WIRELESS COMMUNICATION SYSTEM
Wireless M-Bus

WB169-430-V

Revision 1.0

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1 Introduction

This document describes features, parameters and setting possibilities of the WB169-430-V module, which is used either for remote reading of iPERL series watermeters by Sensus equipped with 433 MHz data transmitter, or other watermeters (*) of the "smart" category, equipped with an 433 MHz transmitter working in Wireless M-Bus format. The module receives messages from watermeters and broadcasts the read data to the superior Automatic Meter Reading (AMR) system n form of 169 MHz Wireless M-Bus standard messages.

(*) Although the module is primarily intended for reading watermeters, it can also be used for reading of any other consumption meters or sensors that send messages in 433 MHz Wireless M-Bus format.

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 reverse 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 WB169-430-V module can be used as local **communication gateway** for remote reading of Sensus iPERL-series watermeters, or other "smart" watermeters with integrated Wireless M-Bus transmitters in the 433 MHz band. The module receives regular radio messages with readings from watermeters within its radio-reach and stores the readings to its memory. In pre-defined intervals the module broadcasts aggregate of received data to the superior remote reading system (AMR) in form of Wireless M-Bus radio-messages in 169 MHz frequency band ("INFO" messages).

The WB169-430-V module can by used for remote reading **up to 20 watermeters** placed in its radio-reach (that is up to hundreds meters). Each watermeter transmits the messages with a short fixed period (e.g. iPERL every 15 seconds). The module receives data from watermeters in regular "receiving windows", that are opened with preset transmitting period (e.g. every 120 minutes). Received data from each receiving window are stored into the module memory. Immediately after closing of the receiving window the module broadcasts received data from all watermeters to the superior system in one Wireless M-Bus message.

Each module has its table of read watermeters, where there are IDs (serial numbers) of meters that should be read by the module. If there are other watermeters in the reach, their messages are ignored. The module supports receiving and transmitting of messages either in open mode, or in **encrypted mode**. The module allows forwarding of original **alarm statuses** ("flags") from watermeters together with normal readings, or conversion of "flags" into the *wacoSystem* alarm messages, that are sent immediately.

Content of INFO-messages is configurable. The messages contain identification and current statuses of module parameters (uptime, battery voltage, processor temperature..), list of read watermeters and current values of its counters. The messages are broadcasted 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 WB169-430-V module supports **bi-directional communication** and it is able to receive commands in Wireless M-Bus format from the 169 MHz network. These messages can be used for setting of module parameters from the remote server.

1.3 Hardware features and power supplying

The module is enclosed in humidity-proof plastic casing with IP65 degree of protection and can be used in interiors as well as in exteriors. The casing is designed for mounting on the wall or other construction element (beam, pipe...). Module can be treated with an additional sealing by high-adhesion silicon filling, that can ensure proof against inundation by water (IP68 grade). If this treatment is required from the manufacturer, it must be ordered separately.

The module is power supplied by internal battery with up to 8 years lifetime for frequency of 6 broadcastings per day. Battery lifetime can be negatively influenced by shorter broadcasting period, or by storing and operation in sites with the temperatures exceeding the recommended range.

The module can be controlled and configured either by configuration cable, or wirelessly, by infra-red optical converter. The module is equipped with the special circular aperture ("peephole") for magnetic fixing of the optical converter. The module can be also configured remotely, with using of reverse channel of bi-directional communication.

External appearance of the WB169-430-V module is shown in the figure 1.

Figure 1: View of the WB169-430-V module

2 Technical parameters overview

Overview of WB169-430-V module technical parameters is shown in the Table1 below.

