
show             : Show all configuration
write            : Write configuration to flash
read             : Read configuration from flash
clear            : Clear configuration and load defaults
 ---  Modem commands ---
mr               : Modem receive mode
mt test time     : Set test on modem, 1-TX carrier, 2-TX PN9, 0-off, time in sec., default 10
ms               : Get modem state
mi               : Get modem info
mfreq            : Set or get radio frequence correction
cfreq            : Set +- frequence correction, 1 = 1Hz
sendp            : Send nx WMBUS message
send             : Send WMBUS message
```

The meaning and usage of individual commands are described in the following part of chapter 3.

3.5.3 „System commands" group for general diagnostics

Commands „**"deb", "ta", "mb", "du addr", "rw addr", "rb addr", "rd addr", "sw addr", "sb addr", "sd addr"** and **"uptime"** are used for troubleshooting and repair of the device in a factory. **Manufacturer strongly recommends not to use these commands during common operation.**

The command **"reset"** performs the equipment reset. Its meaning and using are described in the paragraph 3.5.9.

The command **„?'** can be used to display a list (summary) of configuration commands and their parameters (so called „Help"). Its meaning and using are described in the paragraph 3.5.2.

„sens" command can be used for displaying of current values of A/D converters measuring physical quantities (battery voltage, temperature...). This command is intended only for module checking and diagnostics.

3.5.4 „WMBUS" group commands for setting of messages

This group of commands serves for setting of Wireless M-BUS addressing of the WB169-SI4 module and for setting of broadcasting parameters. There are following command:

mid	*setting of device fabrication number („M-BUS ID" – range 0 to 99999999)*
manuf	*setting of manufacturer code („Manufacturer" - supplement of M-BUS address)*
vers	*setting of „addressing version" („Version" - supplement of M-BUS address)*
medium	*setting of media code („Medium" - supplement of M-BUS address)*
info	*setting device name*
periode	*setting of regular messages broadcasting period*
power	*setting of transmitting power (mW)*
mode	*setting of communication mode (1 - N1 mode, 2 - N2 mode)*
chan	*setting of frequency channel (choice from 7 options)*
ekey	*setting of encryption key (".." - encryption disabled)*

Variable **„M-BUS ID"** is a serial number of the device in M-Bus standard identification system. The address is „read only" type for the WB169-SI4 module and cannot be changed. Assigned serial number of the module can be displayed by**„mid"** command (without parameter):

```
cfg#mid
MBUS ID : 00112233
cfg#
```

Variable **„Manufacturer"** is an international code of device producer according to the M-Bus standard. The code is „read only" type for the WB169-SI4 module, its value is „SFT" (Softlink) and it cannot be changed. Assigned manufacturer code can be displayed by**„manuf"** command (without parameter):

```
cfg#manuf
MBUS manufacturer : SFT
cfg#
```

Variable **„Version"** is number of addressing version according to the M-Bus standard (each type and modification of the device could have its own line of serial numbers). The code is „read only" type for the WB169-SI4 module and cannot be changed. Assigned version number can be displayed by **„vers"** command (without parameter):

```
cfg#vers
MBUS version : 101
cfg#
```

Variable **„Medium"** is an international code of measured medium (water, energy, physical quantity..) according to the M-Bus standard. The variable is editable and it is factory preset to 07 ("Water"). Current setting of the medium value can be displayed by **„medium"** command (without parameter). Medium parameter can be changed by entering of required code of medium according to M-Bus standard (range: 0 to 255).

Example of medium code setting to "02" value (electricity):

```
cfg#medium
MBUS medium : 7
cfg#medium2
MBUS medium changed from 7 to 2
cfg#
```

***Note**: The full identification of the device in M-Bus standard systems is done by combination of four ID components: „M-BUS ID", „Manufacturer", „Version" and „Medium". This combination must be unambiguous that means there cannot exist two M-Bus devices worldwide, that have the same combination of all these parameters. If there are fixed configuration of the address components used, producer of the device is responsible for unique setting of „read only" address components for each device. If M-Bus address components are configurable, operator of the M-Bus system can use serial number of connected meter in combining with its type, subtype and manufacturer. Using of „independent" addressing line is possible only in that case, if the operator of the system owns its M-Bus manufacturer code and can assure that the identification of all operated devices under his code will be unique*

„Info" command can be used for setting of device name that is a part of each broadcasted message (see paragraph 3.7). The parameter is preset from the factory to „SI4" value. By using of **„info"** command (without parameter) an actual value of the name can be displayed. The device name can be set by entering of any string of characters after „info" command.

Example of displaying, setting and follow-up checking of the device name:

```
cfg#info
MBUS manuf info  : 'ABC'
cfg#info XYZ
Change MBUS manuf info from : 'ABC' to : 'XYZ'
cfg#info
MBUS manuf info  : 'XYZ'
cfg#
```

Maximum length of the string is 29 characters. The only basic set of characters can be used (without diacritics). It is not recommended to change this parameter.

„Periode" command serves for setting of broadcasting period of regular info messages. The value of the parameter is factory preset to 60 minutes. Current value can be checked by **„periode"** command (without parameter). Broadcasting period can be changed by entering of required number of minutes after „periode" command.

Example of displaying, setting and follow-up checking of broadcasting period:

```
cfg#periode
Periode is 60 min.
cfg#periode 30
Periode changed from 60 to 30 min.
cfg#periode
Periode is 30 min.
cfg#
```

The module enables also **an external synchronization of its broadcasting** from external source of synchronization pulses. For this purpose any of the four ports can be assigned as „synchronizing" by using of **„Periode -X"** command, where "X" is number (1 - 4) of assigned port.

Example of setting of port No. 4 to „synchronization" mode:

```
cfg#periode -4
Periode changed from 60 min. to I4
mon#
```

If using of this setting, the process of transmitting of info message launch after each falling edge of the synchronization pulse is received on the synchronizing port. There is a protective interval of 1 minute implemented in the system, so the broadcasting period could be at least 1 minute. Requirements for the synchronization pulses are the same, as for metering pulses.

This feature is important in that case, if the measurement and broadcasting of measured values should be synchronized with some other process. Typical example is measurement of electrical energy in 15-minutes intervals, that must be

synchronized with measuring intervals of superior part of the electrical grid. In this case it is necessary to bring 15-minutes synchro-signal (e.g. from electrometer with such kind of output) to the synchronizing port.

***WARNING:** If there are synchronization pulses with inverse logic connected, it could cause a slight decreasing of battery lifetime (up to 5 %). „Inverse logic" means that the input is permanently short-circuited and only during short time pulses it is released.*

Parameters and commands **„power"** (transmitting power), **„chan"** (frequency channel), **„mode"** (communication mode) and **„ekey"** (encryption key) serve for setting of radio-frequency subsystem of the module. These parameters and commands are described in detail in paragraph 3.5.10 „Modem commands group for radio-frequency settings" together with other commands for setting and checking of WB169-SI4 module transmitter and receiver.

3.5.5 „Inputs" group parameters

This group of parameters and commands enables setting of internal pulse registers (counters) and setting of output values of the module.

The WB169-SI4 module is equipped with four inputs (port 1, 2, 3 and 4), that are connected to the corresponding pulse counters (index 0, 1, 2. and 3). Each counter increases its value up one unit each time it receives pulse from a consumption meter connected to its port. Below listed commands are used for settings of the initial counter values and constants (multipliers, divisors) that can be used for adjusting of the output statuses to required values, and also for setting of auxiliary „DIF" and „VIF" M-Bus codes that enable correct decoding of measured values (especially correct decoding of measuring units).

Each input can be switched to so called **„alarm mode"**, in which after each change of input value the counter only changes its status (goes from "0" to "1" or vice versa) and the module transmits the message immediately with the change of status. Thus the module can read and transfer status information from **binary sensors** (e.g. door contacts, flood detectors..). Detailed description of setting of inputs in alarm mode can be found in the paragraph 3.5.8 „Settings of sensor inputs".

Setting of pulse inputs can be performed with using of following commands:

val[index]	*initial counter value setting*
mul[index]	*setting of multiplier (output value = status * multiplier)*
div[index]	*setting of divisor (output value = status / divisor)*
dib[index]	*setting of DIF(E) value (= coding method information)*
vib[index]	*setting of VIF(E) value (= measuring unit information)*
det[index]	*setting of trigger edge (0 - falling edge, 1 - rising edge)*
dmode[index]	*setting of pulse input mode (0 - quick pulses, 1 - slow pulses)*
alr[index]	*setting of alarm mode (sensor input setting)*
leakp[index]	*period of leak detection setting (see „leak" function)*
leakz[index]	*zero interval of leak detection setting (see „leak" function)*
burstp[index]	*burst alarm limit setting (see „burst" function)*
burstt[index]	*burst measuring interval setting (see „burst" function)*
pullup[index]	*long input line correction setting*

By using of **„val[index]"** command an initial (or actual) value of the counter can be set. After the value is setup, it increases from this value with each new-coming pulse. Actual counter value can be displayed by using of „val[index]" command (without parameter). Counter status can be set to required value by using of „val[index]" command followed by required whole number (integer).

Example of setting port No 1 (index=0) counter to "1892" value and follow-up checking of correctness of the configuration:

```
cfg#val0 1892
 Value[0] changed from 1565252980 to 1892
cfg#val0
 Value[0] : 1892 * 1 / 1 -> 1892
cfg#
```

It is evident from the example, that when checking of current status by „val[index]" command, the system displays not only current status value, but also current settings of multiplier and divisor and output value after multiplying/dividing.

By using of **„mul[index]"** and **„div[index]"** commands a value of multiplier and divisor can be set to the counter. Default setting of both values is "1". If it is necessary to adjust the counter value by some coefficient, enter convenient combination of multiplier and divisor as shown in example below.

Actual value of multiplier and divisor can be displayed by using of „val[index]", „mul[index]" or „div[index]" commands (without parameter) as shown in the example:

```
cfg#mul0
Multiplier[0] = 1
cfg#div0
Divider[0] = 1
cfg#
```

Multiplier and divisor setting example:

Watermeter generates measuring pulses after each 50 litres of consumed water. So as to indicate water consumption in m^3, it is necessary to adjust the original counter value by using of multiplier and divisor as shown in the example:

50 litres = 0.05 m^3, so to convert the value to m^3, it must be multiplied by 5/100.

It could be done by setting of multiplier to "5" and divisor to "100" - see example:

```
cfg#mul0 5
 Value[0] changed from 1 to 5
cfg#div0 100
 Value[0] changed from 1 to 100
cfg#val0
 Value[0] : 2000 * 5 / 100 -> 100
cfg#
```

*From the display of summary shown in the last sequence of commands it is evident that current status value (2000) will be interpreted as output value 100 (m^3). As one unit of the counter represents 50 litres, output value of the counter is: 2000*50 = 100 000 litres = 100 m^3.*

By using of **„dib[index]"** command a value of DIF (DIFE) code could be set. The DIFE code describes character of the variable, number of "storage" and format of data field according to the M-Bus standard. Default setting of DIFE parameters of the module counters is as follows:

counter:"0" DIFE = 04 00 (instant value, 32-bit integer, storage No "0")
counter:"1" DIFE = 44 00 (instant value, 32-bit integer, storage No "1")
counter:"2" DIFE = 84 01 (instant value, 32-bit integer, storage No "2")
counter:"3" DIFE = C4 01 (instant value, 32-bit integer, storage No "3")

Warning: It is not recommended to make changes of DIF (DIFE) parameter. *Note: Counters "0" and "1" are preset as "DIF" (bit "extension" = 0), so the value of second (extended) byte ("00") is not used for assembling of info- message.*

By using of **„vib[index]"** command a value of VIF (VIFE) code could be set. The VIFE code describes the kind of measured quantity (e.g. volume, temperature, voltage...) and the measuring unit (including multiplier) in which the value is presented (e.g. m^3, °C, mV, kWh...) according to the M-Bus standard. Default setting of VIFE parameter of all counters is:

VIF = "13" (quantity: „Volume", measuring unit: 10^-3 * m^3)

It means that with using of default setting the information message contains value of measured volume in thousandth of m^3, i.e. **in litres.** If a watermeter is connected to the module with default setting of VIFE code, it is necessary to check out how many litres represent one measuring pulse and setup multiplier and divisor values so as to get output value in litres. If, as an example, the watermeter generates measuring pulse after each 10 litres of volume, it is necessary to set multiplier to value "10".

If it is needed to get volume in other units than litres (e.g. in m^3), or other quantity than volume is measured (e.g. electrical work in kWh), it is necessary to adjust values of multiplier and divisor to get result in required units as well as setup correct VIFE value to ensure correct presentation of the unit in auxiliary information.

Examples of settings of VIFE code

Example of VIFE setting in case the water consumption is presented in m^3:

Setup values of multiplier and divisor in order to convert output value into "m^3" units (see example of multi-

plier/divisor setting above). Calculate value of VIF code for "m^3" units as follows:

„Codes for Value Information Field (VIF)" table of M-Bus standard designates for "Volume" quantity "0001 0nnn" code, where the result is in $10^{(nnn-6)}$ m^3 units. It means that the last three bits of code determine value of unit multiplier. To get result in litres it is necessary to use multiplier $10^{(-3)}$ (because 1 liter = 0.001 m^3), so that the value of last three bits must be '3" (nnn=3). In this case the multiplier is $10^{(3-6)}$, that is $10^{(-3)} = 0.001$). It means that the correct VIFE code for volume in litres is "0001 0**011**", because decadic value nnn=3 converted into binary code means "011" value. Conversion of binary "00010011" value into decadic transcription gives number "13", what is default setting of VIF parameter.

So as to present the measured volume in m^3, it is necessary to put multiplier "1" before „m^3" value. For this case the value of "nnn' must be "6" (so that the multiplier value is $10^{(6-6)}$, that is $10^{(0)} = 1$). So that the correct value of VIF code for volume in m^3 is "0001 0**110**" (because decadic value nnn=6 converted into binary code means "110" value). Conversion of binary "00010110" value into decadic transcription gives number "16", what is required setting of VIF parameter.

Parameter VIF can be setup to "16" value as follows:

```
cfg#vib0
Vib[0] , VIF 13, VIFE 00
cfg#vib0 0x16
Set vib[0] , VIF 16, VIFE 00
cfg#vib0
Vib[0] , VIF 16, VIFE 00
cfg#
```

The same input of VIF parameter could be entered also in decadic form as follows:

```
 cfg#vib0 22
Set vib[0] , VIF 16, VIFE 00
cfg#
```

Example of VIFE code setting in case the variable is electric work in kWh:

„Codes for Value Information Field (VIF)" table of M-Bus standard designates for "Energy" quantity "0000 0nnn" code, where the result is in $10^{(nnn-3)}$ Wh units. The last three bits of code determine unit multiplier. To get result in kWh it is necessary to use multiplier $10^{(3)}$ (because 1 kWh = 1000 Wh), so that the value of nnn=6 (in this case the value of multiplier is $10^{(6-3)}$, that is $10^{(3)} = 1000$). It means that the correct VIFE code for electric work in kWh is "0000 0**110**", because decadic value nnn=6 converted into binary code means "110" value. Conversion of binary "00000110" value into decadic transcription gives number "06", what is required setting of VIF parameter.

Parameter VIF can be setup to "06" value as follows:

```
cfg#vib1 0x06
Set vib[1] , VIF 06, VIFE 00
```

Above described setting of VIF parameter reflects in decoded message as seen in the figure 16.

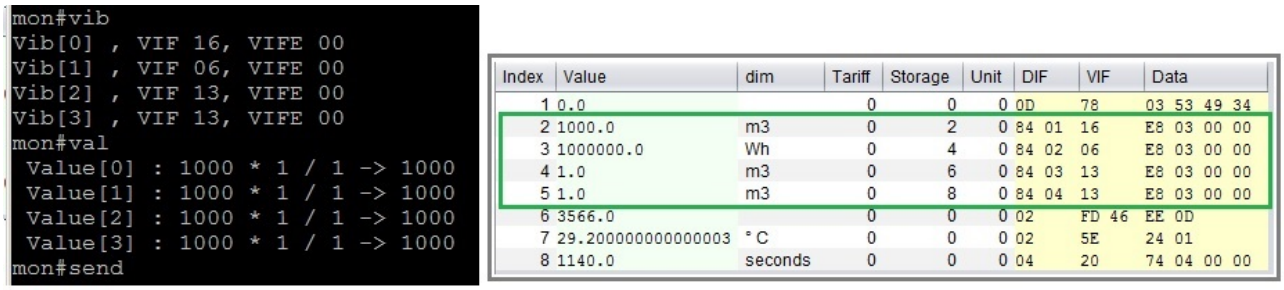


Figure 16: Setting of VIF and its effect on decoding of message

In the figure 16 can be seen a decoded message of the WB169-SI4 module, where there is the same "1000" multiplier value and the same "1" divisor value set up on all four counters.

It is clear from the picture that:

- counter value "0" with preset "1 x m^3" unit is presented as "1000 m^3"
- counter value "1" with preset "1000 x Wh"unit is presented as "1000 000 Wh"
- counter values "2" and "3", with default setting of unit in "litres", show values "1 m^3."

By using of **„det[index]"** command a trigger edge of the counter could be chosen. If it is preset to "0" option (default setting) the value of counter will increase with falling edge of incoming pulse (i.e. when the mechanical contact is short-circuited, or when an electronic pulse generator goes from "1" to "0"). If it is preset to "1" option, the value of counter will increase with rising edge of incoming pulse (i.e. when the mechanical contact is released, or when an electronic pulse generator goes from "0" to "1"). Actual value of trigger edge setting can be displayed by using of „det[index]" command (without parameter).

Example of setting of trigger edge for port No 1 (index=0) to "1" option (rising edge) and follow-up checking of trigger edge setting of all ports:

```
mon#det0 1
Det[0] = 1 - rising
cfg#det
Det[0] = 1 - rising
Det[1] = 0 - falling
Det[2] = 0 - falling
Det[3] = 0 - falling
cfg#
```

By using of **„dmode[index]"** command a smoothening (equalizing) filter of pulse input could be involved or disconnected. If it is preset to "0" option (default setting) the equalizing filter is switched off and the input is preset for detecting of high frequency (quick) pulses. If it is preset to "1" option, the equalizing filter that can suppress disturbing pulses on the input is switched on. This setting could be used if there are some parasitic pulses on the pulse input (e.g. if the input wire is too long), but using of this filter is restricted only for **sensor input**, or for detecting of **slow pulses** with maximum frequency of 2 Hz (minimum length of pulse is 250 ms).

Example of setting of port No 1 (index=0) mode to "1" option with involved equalizing filter (slow pulses):

```
cfg#dmode1 1
Mode[1] = 1 - slow
cfg#
```

By using of **„pullup[index]"** command a „correction of long wire" function can be switched to the pulse input. If it is preset to "0" option (default setting) the function is switched off. If it is preset to "1" option, input circuits of the counter are rearranged in order to increase the current of detecting circuit during short-circuited condition. Reliability of detection of switch off/on status significantly increases with this treatment. The disadvantage of this setting is that in case the pulse contact lasts in the short-circuited condition for longer time, it has negative influence over battery power consumption. Thus, this setting is not recommended in that case, if the principle of pulse generator enables situation, when the input circuit of the counter could be long time in "0" status (e.g. long term short-circuited contact). This could occur in case if the consumption meter (watermeter, gasmeter..) equipped with mechanical reed contact stops its revolving in such position, where the reed contact is permanently "on" (short-circuited). The function cannot be used for sensor input for the same reason.

Example of setting of port No 1 (index=0) input circuit to "1" option with involved „correction of lon wire" function:

```
cfg#pullup1 1
Change Pullup[1] = On
cfg#
```

Detailed description of „Leak" alarm function can be found in the paragraph 3.5.6 below. Detailed description of „Burst" alarm function can be found in the paragraph 3.5.7 below. Detailed description of sensor input settings can be found in the paragraph 3.5.8 „Setting of sensor inputs" below.

3.5.6 Description and setting of „Leak" alarm function

„Leak" function is used for detection of such situations in the consumption of gas, water or other liquids, when there are permanent low-quantity losses caused by minor leaks in the distribution system. In view of the fact that

remote reading systems don't record consumption continuously but in some steps (usually given by full turn of its measuring disk), it could take quite long time until the trouble is discovered.

„Leak" function is based on the common pattern that during the normal long-term (e.g. day, week) operation there are usually some regular time intervals, when the consumption is in its „idle" status, because the gas/liquid is not consumed from natural reasons (e.g. during the night, or out of working hours). In these idle time intervals the consumption should be zero volume. If there are any leaks, time intervals with zero consumption practically either do not occur, or there are only short intervals caused by discontinuity of measuring system (e.g. if one metering pulse represents 100 litres, minor leak could become evident even after several hours, when such quantity will leak).
.

„Leak" function principle is shown in the figure 17. When setting of „Leak" alarm function the length of detection period must be entered by setting of **„Leak Detection Period"** parameter. After expiration of this period the system evaluates whether during this period at least one time occurred the situation, when the consumption was in zero level during preset time interval (entered by **„Zero Period"** parameter). If there is no leakage, it is highly probable that zero consumption period occur at least once during the period and system evaluates the period as „no alarm" status (see upper part of the figure 17). But if there is no one interval with zero consumption registered during whole detection period, module transmits to superior system „Leak" alarm message (see lower part of the figure 17).

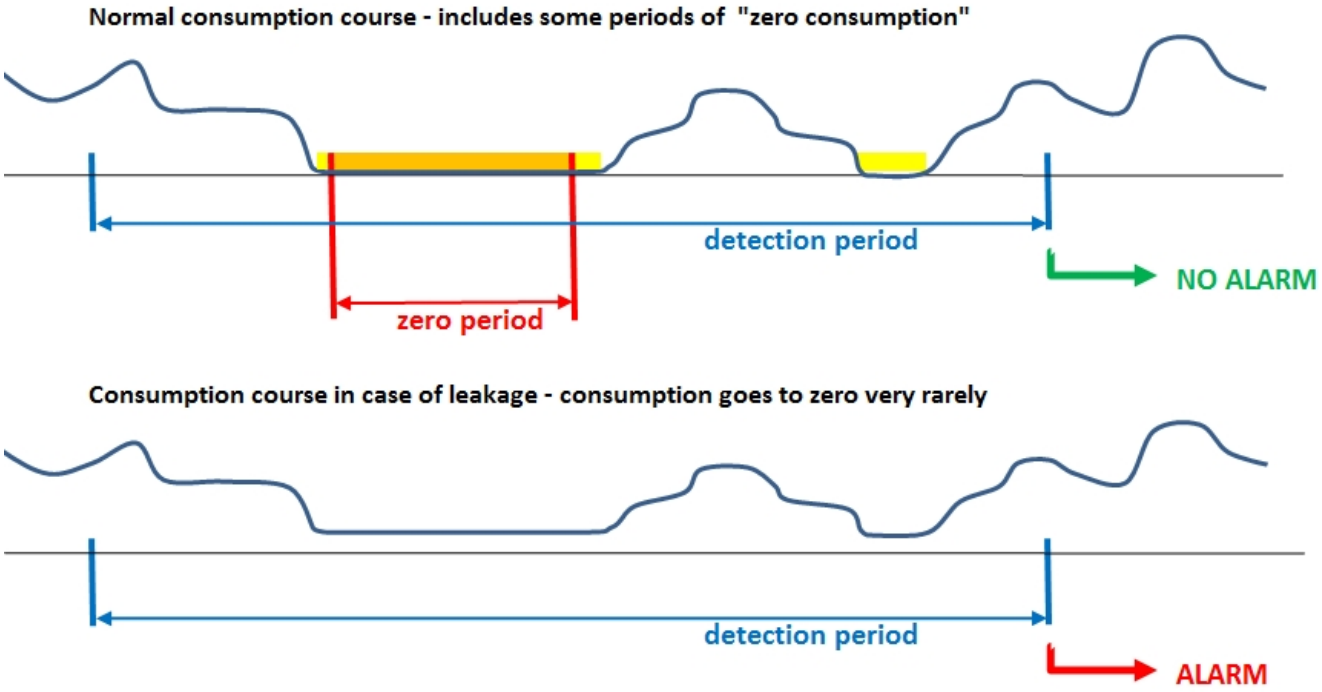


Figure 17: „Leak" alarm function principle

„Leak" function can be activated for chosen port by using of **leakp[index]** command that defines the length of detection period (**„Leak detection period"** parameter) in hours. By using of **leakz[index]** command setup concurrently for the same port the length of zero consumption interval (**„Zero period" parameter)** in minutes. If one of these parameters is set to "0" for some port, „Leak" function is deactivated for that port.

Example of setting **„Leak detection period"** parameter for port No 1 (index "0") to 24 hours value:

```
cfg#leakp 0 24
 Value[0] changed from 0 to 24
cfg#
```

Detection period can be set in range of 1 - 1090 hours, typical setting is 24 hours (daily operational cycle), or 168 hours (weekly operational cycle). Detection period starts running from module restart, or from the moment when the parameter is changed. Alarm message is sent at the end of detection period.

Example of setting **„Zero period"** parameter for port No 1 (index "0") to 60 minutes value:

```
cfg#leakz 0 90
 Value[0] changed from 0 to 90
cfg#
```

Zero consumption period can be set in range of 1 - 1090 minutes with precision of ten minutes (rounded to tens of minutes, e.g. 10, 20, 30...). If the command is entered with any other value (e.g. 36 minutes) the system will store rounded value anyway (in this case 40 minutes). General principle is that setting of zero period parameter to longer values means that the detection is more sensitive (it is capable to detect smaller leaks), but it is also less reliable with higher probability to produce false alarm due to real consumption caused by random changes of operating cycle (e.g. if somebody was held up at work few hours longer).

Setting of „Leak" alarm function parameters appears in the List of configuration parameters („show" command), in the section of the particular port:

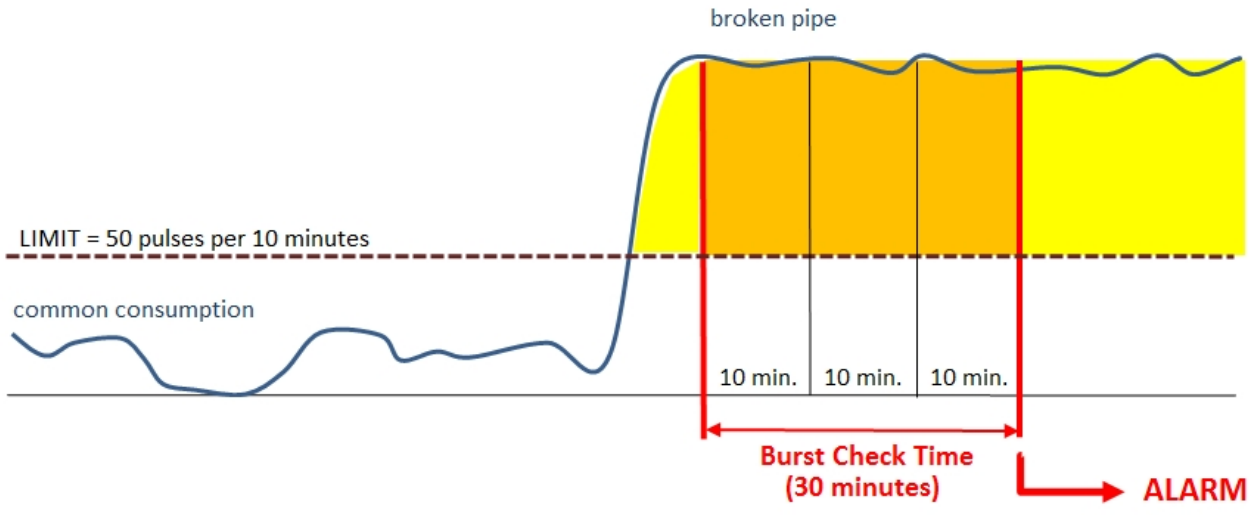
```
MBUS value[0] DIB : 04 00, VIB : 13 00 ,multiplier 1, divider 1
  Leak detection period 24 hour(s), zero period 90 minutes
```

Structure of alarm message of „Leak" type is described in the paragraph „Structure of module data messages".

3.5.7 Description and setting of „Burst" alarm function

„Burst" function is used for detection of such situations in the consumption of gas, water or other liquids, when the burst consumption caused by broken pipe (or similar fatal failure of distribution system) occurs. If the consumption of liquid/gas is abnormally huge for some period of time, the module transmits to superior system „Broken Pipe" alarm message.

„Burst" function principle is shown in the figure 18.. „Burst" alarm function is set-up by entering of the **burst consumption limit** ("burstp[index]" command), that means the limit over which the consumption is considered as abnormal, and entering of **„Burst Check Time" period** ("burstt[index]" command) that means the minimum time period during which the consumption must be permanently over limit to detect the „Broken pipe" alarm.



If the meter generates more than 50 pulses per 10 minutes (i.e. 5 pulses per minute) during three 10-minutes intervals (30 minutes in total) reading module generates Burst Alarm ("Broken Pipe") that is transmitted immediately.

Figure 18: „Burst" alarm function principle

In view of the fact that different meters connected to the module could have different conversion rate of volume per measuring pulse, consumption limit is delimited universally as **number of registered pulses per 10 minutes time period**. Conversion table between „pulses per 10 minutes" and „consumption per minute" for frequently used conversion rates of watermeters is available in the figure 19.

„Burst" function can be activated for chosen port by using of **burstp[index]** command that defines required consumption limit in number of pulses per 10 minutes period. By using of **burstt[index]** command setup concurrently for the same port minimum duration of abnormal consumption („Burst Check Time") in minutes. If one of these

	"LIMIT" value [pulses per 10 minutes]											
	2	4	6	8	10	15	20	30	40	60	80	100
Conversion rate	**Limit flow [m^3 per minute]**											
0,001 m^3 / pulse	0,0002	0,0004	0,0006	0,0008	0,001	0,0015	0,002	0,003	0,004	0,006	0,008	0,01
0,01 m^3 / pulse	0,002	0,004	0,006	0,008	0,01	0,015	0,02	0,03	0,04	0,06	0,08	0,1
0,1 m^3 / pulse	0,02	0,04	0,06	0,08	0,1	0,15	0,2	0,3	0,4	0,6	0,8	1
1 m^3 / pulse	0,2	0,4	0,6	0,8	1	1,5	2	3	4	6	8	10
10 m^3 / pulse	2	4	6	8	10	15	20	30	40	60	80	100
100 m^3 / pulse	20	40	60	80	100	150	200	300	400	600	800	1000
1000 m^3 / pulse	200	400	600	800	1000	1500	2000	3000	4000	6000	8000	10000

Figure 19: Conversion table between "LIMIT" value and corresponding minute flow

parameters is set to "0" for some port, „Burst" function is deactivated for that port.

Example of setting **„LIMIT"** parameter for port No 1 (index "0") to 15 pulses per 10 minutes:

```
cfg#burstp 0 15
 Value[0] changed from 0 to 15
cfg#
```

Consumption limit alarm value can be set in practically unlimited range (1 to 65535 pulses per 10 minutes).

Example of setting **„Burst Check Time"** parameter for port No 1 (index "0") to 40 minutes value:

```
cfg#burstt 0 40
 Value[0] changed from 0 to 40
cfg#
```

Minimum duration of abnormal consumption („Burst Check Time") can be set up in range 1 - 1090 minutes with precision of ten minutes (rounded to tens of minutes, e.g. 10, 20, 30...). If the command is entered with any other value (e.g. 36 minutes) the system will store rounded value anyway (in this case 40 minutes). General principle is that setting of Burst Check Time parameter to longer values means that the detection is more reliable, with lower probability to produce false alarm due to random changes in normal operation (e.g. during filling a tank with water), but in the same time it will prolong the response time between the breakdown and sending of alarm.

Setting of „Burst" alarm function parameters appears in the List of configuration parameters („show" command), in the section of the particular port:

```
 MBUS value[0] DIB : 04 00, VIB : 13 00 ,multiplier 1, divider 1
  Broken pipe min. 15 pulse/10 min. during 40 minutes
```

Structure of alarm message of „Broken Pipe" type is described in the paragraph „Structure of module data messages".

3.5.8 Setting of sensor inputs

Any two-state sensors of „on/off" (0/1) type with contact, relay, or electronic binary output (e.g. door contacts, flood detectors, fire detectors, electronic seals...etc.) can be connected to any of four WB169-SI4 module ports. If the port is not preset to „alarm mode", the module only stores number of 0/1 transitions of the sensor into the counter and transmits the number in periodical info-messages. If, as an example, the door contact is connected to the port, the module registers each open/close cycle and regularly broadcasts number of cycles from last reset of the counter. If it is required to send a message immediately after each opening/closing of the door, it is necessary to preset the port (counter) into the **alarm mode**. For increasing of detection reliability it is recommended to involve **equalizing filter** for each sensor input as described above (see description of "dmode" command). By involving the filter, the detection will be more resistant to false alarms caused by any signal disturbances on the input wire.

„Alarm mode" can be activated for chosen port by using of **„alr[index]"** command, followed by parameter with 0, 1, 2 or 3 value. If **"0"** value is preset, alarm mode is switched off. If **"1"** value is entered, the input is switched to alarm mode and generates alarm in 1-to-0 transition (e.g. when the smoke sensor contact is switched on). If **"2"** value is entered, the input is switched to alarm mode and generates alarm in 0-to-1 transition (e.g. when the door

are opened and the door contact is switched off). If **"3"** value is entered, the input is switched to alarm mode and generates alarm in both transitions (e.g. when the door is opened as well as when it is closed) .

Example of setting port No 2 (index "1") to "2" value, where the module transmits alarm when the sensor goes to "1" status (released contact), and follow-up checking of settings of all ports:

```
cfg#alr1 2
Alr[1] = 2 - rising
cfg#alr
Alr[0] = 3 - both
Alr[1] = 2 - rising
Alr[2] = 0 - none
Alr[3] = 0 - none
cfg#
```

As shown in the example, second port was switched to alarm mode with sending an alarm only in 0-to-1 transition (released contact). From the follow-up checking of all ports status (by using of "alr" command without index) it is clear, that there is the alarm mode with both announced transitions on the first port and that the alarm mode is switched off on the third and fourth port.

Alarm message always contains **actual status** after transition (value is "0" or "1") and a relevant **port identification**, coded into DIF-code as follows:

- status of "0" input - DIF=31
- status of "1" input - DIF=71
- status of "2" input - DIF=B1 01
- status of "3" input - DIF=F1 01

VIF code is alway set to "FD 3A" value, that in M-Bus coding system means dimensionless value („dimensionless - no ViF" option).

If some of the inputs is preset to alarm mode, actual status of the connected sensor is regularly broadcasted in each info message and the format of the information is the same, as used in alarm message. Data segments with status of „alarm" ports are attached to the very end of the message (i.e. after ninth segment „Uptime" - see section 3.7 „Structure of module data messages"). If the alarm message is lost during broadcasting, the information about actual status of the sensor will be synchronized with reality after next "INFO" message is received.

3.5.9 „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 to 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 shorten of the broadcasting period during installation), it is not necessary to save operating configuration in FLASH memory (after the work finishing module can be returned to normal configuration by its reset). If the parameter should be changed permanently, there is necessary to save configuration to FLASH memory.

If operating configuration corresponds to the saved set (ie. there are no differences between commands in FLASH and in the operating set), the module will „report" prompt in the format "mon#". If operating configuration was changed so that it no longer matches to the saved set, the module will report prompt in the format „cfg#".

Every time the current configuration is saved into FLASH memory the value of the „Configuration version" parameter increases by one and the prompt changes to „mon#". The parameter resets to zero by erasing of the FLASH memory.

Current operating configuration can be displayed by using of **„show"** command (see paragraph 3.5.1):

```
cfg#show
```

Current operating configuration can be rewrite the to FLASH memory by using of **„write"** command:

```
cfg#write
Writing config ... OK, version 3
```

Reading of the configuration from FLASH memory can be done by by using of **„read“** command (for some modifications the command is **„cread“**):

```
cfg#read
Reading config ... OK, version 3
```

The configuration can be erased in Flash memory by using of **„clear“** command:

```
cfg#clear
Clearing configuration ... OK, version
```

This command deletes all configuration parameters from the FLASH memory, so it is necessary to set them again. If after erasing all parameters in FLASH memory the module goes to reset, default set of parameters (configured in the program of the device) is duplicated to FLASH memory. There is only one exception - frequency constant keeps the actual value also after cleaning of FLASH memory by "clean" command.

This command is recommended to use only by users with good knowledge of the system or after consultaion with the manufacturer.

The module reset can be performed by using of **„reset“** command:

```
cfg#reset
cfg#
Reset code 22 : WDT time out (PUC)
RF module started, sw version 1.02, date Aug 15 2014
mon#
```

3.5.10 „Modem commands" group for radio-frequency settings

This group of commands enables setting of transmitting system and setting of radio-frequency modem parameters.

The first part comprises commands for setting of Wireless M-Bus messages transmitting system. These parameters are relevant for all messages of the module. There are following commands:

power	*setting of transmitting power (5 options)*
mode	*setting of communication mode (N1 or N2)*
chan	*setting of transmitting channel (7 options)*
ekey	*setting of necryption key (“.” - no encryption)*

The command **„Power"** is used for adjusting of the module broadcasting power. Factory setting is 100 mW (average power). Actual value of the power can be displayed by using of the **"power"** command without parameter. Transmitting power can be set-up by entering of the number of power level. There are five levels available:

- value "1" for transmitting power 14 dBm (25 mW)
- value "2" for transmitting power 17 dBm (50 mW)
- value "3" for transmitting power 20 dBm (100 mW)
- value "4" for transmitting power 24 dBm (250 mW)
- value "5" for transmitting power 27 dBm (500 mW)

An example of checking, setting and re-checking of transmitting power:

```
cfg#power
MBUS power : 3 (20 dBm)
cfg#power 5
MBUS power changed from 3 to 5 (27 dbm)
cfg#power
MBUS power : 5 (27 dBm)
cfg#
```

The command **„Communication mode"** is used for selecting of the module's communication mode. Factory setting is N1 (unidirectional), or N2 (bidirectional), actual setting can be checked by using of **„mode“** command

without parameter. Change of mode can be done by entering of desired option as a parameter of the command. Communication modes are defined by the Wireless M-BUS standard, accurate choice of relevant communication modes of the module is stated in the line "mode" of "Help" summary (see the paragraph 3.5.2).

An example of checking, setting and re-checking of communication mode:

```
Mode changed from 1 to 2
cfg#mode
Mode N1
cfg#mode 2
CC1120 state 0x0f, marcstate 65, fifo tx 0, rx 0
cfg#mode
Mode N2
cfg#
```

The command **„Frequency channel"** is used for selecting of the module's radio frequency channel. Frequency channels for the particular frequency bands are defined by the Wireless M-BUS standard. Actual setting can be checked by using of **„chan"** command without parameter. Change of channel can be done by entering of desired option as a parameter of the command. Accurate choice of relevant broacasting communication modes of the module is stated in a line "mode" in "Help" summary (see the paragraph 3.5.2).

An example of checking, setting, saving and re-checking of frequency channel:

```
cfg#chan
Help :
  1 - chan 1a (169.40625 Mhz), 4.8 kbps
  2 - chan 1b (169.41875 Mhz), 4.8 kbps
* 3 - chan 2a (169.43125 Mhz), 2.4 kbps
  4 - chan 2b (169.44375 Mhz), 2.4 kbps
  5 - chan 3a (169.45625 Mhz), 4.8 kbps
  6 - chan 3b (169.46875 Mhz), 4.8 kbps
  7 - chan 3g (169.43750 Mhz), 19.2 kbps
cfg#chan 1
Channel changed from 3 to 1 : chan 1a (169.40625 Mhz), 4.8 kbps
CC1120 state 0x0f, marcstate 65, fifo tx 0, rx 0
cfg#chan
Help :
* 1 - chan 1a (169.40625 Mhz), 4.8 kbps
  2 - chan 1b (169.41875 Mhz), 4.8 kbps
  3 - chan 2a (169.43125 Mhz), 2.4 kbps
...
  7 - chan 3g (169.43750 Mhz), 19.2 kbps
cfg#
```

The command **„Encryption key"** is used for setting of the encryption key for an encryption of transmitted messages by using of AES-128 key. The encryption key of 16 bytes length is entered by using of **„ekey"** command, followed by the string of 16 bytes that can be entered in a decimal or hexadecimal format (see examples).

An example of insertion of the encryption key in hexadecimal format:

```
cfg#ekey 0x1a 0x2b 0x3c 0x4d 0x5e 0x6f 0xa1 0xb2 0xc3 0xd4 0xe5 0xf6 0x77 0x88 0x99 0xaf
Setting encyption key : 1a 2b 3c 4d 5e 6f a1 b2 c3 d4 e5 f6 77 88 99 af
cfg#
```

An example of insertion of the encryption key in decimal format:

```
cfg#ekey42 53 159 188 255 138 241 202 136 21 98 147 235 15 145 136
Setting encyption key : 2a 35 9f bc ff 8a f1 ca 88 15 62 93 eb 0f 91 88
cfg#
```

If the encryption key is set to the module's configuration, an information ***„Data will be encrypted by AES"*** displays in the list of configuration parameters (see chapter 3.5.1)

Encryption can be switched off by setting of "." (dot) parameter after the „ekey" command:

```
cfg#ekey.
Encyption disabling
cfg#
```

In this case the information that displays in the list of configuration parameters looks like ***„Data will be unencrypted”***.

The second part comprises commands for setting of radio-frequency sub-system of the module. These commands are used primarily for the initial setting of the module in factory.

There are following commands:

mr	*receiving mode switch-on (diagnostics)*
mt test	*testing broadcasting switch-on (set-up and diagnostics)*
ms	*internal status of RF-modem (diagnostics)*
mi	*dump of modem internal registers (diagnostics)*
mfreq	*frequency constant setting (frequency setting)*
cfreq	*frequency constant correction (frequency tunnig)*
send	*immediate sending of radio message*

The command **„send”** can be used for immediate („out od turn“) transmitting of the standard Wireless M-Bus information message that contents information about temperature, voltage and other measured parameters (see paragraph 3.7) relevant to the connected device (meter) specified by index. This command can be used for example for checking of radio signal availability during the system installation, or for any adjustments and testing of the module, connected meter, or receiving device. The command makes possible to send the information message anytime without necessity to change the transmission period or without waiting until the message will be sent spontaneously within the pre-set period.

An example of the command for immediate sending of the information message with the information from the device (attached meter) with index ”2”:

```
mon#send 2
Send [2] ...
 send [2] msg 255
mon#
```

Similar command **„sendp [number]”** can be used for transmitting of series of several message when the first message is transmitted immediately. Number of messages in the series is done by ”number” parameter after command, where maximum number of messages in series is 30. This command can be used during installation and testing of the module. The command is implemented only in newer modifications of the module (only if it appears in ”HELP”).

An example of the command for sending of series of 5 messages:

```
mon#sendp 5
 send 5 msgs
mon#
```

Commands **„mr”, „mt test”, „ms” „mi”, „mfreq”** and **„cfreq”** are used for radio-frequency subsystem diagnostics and initial adjustment of the nominal frequency during the manufacturing process and outgoing inspection in factory.

Manufacturer strongly recommends not to use these commands during the common operation. Using of these commands can cause inoperability of the device.

3.5.11 Overview of module configuration parameters

Overview of configuration parameters that can be used for user settings of the WB169-SI4 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 (see paragraph 3.5.1).

Table 2: Overview of WB169-SI4 module configuration parameters

Item	Name	Value	Description	Default.
1	MBUS ID	0 - 99999999	Serial number (M-Bus address)	read only
2	MBUS Version	0 - 255	Generation or version (M-Bus address suppl.)	read only
3	MBUS Manufacturer	code	Device producer (M-Bus address suppl.)	read only
4	MBUS Medium	code	Medium (M-Bus address suppl.)	07
5	MBUS Manuf. info	0 - 29 char.	Device name	SI4
6	Multiplier	1 - 65535	Counter value multiplier	1
7	Divisor	1 - 65535	Counter value divisor	1
8	DIF(E)	code	Data field format (M-Bus)	84 0n
9	VIF(E)	code	Measured quantity and unit (M-Bus)	13
10	Mode	desc.	Filter and trigger edge setting	falling, quick
11	Alarm	desc.	Alarm mode setting	none
12	Leak period	0 - 1090	Leak detection period („Leak" function)	0
13	Leak zero time	0 - 1090	Zero consumption period („Leak" function)	0
14	Burst limit	0 - 65535	Alarm limit value („Burst" function)	0
15	Burst period	0 - 1090	Burst check time („Burst" function)	0
16	Radio Power	1 - 5	Transmitting power	5
17	Mode	1 - 2	Communication mode	1 (N1)
18	Channel	1 - 7	Frequency channel	1
19	Periode	1 - 65535	Broadcasting period in minutes	60
20	Encryption	code	Encryption key	individuální
21	Next send time	curr. status	Time to next message in minutes	read only
22	No of sent msgs	curr. status	No of messages since last reset	read only
23	Config. Version	curr. status	No of stored images since last FLASH erasure	read only
24	SW Version	curr. status	Software version and date of issue	read only

In **„Value"** column there are allowable ranges of parameter values. If there is a „code" indication in the „Value" column, it means that the value is displayed in hexadecimal code (where couple of hexadecimal characters represents one Byte).

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")

Yellow colouring of the „Item" number highlights the parameters, that can be configured by using of **USB-IRDA optical converter** as described in details in chapter 3.6 „Setting of parameters by using of optical „USB-IRDA" converter".

3.6 Setting of parameters by using of optical „USB-IRDA" converter

All WB169-SI4 modules with hardware revision higher than 1 (i.e. with "Rev. 2" and more on the product label) are equipped with optical interface and can be configured by „USB-IRDA" optical converter.

All parameters that is necessary to set-up during common operation can be configured by optical interface. The settings can be performed through the transparent casing without necessity to open the module's cover. This is the significant advantage especially if the module is used in humid environment and has been sealed by additional silicon filling (additional adaptation for IP-68 proofing).

Principles of the optical configuration, technique of connection to computer and working procedure with using of the **„WACO OptoConf"** program are explained in detail in the section 3.2 „Configuration of the WB169-SI4 module with using of optical converter".

Any changes in module's settings can be performed in **Module configuration table** that opens by click on the „Read device" button in "WACO OptoConf" program window. View of configuration table is depicted in figure 20.

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

Device name	*device name by manufacturer*
Device type	*device type by manufacturer*
Device subtype	*device subtype by manufacturer*
Serial No.	*device serial number (as well MBUS-ID in M-Bus address)*
HW Version	*hardware version by manufacturer*
HW Revision	*hardware revision by manufacturer*
SW Version	*software version by manufacturer*
SW Revision	*software revision by manufacturer*
Manufacturer	*MBUS Manufacturer code*
Version	*MBUS-Version in M-Bus address*

Meaning of **„Serial No."** (MBUS-ID), **„SW Version"** (MBUS Version) and **„Manufacturer"** (MBUS Manufacturer) parameters is more precisely described in section 3.5.4 **„Commands for WMBUS messages settings"**. The rest of parameters contain information about specific identification of production series and software version of the device and are intended only for manufacturer's use.

In the **middle section of the table** there is a group of commonly used configurable parameters of the WB169-SI4 module. There are following parameters:

Medium	*MBUS-Medium code in M-Bus address*
Encryption	*encryption key setting*
Info text	*device type information*
Value	*counter initial value*
Multiplier	*multiplier of the counter (output value = counter value * multiplier)*
Divider	*counter's divisor (output value = counter value / divisor)*
DIFE	*DIF(E) code setting (= type and coding of the data)*
VIFE	*VIF(E) code setting (= unit and the multiplier code)*
Detection Type	*setting of equalizing filter and alarm mode*
Detection Level	*setting of trigger edge of the counter*
Leak check. time	*setting of "detection period" of the "Leak" function in hours*
Time with zero flow	*setting of "zero period" of the "Leak" function in minutes*
Burst flow	*setting of "LIMIT" of the "Burst" function (pulses per 10 minutes)*
Burst check. time	*setting of "burst check time" of the "Burst" function in minutes*

The **„Medium"** parameter is an international code of measured energy, water or other medium according to the M-Bus coding system. The value of the parameter is editable for the WB169-SI4 (it is an editable part of full meter/sensor M-Bus identification), the default value of the "Medium" parameter is 07 ("Water"). More detailed description of the variable and possibilities of its setting are explained in details in section 3.5.4 „Commands for WMBUS messages settings".

The **„Encryption"** parameter is used for entering of the encryption key for AES-128 encryption of transmitted messages. If there is "AES-128" selected in the "Type" field then the encryption key of 16 bytes length should be entered to the „Key" field (always in hexadecimal format). If there is "none" selected in the "Type" field then the encryption is switched off.

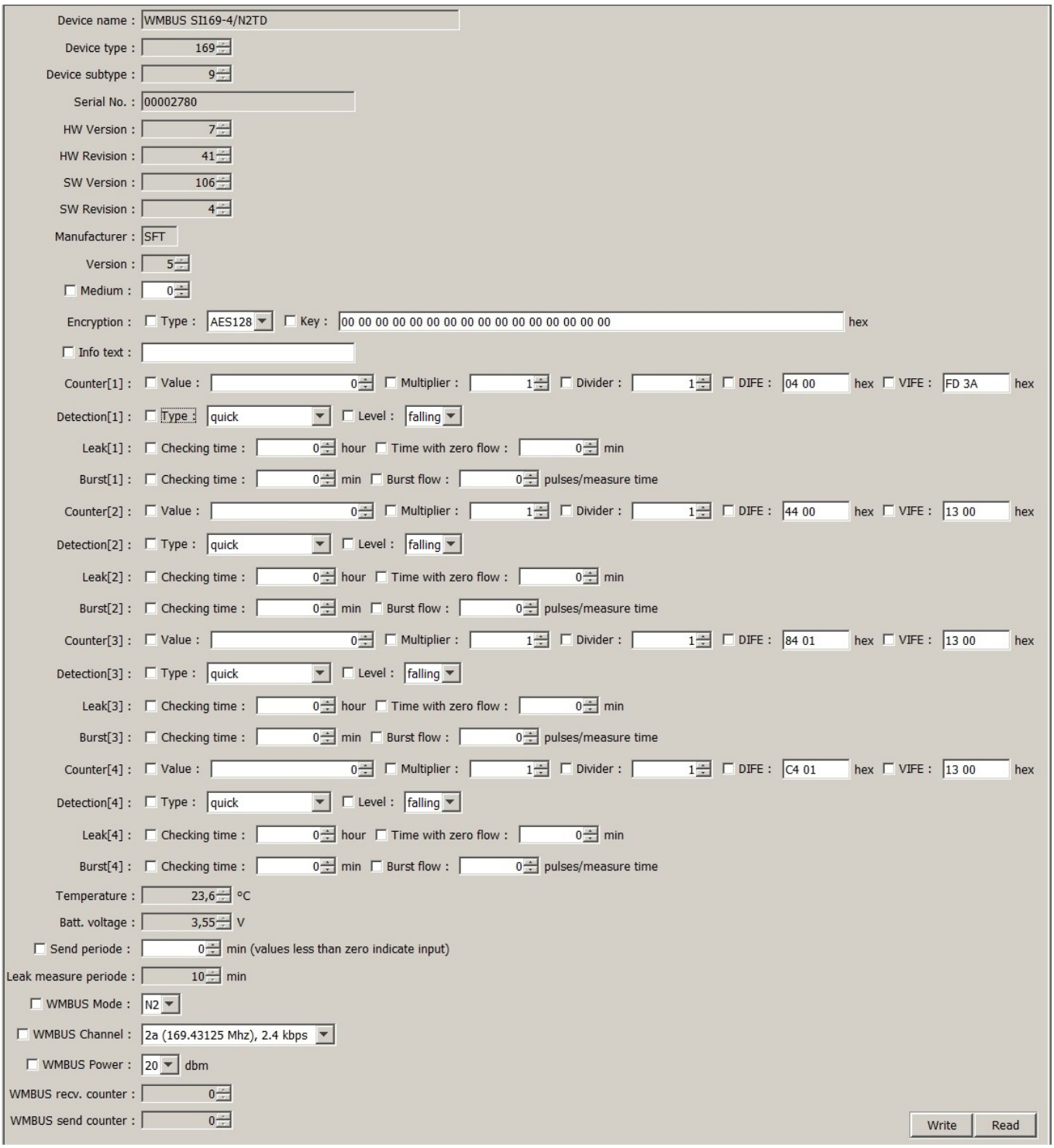


Figure 20: WB169-SI4 module configuration table

The **„Info text”** parameter is used for setting of the device name. Entered device name is thus a part of each information message (see paragraph 3.7). Default setting of this variable is „SI4”. More detailed description of the variable and possibilities of its setting are explained in details in section 3.5.4 „Commands for WMBUS messages settings”.

In the following part of this section there is a group of parameters **Value**, **Multiplier**, **Divider**, **DIFE** and **VIFE**, that are intended for setting of individual counters and their outputs. The module WB169-SI4 is equipped with four inputs (ports No 1, 2 3 and 4), connected to four corresponding pulse counters. Each counter always increases its status by one with every incoming measuring pulse. The following variables are used to set initial values of counters, for setting of constants that enable adjust desired output values (multipliers and divisors), and for setting of „DIF” and „VIF” codes that allow the correct decoding of measured values according to the M-Bus standard (especially for correct decording of measuring units) in collecting data device („Master”). More detailed description

of these variables and possibilities of their setting are explained in details in section 3.5.5 „Commands for setting of inputs parameters". Editing fields are designed to four sub-sections, each of them is intended for setting of one counter (from „Counter[1]" to „Counter[4]"). In each sub-sections are also variables for setting of criteria for „Leak" and „Burst" alarms for individual inputs.

The „Value" parameter is used for setting of the initial (or current) value of the counter. After this setting the initial value increases by one unit with each incoming measuring pulse.

The **„Multiplier"** and **„Divider"** parameters are used for settings of multiplier and divisor of the counter. The default setting of both parameters is "1". If it is required to adjust the output value of the counter by some constant (coefficient), enter the appropriate combination of the multiplier and divisor.

The **„DIFE"** parameter describes the character of the variable, the number of "storage" and a format of the data field according to the M-Bus standard. The variable should be always entered in hexadecimal format.

The **„VIFE"** parameter describes the kind of the measured value (whether the volume, temperature, voltage, etc.) and the measuring unit (including its multiplier) in which the value is presented (whether m^3, °C, mV, kWh, etc.). Examples of settings can be found in section 3.5.5. The variable should be always entered in hexadecimal format.

The **„Type"** parameter in "Detection" section is used for setting of equalizing filter on the counter input as well as for setting of alarm mode for the input. Parameter can be setup as follows:

- „quick" - equalizing filter disabled
- „slow" - equalizing filter involved for the input
- „slow+alarm falling" - involved filter, alarm message in "1-0" transition
- „slow+alarm rising" - involved filter, alarm message in "0-1" transition
- „slow+alarm both" - involved filter, alarm message in both transitions

Detailed description of these settings can be found in paragraph 3.5.5 („Inputs" group of parameters) and in paragraph 3.5.8 („Setting of sensor inputs").

The **„Level"** parameter in "Detection" section can be used for setting of counter trigger edge. "Falling" option means that the counter value will increase with falling edge of measuring pulse (i.e. short-circuiting of mechanical contact, or "1-to-0" transition of electronic pulse generator). "Rising" option means that the counter value will increase with rising edge of measuring pulse (i.e. releasing of contact, or "0-to-1" transition).

Variable **„Leak Checking time"** is used for setting of the length of „detection period" related to the „Leak" alarm function. Length of the detection period should be entered in hours. Variable **„Time with zero flow"** is used for setting of the minimal length of period with zero consumption related to the „Leak" alarm function. Length of the zero consumption period should be entered in minutes rounded to tens (e.g. 10, 20, 30...). More detailed description of these variables and possibilities of their settings are explained in section 3.5.6 „Description and setting of the „Leak" function".

Variable **„Burst flow"** is used for setting of the upper consumption limit for the detection of broken pipe purpose („Burst" function). This limit should be entered in number of measuring pulses per 10 minutes (=constant measuring interval). Variable **„Burst Checking time"** is used for setting of minimal duration of over-limit consumption related to the „Burst" function. Length of this interval should be entered in minutes rounded to tens (e.g. 10, 20, 30...). More detailed description of these variables and possibilities of their settings are explained in details in section 3.5.7 „Description and setting of the „Burst" function".

In the **lower section of the table** there are current values of power supply voltage and processor temperature measured by internal sensors and variables for setting of transmitting parameters.

There are following parameters:

Temperature	*current processor temperature (read only)*
Batt. voltage	*current battery voltage (read only)*
Send periode	*setting of info-messages transmitting period*
WMBUS Mode	*setting of WMBUS communication mode*
WMBUS Channel	*setting of WMBUS RF channel*
WMBUS Power	*setting of transmitting power*
WMBUS recv. counter	*current number of received messages (read only)*
WMBUS send counter	*current number of transmitted messages (read only)*

In the non-editable fields **„Temperature"** and **„Batt. voltage"** there are displayed current values of processor temperature and battery voltage of the module. These values are transmitted in each info-message (see description of information message in section 3.7 "Structure of WB169-SI4 module data message").

The **„Send periode"** parameter is used for setting of broadcasting period of regular information messages. Value

of the period should be set in minutes, default setting is 60 minutes. For switching to external synchronization mode it is required to enter the number of synchronization port with "-" (minus) sign. More detailed description of this variable and possibilities of its setting are explained in details in section 3.5.4 "Commands for WMBUS messages settings".