Table 1: Overview of WB169-430-V 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
Communication protocol	Wireless M-Bus	
Communication mode (by EN 13757-4)	N2	
Transmission speed *	2400, 4800, or 19200	Baud
Antenna connector	SMA female	
Antenna characteristic impedance	50	Ω
Parameters of 433 MHz receiver		
Carrier frequency	433	MHz
Antenna connector	SMA female	
Supported communication protocols	Sensus iPERL, Wireless M-Bus	
Max. number of read watermeters	20	
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 wavelength	870	nm
Optical interface specification	IrPHY 1.4 standard	
Power supplying		
Lithium battery voltage	3,6	V
Lithium battery capacity	13	Ah
Weight and dimensions		
Length (w/o antennas)	200	mm
Width	70	mm
Height	60	mm
Weight	cca 250	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 treated by additional silicon filling are waterproof with IP68 degree of protection.

3 Configuration of the WB169-430-V module

Configuration parameters of the WB169-430-V 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;
- wirelessly, with using of **„USB-IRDA"** or **„BT-IRDA"** converter;
- **remotely**, by using of bi-directional communication system.

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

www.wacosystem.com/support/
www.softlink.cz/en/documents/

The description and meaning of all configuration parameters that can be checked and changed by cable can be found in the section 3.1 „Setting of WB169-430-V parameters via configuration cable".

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

Principles and short description of communication through the **Wireless M-Bus reverse channel** can be found in paragraph i 3.3 „Remote setting of module parameters through the reverse channel".

3.1 Setting of WB169-430-V module parameters by configuration cable

In following part of the document there is a description of these parameters of the WB169-430-V module, that can be displayed and examined from PC connected to the module by configuration cable. Some of the parameters can be changed by configuration commands entered „from the console".

3.1.1 List of WB169-430-V module configuration parameters and commands

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:

```
cfg#show
----- Configuration -----
 Timezone : 1
 MBUS ID : 00940001
 MBUS manufacturer : SFT
 MBUS medium  : 7
 MBUS version : 1
 Send periode : 60
 Data will be encrypted by AES
 Sensus meters :
  ID[1] : 121362071
  ID[2] : 120233618
-- 868Mhz modem --
  No. sent : 0 msg(s)
  No. recv : 21 msg(s)
  No. recv error : 0 msg(s)
  Receive window : 40 sec.
-- 169Mhz modem --
  No. sent : 3 msg(s)
  No. recv : 0 msg(s)
  No. recv error : 0 msg(s)
 Conf. version : 3
 SW version 1.01, date Aug 12 2021
cfg#
```

List of all configuration commands ("HELP") can be displayed by entering of **"?"** command into the command line and pressing of „ENTER" key.

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

```
cfg#?
 Help :
 --- System commands ---
deb               : Show or set debug level
ta                : Show tasks
mb                : Show mail boxes
du addr           : Dump memmory
rb addr           : Read byte from addr
rw addr           : Read word from addr
rd addr           : Read dword from addr
sb addr val       : Set byte on addr
sw addr val       : Set word on addr
sd addr val       : Set dword on addr
port              : Show port [a,b,..]
ppm               : Set RTC ppm
show              : Show info
write             : Write configuration to flash
cread             : Read configuration from flash
clear             : Clear configation and load defaults

 ---  868 commands --- ---
power1            : Show or set 868 power (1 - 5)
mread1            : Modem properties read, params : group, index, count
mset1             : Modem properties set, params : group, index, data
mr1               : Modem receive mode 0 - off, 1 - on
mm1               : send test msg
mt1 test time     : Set test on modem, 1 - TX carrier, 2 - TX PN9, time is in second, default 10
ms1               : Get modem state
mi1               : Get modem info
mode              : Set/Get recv. protocol : 0 - iPerl, 1 - WMBUS
recvwin           : Set receive window in sec.
recvsec           : Modem receive on sec.
radar             : show radar
clradar           : clear radar
si1cap            : Set or get xtal capacity correction
si1xtal           : Set or get xtal frequence
cfreq1            : Set xtal from analyzer

 ---  169 commands --- ---
power2            : Show or set 169 power (1 - 5)
mread2            : Modem properties read, params : group, index, count
mset2             : Modem properties set, params : group, index, data
chan2            : Set WMBUS channel, type ? for help
mr2               : Modem receive mode 0 - off, 1 - on
mm2               : send test msg
mt2 test time     : Set test on modem, 1 - TX carrier, 2 - TX PN9, time is in second, default 10
ms2               : Get modem state
mi2               : Get modem info
si2cap            : Set or get xtal capacity correction
si2xtal           : Set or get xtal frequence
cfreq2            : Set xtal from analyzer
```

```
 --- Sensus ---
skey              : Set decrypt key Sensus
sid [index] [value] : Set Sensus meter ID

 --- W-MBUS ---
wkey              : Set decrypt W*-MUBS key
sid [index] [value] : Set WMBUS meter ID
dib1 [index] [value] : Set WMBUS DIF/VIF 1
dib2 [index] [value] : Set WMBUS DIF/VIF 2
diba [index] [value] : Set WMBUS DIF/VIF for alarm flags
alrb [index] [type] [value] : Set WMBUS alarm flags bits
wtab              : Show known vif dif table

 --- Utils ---
tz                : Time offset in hours
time              : Show or set rtc time, set as BCD : 0x102033 is 10:20:33
date              : Show or set rtc date, set as BCD : 0x171231 is 2017-12-31
uptime            : Show uptime
sens              : Show sensors
med               : Set w-mbus medium
vers              : Set w-mbus version
periode           : Send periode 0 - disable, >0 periode in minutes
ekey              : Set encrypt key NEP, point '.' no encrypt
info              : Show or set manuf. info string (0-30 chars)
send              : Send W-MBUS message
reset             : Reset device
?                 : Show this help
cfg#
```

Overview of configuration parameters with short description of their meaning can be also found in table 2 on the page 22. The meaning of individual parameters and detailed description of their usage can be found below.

3.1.2 „System commands" group for general diagnostics

Commands „**"deb", "ta", "mb", "du addr", "rw addr", "rb addr", "rd addr", "sw addr", "sb addr", "sd addr", "ppm"** 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.**

Other system commands **"show"** (configuration statement) and **„?'** („Help") are described in previous part of section 3.1.

By using of **"port"** command an actual setting of module ports can be displayed. This command is intended only for module diagnostics.

3.1.3 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 3.1.1):

```
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 **"cread"** command (for older some modifications the command is **"read"**):

```
cfg#cread
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.

3.1.4 Commands of „433 Commands" group for setting of receiving system of watermeter messages

The module is equipped with internal 433 MHz modem, that serves for receiving of data from watermeters. In regular operation the modem is periodically (with preset reading period) switched to receiving mode for preset time interval (called „Receive window"), when radio-messages from all watermeters in radio-reach are received. After closing the receive window the modem is switched off to save battery energy.

The module is able to receive either only "Bubble-Up" 433 MHz messages from **Sensus iPERL** watermeters, or only messages in universal **Wireless M-Bus** ("WMBUS") protocol in the 433 MHz band from other manufacturer watermeters (or from other types of equipment). The "iPERL" messages have a completely different format than "WMBUS" messages and the modem cannot receive both types of messages at the same time.

Next part of commands can be used for setting of 169 MHz modem during initial activation, factory setting and diagnostics. There are following commands:

power1	*setting of 433 MHz modem transmitting power (factory setting)*
mread1	*reading of 433 MHz modem parameters (factory setting)*
mset1	*writing of 433 MHz modem parameters (factory setting)*
mm1	*broadcasting of test message by 433 MHz modem (factory setting)*
mt1 test time	*activation of 433 MHz modem testing transmission (factory setting)*
ms1	*internal status of 433 MHz modem (diagnostics)*
mi1	*dump of 433 MHz modem internal registers (diagnostics)*
si1xtal	*169 MHz modem frequency constant setting (factory setting)*
si1cap	*169 MHz modem crystal correction (factory setting)*
cfreq1	*169 MHz modem frequency constant correction (factory setting)*

Manufacturer strongly recommends not to use these commands during common operation.