Editable variables **„WMBUS Mode"**, **„WMBUS Channel"** and **„WMBUS Power"** are used for settings of radio-frequency subsystem of the module. More detailed description of these variables and possibilities of their setting are explained in details in section 3.5.10 „Modem group commands".

The **„WMBUS Mode"** parameter can be used for selection of the module's WMBUS communication mode. Factory setting is "N1" mode, variable is entered by choosing from pre-set relevant options.

The **„WMBUS Channel"** parameter can be used for selection of the module's frequency channel. Frequency channels within particular frequency bands are defined by the M-Bus standard. Variable is entered by choosing from pre-set relevant options (there are 7 options for WB169-SI4 module).

The **„WMBUS Power"** parameter can be used for selection of the module's transmitting power. Factory setting is 100 mW (moderate power), variable is entered by choosing from pre-set relevant options.

In the non-editable fields **„WMBUS recv. counter"** and **„WMBUS send counter"** there are displayed current numbers of received and transmitted messages from the last reset of the module. These data can be used for module's diagnostics.

3.7 Structure of module data messages

The WB169-SI4 module transmits following types of messages:

- standard („long") information messages with all variables, broadcasted periodically
- short information messages with change of sensor input status, sent in alarm mode
- alarm messages of „Burst" and „Leak" functions

3.7.1 Standard information message

Standard („long") information message of the module consists from the Wireless M-BUS header, short 4 Byte M-Bus header and at least eight data blocks with total length of 48 Byte (it could vary in reliance on configuration).

Structure of Wireless M-BUS message header of the WB169-SI4 module is described in the Table 3.

Table 3: Structure of Wireless M-BUS message header of the WB169-SI4 module

Name	Length (Byte)	Description/meaning
Length (L)	1	Message length in Byte
Type (C)	1	"Spontaneous User Data"
Manufacturer ID (M)	2	"SFT" (manufacturer code of Softlink)
Address (A)	4	M-BUS Device ID (configurable)
Version (V)	1	M-BUS Version/Generation (configurable)
Medium (T)	1	M-BUS type of medium (configurable)
Application type (Cl)	1	"Slave to Master, 4-Byte header, variable data format"

Wireless M-BUS header contains full identification of the device according to the M-Bus specification (manufacturer/medium/version/serial number) and also message type and format of content.

Short 4-Byte M-Bus header of the message application layer contains following data:

- item "Access No" that increases by one with each sent message;
- item „Status" that is normally "00", value "04" („Low Power") signalizes low battery volatge;
- item „Signature" contains encryption type and parameter ("00 00" means no encryption).

If the message has been re-transmitted (repeated), item „Signature" is modified by Wireless M-Bus repeater to "01 XX" (low bit of the first Byte changes from "0" to "1").

Basic data block consists from nine (*) data segments, each of them carries data of one variable. List of variables transmitted in the information message of WB169-SI4 module can be found in the Table No. 4:

(*) Length of „INFO" data segment depends on the number of characters in „Info" string (see paragraph 3.5.4). If the „Info" string is not set, the "INFO" data segment is removed from the message and in this case the data bock consists only from 8 segments.

Table 4: Description of variables of info-message data block

Order	Variable (description)	Unit	Type	Data format
1	INFO (text)	Fabric. No.	Inst.	Variable
2	Current consumption (counter 1)	m^3 (10^{-3})	Inst.	32 bit Integer
3	Current consumption (counter 2)	m^3 (10^{-3})	Inst.	32 bit Integer
4	Current consumption (counter 3)	m^3 (10^{-3})	Inst.	32 bit Integer
5	Current consumption (counter 4)	m^3 (10^{-3})	Inst.	32 bit Integer
6	Internal battery voltage	V (10^{-3})	Inst.	16 bit Integer
7	Transmitting power setting	W (10^{-3})	Inst.	16 bit Integer
8	Processor temperature	°C (1)	Inst.	16 bit Integer
9	"Uptime" from last reset	seconds	Inst.	32 bit Integer

View of data message with default setting, received and decoded by *WMBUS RFAN1* Wireless M-BUS signal analyzer, is shown in the figure 21.

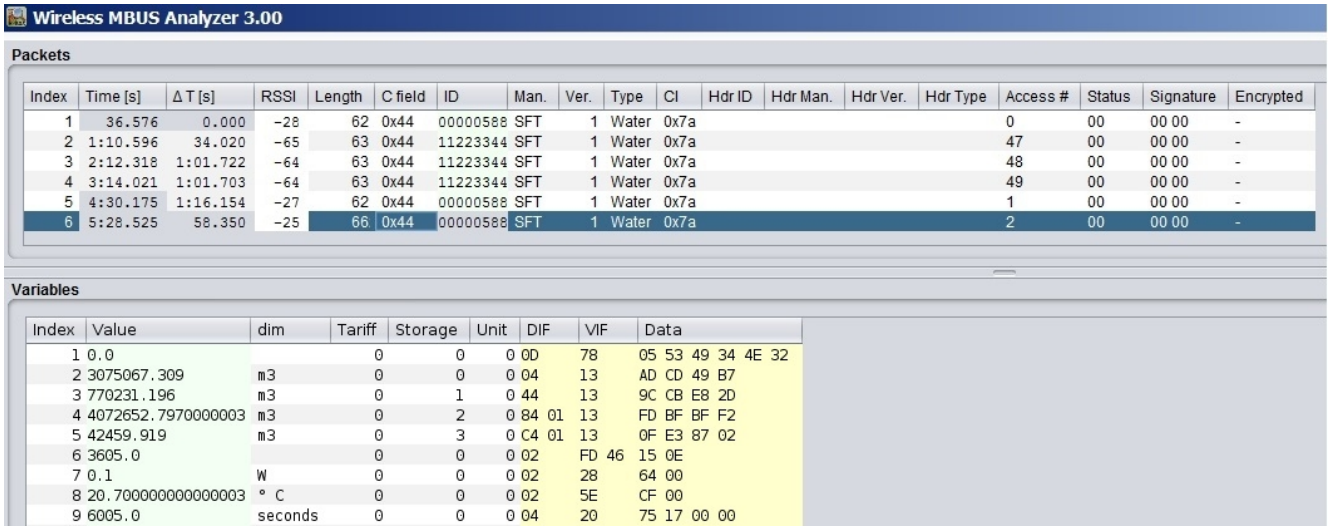


Figure 21: View of WB169-SI4 module message received by *WMBUS RFAN1* analyzer

If the AES-128 data encryption is switched on, there are two additional „control segments" inserted before data segments of the message. These "2F" segments don't carry any information and serve only for checking of correctness of the decryption. If using encryption, the total number of data block bytes must be „rounded" into integer multiple of 16 Byte (i.e. the length of data block must be of 16, 32, 48, 64...etc. Bytes). Rounding of the message is performed by inserting of required number of "2F" blocks.

Decoded encrypted message of the WB169-SI4 module with two control segments at the beginning and several other "2F" blocks at the end is shown in the Figure 22. This way the length of message data block is rounded to 64 Byte.

If there is a sensor connected to some module's input and its counter is preset into **alarm mode** (see paragraph 3.5.8 „Setting of sensor inputs"), there is another data segment inserted after the last „normal" data segment. The inserted segment carries an information about actual status of the sensor input. Thus, if there are all 4 ports preset into the alarm mode, standard info message (including "INFO" segment) contains 9 + 4 = 13 data segments in total.

Decoded message of the WB169-SI4 module with one additional data segment carrying status of sensor in alarm mode is shown in the Figure 23.

Additional data segment with status of sensor input in alarm mode carries an information about the current port status and its structure is same as a structure of short data message (see paragraph 3.7.2 „Short information message" below). ,

3.7.2 Short information message

Short information message of the WB169-SI4 is transmitted in that case, if there is a sensor connected to some module input and the input is switched into alarm mode. The message is transmitted immediately (out of standard broadcasting period) and contains only information about the current status of that port, of which status

Index	Value	dim	Tariff	Storage	Unit	DIF	VIF	Data
1	0.0		0	0	0	2F		
2	0.0		0	0	0	2F		
3	0.0		0	0	0	0D	78	05 53 49 34 4E 32
4	3075067.309	m3	0	0	0	04	13	AD CD 49 B7
5	770231.196	m3	0	1	0	44	13	9C CB E8 2D
6	4072652.7970000003	m3	0	2	0	84 01	13	FD BF BF F2
7	42459.919	m3	0	3	0	C4 01	13	0F E3 87 02
8	3605.0		0	0	0	02	FD 46	15 0E
9	0.1	W	0	0	0	02	28	64 00
10	20.700000000000003	° C	0	0	0	02	5E	CF 00
11	6005.0	seconds	0	0	0	04	20	75 17 00 00
12	0.0		0	0	0	2F		
13	0.0		0	0	0	2F		
14	0.0		0	0	0	2F		
15	0.0		0	0	0	2F		
16	0.0		0	0	0	2F		
17	0.0		0	0	0	2F		
18	0.0		0	0	0	2F		
19	0.0		0	0	0	2F		
20	0.0		0	0	0	2F		

Figure 22: Encrypted and decrypted message of the WB169-SI4 module

Packets

Index	Time [s]	Δ T [s]	RSSI	Length	C field	ID	Man.	Ver.	Type	CI	Hdr ID	Hdr Man.	H
1	30.720	0.000	-69	78	0x44	00002780	SFT	5	Other	0x7a			
2	1:03.630	32.910	-82	20	0x44	00000153	NNT	1	Water	0x7a			

Variables

Index	Value	dim	Tariff	Storage	Unit	DIF	VIF	Data
1	0.0		0	0	0	0D	78	0B 31 32 31 32 33 34 33 34 41 42 43
2	0.0		0	0	0	04	FD 3A	00 00 00 00
3	0.0	m3	0	1	0	44	13	00 00 00 00
4	0.0	m3	0	2	0	84 01	13	00 00 00 00
5	0.0	m3	0	3	0	C4 01	13	00 00 00 00
6	3562.0		0	0	0	02	FD 46	EA 0D
7	0.1	W	0	0	0	02	28	64 00
8	19.6	°C	0	0	0	02	5E	C4 00
9	9971.0	seconds	0	0	0	04	20	F3 26 00 00
10	1.0		0	0	0	31	FD 3A	01

Figure 23: Structure of WB169-SI4 module message with one input in alarm mode

was changed. The message consists of standard Wireless M-BUS header, short 4-Byte M-Bus header and one data segment with a new status of sensor input where the change occurred

Data segment carries information about a new status of connected sensor (after indicated change) and its variable has ”0” or ”1” value. Auxiliary information carried by DIF/VIF code are set as follows:

DIF = 31 for the 1. input (avg. value, 8-bit integer, storage ”0”)
DIF = 71 for the 2. input (avg. value, 8-bit integer, storage ”1”)
DIF = B1 for the 3. input (avg. value, 8-bit integer, storage ”2”)
DIF = F1 for the 4. input (avg. value, 8-bit integer, storage ”3”)
VIFE = FD 3A for all inputs (dimensionless value - ”NO VIF”)

Decoded short message of the WB169-SI4 module with one data segment carrying information about the change of sensor status on the 1-st input is shown in the Figure 24.

Packets

Index	Time [s]	Δ T [s]	RSSI	Length	C field	ID	Man.	Ver.	Type	CI	Hdr ID	Hdr Man.	Hdr Ver.	Hdr Type	Access #	Status	Signature	Encrypted
1	4.883	0.000	-55	18	0x44	00002780	SFT	5	Other	0x7a					7	00	00 00	-
2	8.814	3.931	-58	18	0x44	00002780	SFT	5	Other	0x7a					8	00	00 00	-

Variables

Index	Value	dim	Tariff	Storage	Unit	DIF	VIF	Data
1	0.0		0	0	0	31	FD 3A	00

Figure 24: Structure of short message of the WB169-SI4 module with change of input status

3.7.3 Alarm messages of „Burst" and „Leak" functions

Alarm message of „Burst" and „Leak" function generates only in that case, if there is a „Burst", or „Leak" setting on some of the module's input. The message is transmitted immediately after alarm conditions had been recognized. The message consists of standard Wireless M-BUS header, short 4-Byte M-Bus header and one or two data segments with total length of 4 Byte (1 segment), or 8 Byte (2 segments).

WMBUS Header of the message differs from regular „long" information message in setting of application type ("Cl") code, where the "74" code value with „Alarm from meter with short Transport Layer" meaning is preset. Data segment carries the information about the alarm, if both alarms („Leak" and „Burst") occur in the same moment, the message carries two data segments.

Data segment for **„Leak"** type of alarm has following structure:

DIF = 01 (current value, 8-bit integer, storage No. "0")
VIFE = FD 1A (digital output - binary)
variable = coded number of relevant input (or more inputs (*))

Data segment for **„Burst"** type of alarm has following structure:

DIF = 41 (current value, 8-bit integer, storage No. "1")
VIFE = FD 1A (digital output - binary)
variable = coded number of relevant input (or more inputs (*))

(*) Numbers of relevant ports are coded as lower 4 bits in binary output, where "1" value of the bit means that the alarm is relevant for that input. Example:

0000 0001 ("01") - alarm on the first input
0000 0010 ("02") - alarm on the second input
0000 0100 ("04") - alarm on the third input
0000 1000 ("08") - alarm on the fourth input
0000 0110 ("06") - alarm on the second and third inputs
0000 1111 ("0F") - alarm on all four inputs

Alarm messages of the WB169-SI4 module as seen in the screen of *WMBUS RFAN1* Wireless M-BUS analyzer with disabled decoding of the data content are shown in the Figure 25.

27	12:40.683	34.255	-40	18	44	D4	4C	39	22	00	00	03	07	74	02	00	00	00	01	FD	1A	01			
15	7:21.497	37.019	-43	18	44	D4	4C	39	22	00	00	03	07	74	00	00	00	00	41	FD	1A	03			
116	58:31.653	8.300	-53	24	44	D4	4C	55	44	33	22	03	07	74	01	00	00	00	01	FD	1A	01	41	FD	1A	03

Figure 25: View of alarm messages of WB169-SI4 module on the screen of *WMBUS RFAN1* analyzer

In the first row there is an alarm message of „Leak" type (DIF=01) on the first input (01).

In the second row there is an alarm message of „Burst" type (DIF=41) on the first and second inputs (03).

In the third row there is an alarm message of „Leak" type (DIF=01) on the first input (01) and at the same time an alarm message of „Burst" type (DIF=41) on the first and second input (03).

Alarm messages are transmitted always out of standard broadcasting period, regardless of the period setting.

4 Operational conditions

This section of the document describes basic recommendations for transportation, storing, installation and operation of WB169-SI4 radio modules.

4.1 General Operation Risks

The radio modules are electronic devices power-supplied by internal batteries. The modules read counters or registers of the connected consumption meters or sensors. 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. In normal operation no special precautions are needed, besides avoiding of the mechanical damage from strong pressure or shocks.

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

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. It is recommended to lead antenna and signal cables as far from 230/50 Hz power cables as possible.

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.

4.1.3 Risk of damage by excessive humidity

Radio modules could be (as any other electronic devices) damaged by water, that could cause a short-circuit among some electronic elements or corrosion of the elements. Correctly assembled plastic box protects the module's printed circuit board against direct penetration of water, but the damage could be caused also by gradual penetration of humid air which can cause corrosion or other damage by condensed water inside the box.

Modules are enclosed in IP65 grade plastic boxes (proof against short-time squirted water) or with additional sealing by high-adhesion silicon filling, that can ensure proof against inundation by water (IP68 grade). Modules, that are delivered with IP68 sealing from factory are clearly assigned by IP68 degree of protection on the manufacturer's production label (e.g.: "WB169-SI4/B13/IP68").

Risks of damage of the device in basic **"IP65"** design caused by penetration of excessive humidity can be eliminated by these precautions:

- install only modules that are correctly assembled, with undamaged box and undamaged rubber seal;
- in case of any doubt perform additional sealing of connection of both parts of the box and both cable bushings by silicon sealant;
- install modules only to the sites where relative humidity exceed value of 95% only occasionally;

- install modules only to the sites where they can be squirted or sprayed by water only occasionally and only for a short time;
- do not install modules to the sites where they can be dipped into the water.

Risks of damage of the device in waterproof **"IP68"** design caused by penetration of excessive humidity can be eliminated by these precautions:

- do not open the module with silicon filling without serious reason;
- if (from some reason) the module was already opened, manipulate with it very carefully or renew its silicon filling by pouring of a few milliliters of special silicon (same as original - consult the technique with manufacturer). **In case the module has been opened, there is no manufacturer's guarantee of IP68 degree of protection.**;
- install modules only to the sites where they can be dipped into the water only occasionally and only for a short time;
- do not install modules to the sites where their antenna could be submerged under water. Antenna must be installed to such place, where there is no possibility to be flooded. **Operating of the module with antenna submerged under water could cause irretrievable damage of the device!**

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 ÷ 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 WB169-SI4 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 WB169-SI4 module installation

WB169-SI4 radio modules are enclosed in plastic casings with an IP65 degree of protection equipped with mounts for mounting on the wall, pipe or any other construction element. Input clamps, battery switch, configuration connector as well as antenna connector are placed on the module's printed circuit board, so that it is necessary to open the casing to access these elements.

Modules with additional silicon filling (IP68 degree of protection) are delivered with battery switched on and with both cables connected before silicon filling. **It is recommended do not open the casing during operation until it is really necessary, and if so, do it very carefully**. Configuration of the modules should be performed by USB-IRDA optical converter as described in section 3.6 „Setting of parameters by using of optical „IRDA" converter"

In the figure 26 there is displayed the WB169-SI4 module dismantled into individual components

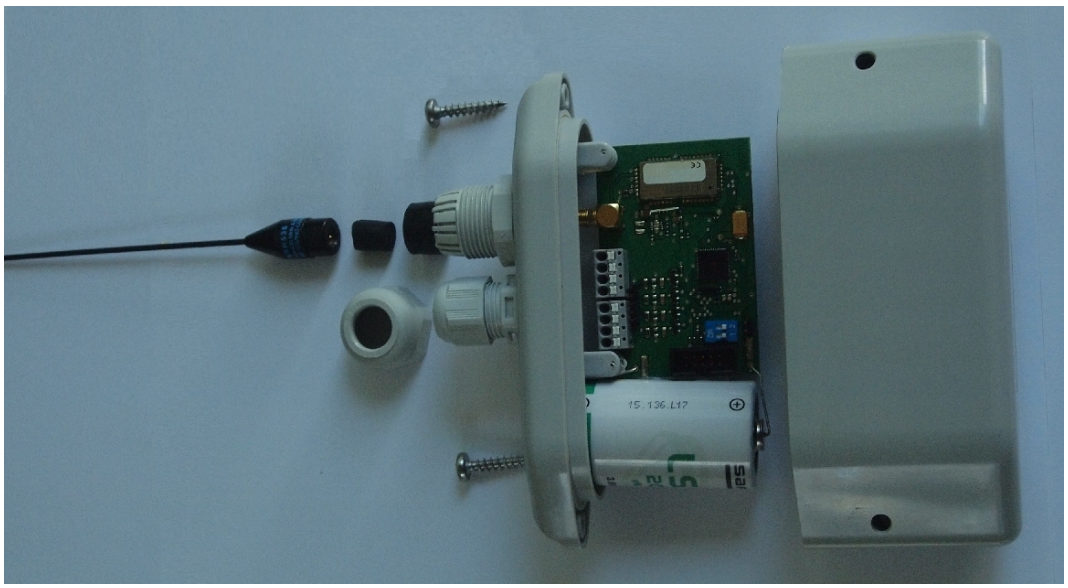


Figure 26: Set of WB169-SI4 module components with rod antenna

In the figure 27 there is displayed the detail of WB169-SI4 module printed circuit board with configuration connector marked by violet colour, battery switch marked by red colour, input clams marked by green colour and antenna connector marked by blue colour. Appearance of the module PCB could slightly vary in dependence on the module modification.

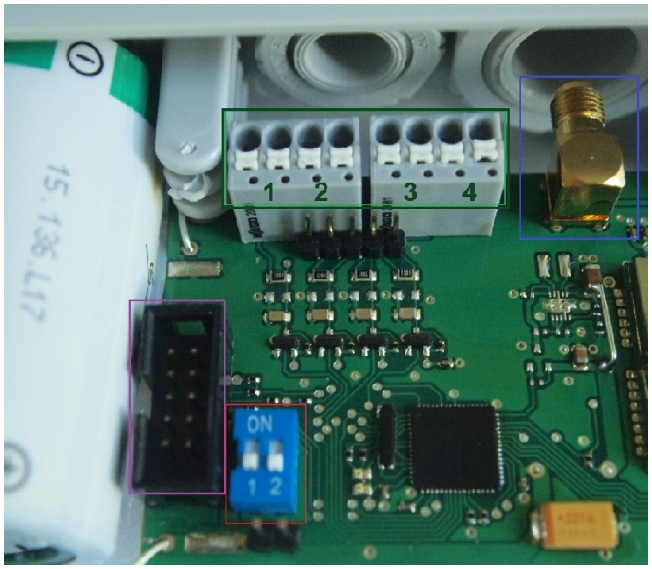


Figure 27: Detail of WB169-SI4 module PCB

The case of WB169-SI4 module consists of two parts:

- module base with the printed circuit board attached. It is the where the cable bushings are placed;
- box cap that covers the printed circuit board, with mounts for attaching of the module to the wall or other construction element

When mounting the device follow these instructions:

- attach the module to a suitable firm object (wall, pipe) by two screws or by a clamping tape. There are mounts by the box sides for the attachment. The recommended position of the mounted module is in the way that the base is down, cable bushings are facing to the floor;
- unscrew the screws on the sides of the module base (right beside the cable bushings), loosen the cap of the module and slide the base out of the cap;
- pull the cables with the pulse outputs from the consumption meters through the cable bushings (**) and connect the individual conductors to the input clamps of the module. The scheme of deployment and polarity

of individual clamps is glued inside on the cap of the box. Make sure that the meters are connected to the relevant inputs according to the project materials or write down the diagram of individual connections;

- connect the local antenna (stick or rod type) or an antenna cable from a remote antenna into the antenna connector (coaxial connector on the printed circuit board beside the input clamps). Pull the antenna or the antenna cable through the cable bushings that is just right opposite to the antenna connector;
- switch-on battery by switching of both of the micro-switches („jumpers") placed on the PCB beside the configuration connector into the „ON" position. Some modifications of the module could be equipped with a pair of simple shortening pins, that should be short-circuited by shortening connector;
- perform an elementary module diagnostics and alternatively go through the module configuration (setting of parameters) with using of configuration cable as described in chapter 3 „Module configuration". In case the module has been fully pre-configured in the preparatory phase of installation, at least check and set-up input/output values to ensure that the information sent in the radio-messages will be correct;
- tighten the nuts on the cable bushings to seal them and protect the cables from unwanted pulling out of the clamps;
- insert the base back into the cap and fix with screws. For the mounting in a humid environment it is recommended to apply silicone sealant on the outer perimeter of the seating edge of the base before screwing the box back together;
- if the internal rules or the mounting process needs the antifraud seal to be installed (as the protection from the unwanted influencing), stick the antifraud seal across the joint between the two parts of the box.

(*) ATTENTION! *If the module is sealed by additional silicon filling with IP68 degree of protection do not open its casing during the installation! Meter outputs can be connected to appropriate wires of the input cable (that had been connected to the module before silicon filling) and configuration could be performed by radio or by using of an optical converter USB-IRDA.*

If the module is rated in IP65 or IP68 degree of protection, this declaration is valid only under condition of the proper mounting and sealing. When assembling the modules with IP68 degree of protection that will be placed in the humid environment, it is necessary to follow these rules:

- both cable bushings must be properly sealed;
- the joint of both parts of the box must be properly sealed by original rubber sealing).

After the mounting, write down the counter values of all consumption meters connected to the module into the mounting sheet and alternatively once again check out the module's functionality and the correctness of output values (which must correspond to consumption meter mechanical counters). Test the module functionality by „end-to-end" method, that means by checking of the readings directly in the central system of remote reading.

Follow the consumption meter manufacturer's instructions for determination of the length of the connection cables between the consumption meters and the radio modules.

When locating installation site, selecting antenna type and antenna position it is necessary to take into account conditions for radio signal propagation in the area of installation as well as protection of the device against possible mechanical damage. The radio-signal conditions can be estimated empirically on the base of previous experience, or examined by measuring of the signal strength by the reference transmitter/receiver.

4.7 Module and Meter Replacement

When there is necessary to replace the 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;
- unscrew two screws on the sides of the module base (beside the cable bushings), loosen the cap of the module and slide out the base from the cap;
- disconnect the cables from the consumption meters from the input clamps, alternatively disconnect the cable of the external antenna from the antenna connector;
- by switching of both of the micro-switches („jumpers") placed on the PCB beside the configuration connector into the „OFF" position (or replacing of shortening connector from shortening pins) disconnect the module from the battery power supply;
- loosen the fixing screws (or clamping tape) that hold the module on the wall, pipe or other pad and dismantle the cap;

- put both parts of the module back together by screwing the cap together with base (*). Mark the module visibly as „defective", alternatively you can fill in the form (mounting report) about the module replacement;
- install a new module in the same way as described in paragraph 4.6 above. Pay attention to the correct connection of the input cables (must be the same inputs as they were on the original module) and set up the relevant configuration parameters, namely broadcasting period and input/output values.
- write down the serial number and seal number of the module, alternatively also actual statuses of counters of connected meters;
- if possible, arrange making of all appropriate changes in the database of the remote reading system immediately.

(*) CAUTION! *The type label with RF-address and serial number of the module is always on the cap of the module so the base and the cap of the module must always be one whole unchangeable unit. Always pay attention to the completing of the correct cap with the correct base of the module, that is the reason why it is always necessary to replace the whole module – the base and the cap together. The correct module completion can be checked out according to the auxiliary label with the RF-address glued on the PCB (RF-address on the PCB must correspond with the RF-address on the cap of the module).*

When there is necessary to replace a consumption meter connected to the module due to the meter failure, expired metrology period or for any other reason, follow this procedure:

- check the antifraud seal before dismantling – the antifraud seal damage must be solved according to the internal rules of each customer/project;
- if the module is sealed by additional silicon filling with IP68 degree of protection do not open its casing! Disconnect replaced meter from the input cable and connect new meter to the same wires;
- if the module is in common IP-68 design, unscrew two screws on the sides of the box (beside the cable bushings), loosen the cap of the module and slide out the base from the cap;
- disconnect the cables from replaced consumption meter from the input clamps, replace the consumption meter and connect its cable back into the input clamps;
- perform setting of input/output values of the relevant input according to the instruction in the chapter 3 „Module configuration". Check out the correctness of output values (which must correspond to consumption meter mechanical counters) by checking of the readings directly in the remote reading system.
- fill in the required documentation for the meter replacement (mounting sheet), precisely write down the value of the mechanical counter of the new meter;
- cover the module and, if needed, apply the sealant according to the instructions in paragraph 4.6. Alternatively wait for the first reading and cover the module afterwards.

(*) CAUTION! *The new meter might require a different setting of module's input/output even if the meter is the same type and manufacturer. Conversion constants can differ from each other even in various modifications of the same type of the meter.*

4.8 Module Dismantling

When dismantling, open the module, disconnect cables and dismantle the cap from the wall, pad or pipe. Switch the battery off and put the module parts back together (put the cap on the base of the module). After the dismantling mark the module as „dismantled" and fill in the relevant documentation, prescribed for this situation by the internal rules. If possible, arrange deactivation of the module in the database of remote reading system immediately.

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 functionality of its broadcasting with using of common „Master" receiver, testing (reference) receiver, signal analyzer or any other convenient device.

If the WB169-SI4 module is connected to remote data collecting system with using of WB169-RFE gateway, functionality of its broadcasting could be checked from any computer in **„Radar" mode** by presence of module's signal in the „Radar" application. Open any WEB browser in the computer and enter IP-address of the module's superior WB169-RFE gateway. URL address of the gateway should be entered in „**http://ip_adresa/**" form and search should be started after that. If an IP-connectivity between the computer and gateway is available, the website of „Radar" application opens (see figure 28), where there is a table with last reports from all devices broadcasting in the area of the gateway radio receiving (that work on the same frequency and with same communication mode).

The record of each device registered by gateway is displayed in a separate line where the following data can be seen:

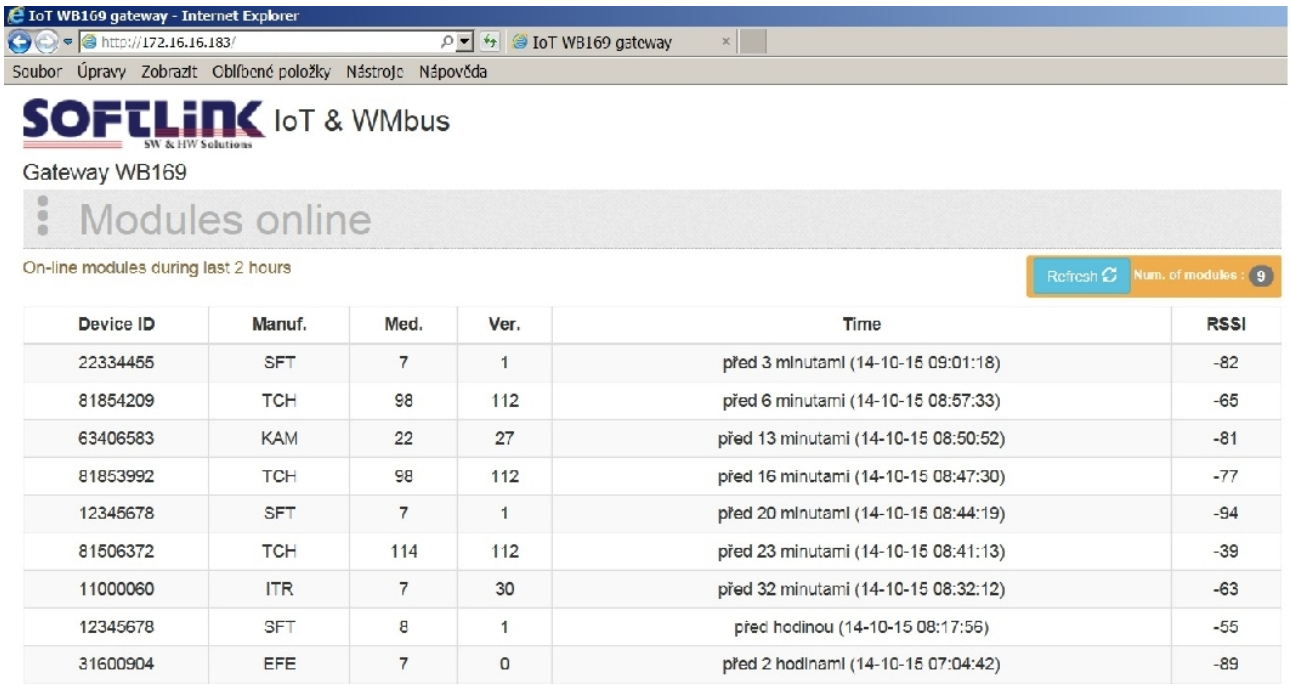


Figure 28: Example of „Radar" application table

- equipment identification
- receiving time of the last report from the equipment
- indication of radio signal quality of received message (RSSI = Received Signal Strength Indicator)

If the „Radar" table is displayed in a sufficiently long time since the WB169-SI4 module was putting into operation (or since its rebooting), the table should contain reports from meters and sensors connected to the module, including the evaluation of the receiving quality. The „Radar" table displays only records received during last 2 hours.

4.10 Operation of the WB169-SI4 module

The WB169-SI4 module performs broadcasting of radio messages fully automatically. Take into consideration that the broadcasting systems according to the Wireless M-BUS standard has no protection against interference during transmission (a signal collision, which occurs when two modules broadcast at the same time), so that temporary loss of data from some modules can commonly occur in case of operating of a large number of modules in one radio network. These losses can last for several hours or days.

The greatest risks of permanent breakdown of module broadcasting are commonly caused by human activities within the installation. It is mainly about the following risks:

- temporary or permanent shading of the antenna (e.g. due to building operations);
- mechanical damage of the module, the antenna cable or the antenna when handling things at the installation site.

To eliminate these risks, it is recommended to pay close attention to selection of the installation site and choice of antenna and antenna location so that to find appropriate compromise between qualities of signal and the level of risk of mechanical damage of the module or antenna. It is necessary to carry out the installation carefully with using of high-quality cables and mounting components.

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.

4.11 Using of WB169-SI4 module for remote monitoring of sensors

The WB169-SI4 module can be used also for remote monitoring of any two-state sensors with either isolated contact (e.g. mechanical contact, relay, reed contact...), or solid-state relay, or open collector types of outputs. It is not

possible to connect a sensor with its own source of voltage on its output. Convenient types of sensors are displayed in the Figure 29.

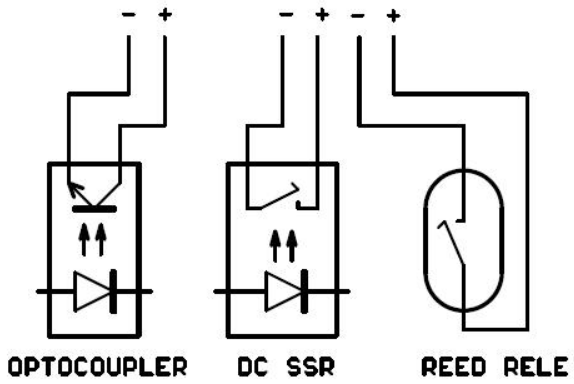


Figure 29: Types of sensor outputs convenient for WB169-SI4 module

When using of sensor with „open collector" output (see „optocoupler" in the Figure 29 left), it is necessary to observe its +/- polarity as marked on the module's and sensor's labels. When using of sensors with solid state relay output (see Figure 29 in the middle), or with isolated contact (see Figure 29 right), the polarity is usually not important.

Sensor output should be connected to the module's input clamps same way, as consumption meter. It is recommended to use shielded cable with minimum length.

Setting of sensor input is described in detail in paragraph 3.5.8 „Setting of sensor inputs". Before setting it is necessary to realize, in which state the sensor output is switched off, and in which state it is switched on, and which status should be propagated as „alarm message". If, as an example, the monitored sensor is a security loop (electronic seal - see Figure refimg:sensor-seal), it is clear, that in „normal" status the contact is switched on, because the contact head is coupled with magnet segment. In this case the primary cause of alarm status should be opening of security loop that causes detachment of contact head from magnet and releasing of reed contact inside the head. Releasing of contact is detected as rising edge ("0-to-1" transition) so that the alarm mode should be set to "2" ("rising") value. If the loop (or cable) is torn, the result would be the same.

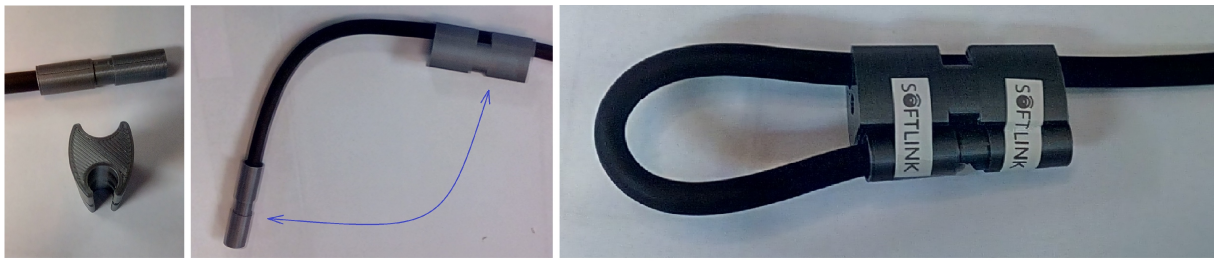


Figure 30: Principle of „electronic seal" sensor

If the subject of monitoring is opening of doors with using of position sensor. (see Figure 31), setting of alarm mode depends on the manner how the sensor was mounted on the door (whether contact head is coupled with magnet when the door is open, or when the door is closed).

5 Troubleshooting

5.1 Possible causes of module failures

If during operation of WB169-SI4 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 ba circumstances that are described in

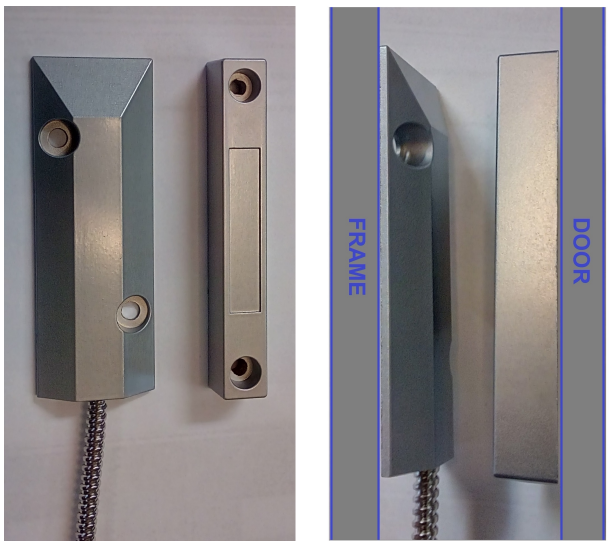


Figure 31: Using of position sensor for door monitoring

detail in paragarph 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 failes.

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 Transmitter and receiver failures

Transmitting of messages is signaled by flashing of red "TXA" LED on the module's printed circuit board. Flashing of LED during broadcasting can be observed through the transparent casing of the module.

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, when there are repetitive breakdowns in reception data from the module or occasional malfunctions of back channel (if implemented).

The ground of all above described troubles with communication could be unreliable radio-communication caused by one of these reasons:

- incorrect setting of transmitter parameters, mainly frequency channel, mode, 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 externel source (another radio system in the same frequency band, or industrial disturbance);
- low level of transmitting power caused by wrong setting or by failure of transmitter;

- failure of receiver that causes malfunction of back channel;
- 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 3.5.10 and perform the check of module overall functionality as described in paragraph 4.9;
- replace the module according to the paragraph 4.7 and perform the setting and check of overall functionality off the new module after that;
- if the module is not properly working even after its replacement for proven device and equipment, the trouble can be caused by local interference (jamming) from external source. Another possible reason could be an unsuitable setting of some configuration parameter that has not been discovered. In this case ask for your supplier, producer, or other experienced person for some form of assistance.

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

5.1.4 Failures of communication with meters

Failures of pulse signal transfer from the consumption meters to the correspond module inputs 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 meter and connecting cable between meter and radio-module, especially whether the meter's pulse generator is correctly mounted on the meter (if it is removable) and whether the meter or cable are not damaged;
2. in case of any doubt check the functionality of cable connection by ohm-meter. If there is a problem with reliability of the connection, or the cable is evidently damaged, replace the cable immediately;
3. check whether the cable is correctly associated with the module input (correct port number, correctness of polarity - if required by meter producer);
4. Visually check if there are not placed any objects or devices radiating a magnetic field (for example a device for water treatment with magnet, electrical installation...) around the consumption meter. The pulse generators of some types of the consumption meters are very sensitive to the magnetic field presence. If such devise is detected, it must be removed or there must be taken necessary measures to eliminate the magnetic field influence on the pulse generator of the consumption meter. To find more about the influence of the magnetic field on a particular consumption meter, you must follow its manufacturer instructions;
5. if there is some possibility of measuring metering pulses, make sure that the meter generates the pulses properly and that these pulses lead up entirely to the radio module input;
6. correctness of generating and transfer of metering pulses can be alternatively checked by short-circuiting of the cable on the meter side. If after each short-circuit the status value of the module's counter goes up, the module and cable are probably correct, and the trouble is probable caused by meter or by its pulse generator;
7. if the module doesn't read the data even the metering pulses are provably brought to the correct radio module input, check the pulse counter parameter settings (counter mode, trigger edge) according to the paragraph 3.5.5 „Internal Counter Setting Commands". In case the setting is correct, the problem is the most probably in the malfunction of the radio module. Replace the module following the instructions in the paragraph 4.7.

If the module register „false" pulses (consumption registered by remote reading is significantly higher than consumption registered by mechanical counter) and setting of the counter to „slow" mode has not solved the problem, the failure could be caused either by too long or poor-quality cable or strong local disturbance (or combining of these two circumstances). In this case replace the cable for high-quality shielded one or make changes in the installation to shorten the cable.

In case of unstable data transfer from connected sensors the signs of failure are very similar to the troubles with pulse meters - the wrong indication of measured data from sensors. Troubleshooting of this failure is similar with troubleshooting of pulse meters:

1. visually check the sensor and connecting cable between sensor and radio-module for any damage;
2. check whether the cable is correctly associated with the module input (correct port number, correctness of polarity - if required by sensor producer);
3. visually check if there are not placed any objects or devices around the sensor that can influence its functioning;
4. check correctness of the sensor input by short-circuiting of the cable on the sensor side. If after each short-circuit the value of the module's counter changes, the module and cable are probably correct, and the trouble is with high probability caused by sensor;
5. if the module doesn't register the changes of sensor status even though the changes are provably brought to the correct radio module input, check the counter parameter settings (counter mode, trigger edge) according to the paragraph 3.5.5 „Internal Counter Setting Commands". In case the setting is correct, the problem is the most probably in the malfunction of the radio module. Replace the module following the instructions in the paragraph 4.7.

5.2 Troubleshooting procedure

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

1. No data are available from all meters/sensors connected to the WB169-SI4 module. In this case it is recommmended to check functionality of the module subsystems in following order:
   - check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures"
   - check functionality of the system as described in the paragraph 5.1.2 „System failures"
   - check functionality of the transmitting and receiving of the radio-signal as described in the paragraph 5.1.3 „Transmitter and receiver failures"
   - check functionality of correct reading of pulse/sensor signals on the module inputs as described in the paragraph 5.1.4 „Failures of communication with meters"
2. No data are available from only one meter/sensor connected to the WB169-SI4 module. In this case it is recommended to check functionality of the module subsystems in following order:
   - check functionality of the meter/sensor
   - check correctness of central application configuration related to the meter/sensor, especially correctness of its ID, address and association of the meter/sensor with right port of reading module
   - check functionality of receiving pulse signals on the module's input as described in paragraph 5.1.4 „Failures of communication with meters"

NOTE: WB169-SI4 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 installation environment, mechanical damage, excessive humidity, discharging of internal battery, or voltage pulses induced to the input cables. 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 WB169-SI4, operating according to the Wireless M-BUS standard (EN 13757-3 / EN 13757-4 recommendation) for the 169 MHz band, that are a part of the Softlink's **wacoSystem** product family. More information about all WB169, WB868 (Wireless M-BUS), WM169, WM868 (WACO) or WS868 (Sigfox) series of the modules can be found on the manufacturer website:

www.wacosystem.com
www.softlink.cz

If interested in any additional information related to application of radio modules of WB169, WB868, WM169, WM868, WB868, 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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