Next group of commands is used for general setup and control of the 433 MHz modem, which is common for receiving both types of messages. There are following commands:

mr1	*manual switching of 433 MHz modem to receive mode*
mode	*receiver mode switching: 0=iPERL, 1=WMBUS*
recvwin	*setting the length of the "receive window" in seconds*
recvsec	*open 433 MHz receive window for preset time interval*
radar	*list of watermeters within module reach ("RADAR" mode)*
clradar	*emptying the radar table*

Receive mode of 433 MHz modem can be manually switched by using of **"mr [1/0]"** command. By entering of "1" parameter the receiver is switched on, by entering of "0" parameter the receiver is switched off. When the receiver is switched on, all received messages from water meters within range of the modem are read into the "radar" table (see below) and in the "debug" mode, incoming messages can be checked online in the communication window of the serial communication program. This way it can be surveyed, which meters are in the reach and with what frequency and reliability is their signal received. The receive window can be opened for desired time, until it is manually closed by command with "0" parameter.

Example of opening and closing of receive mode:

```
mon#mr 1
Receive 1 (2)
cfg#mr 0
Receive 0 (4)
cfg#
```

The **"mode [1/0]"** command can be used for switching of 433 MHz modem between **„iPERL"** mode for reception of Sensus iPERL watermeters signal (parameter value is "0") and **„Wireless M-Bus"** mode for reception of WMBUS watermeters signal (parameter value is "1").

Example of current mode checking and subsequent switching of 433 MHz modem into the „Wireles M-Bus" mode:

```
cfg#mode
Protocol 0
cfg#mode 1
Protocol 1
cfg#
```

By using of the **"recvwin [time]"** command the length of "receive window" parameter can be preset to the specified number of seconds. In normal operation the 433 MHz modem will open periodically for a preset time and store data from all water meters that are on the reading list.

Example of setting the receive window of the 433 MHz modem to 60 seconds value:

```
cfg#recvwin 60
Set receive window on 60 sec.
cfg#
```

The length of the receive window is stated in "433MHz modem" section of the list of module parameters (displayed by using of "show" command) as follows:

```
-- 433Mhz modem --
  No. sent : 0 msg(s)
  No. recv : 0 msg(s)
  No. recv error : 0 msg(s)
  Receive window : 60 sec.
```

Using the **"recvsec [time]"**command the 433 MHz modem is turned for a specified time into the "RADAR" mode. In this mode, the receiver receives all messages from watermeters and a "RADAR" table, in which each received watermeter is listed only once (regardless of the number of messages received from this meter), is filled. The result is a table of all water meters, from which at least one message was captured in the receiving window. The opening time of the receive window is set by the command parameter [time].

Example of turning the 433 MHz modem into the "RADAR" mode for 60 seconds:

```
mon#recvsec 60
Modem goes to receive for 60 sec.
mon#
```

After entering the "recvsec" command and waiting until the set time has elapsed, the "RADAR" table content can be browsed by using of **"radar"** command:

```
mon#radar
Show radar :
 id 130551474, rssi -75, time 2019-01-01, 0:01:25+01
 id 130551473, rssi -69, time 2019-01-01, 0:01:21+01
 id 130551476, rssi -69, time 2019-01-01, 0:01:17+01
 id 130551477, rssi -54, time 2019-01-01, 0:01:13+01
 id 130400388, rssi -103, time 2019-01-01, 0:01:12+01
 id 130551475, rssi -62, time 2019-01-01, 0:01:11+01
mon#
```

As evident form the example, during the receive window the module received messages from six watermeters. Each record contains watermeter serial number (id), radio-signal strength in dB (rssi) and message receiving time (time). Stored values come from the first received message from the watermeter within the receive window.

After entering the **"clradar"** command, the "RADAR" table is emptied. It is recommended to use this command before turning on the "RADAR" function, if the conditions have changed significantly since the last radar start (mode change, module location change, etc.). Example of using the "clradar" function:

```
mon#clradar
Cleared 0 rec(s)
mon#
```

3.1.5 Commands of „169 Commands" group for setting of 169 MHz network communication

This group of commands can be used for setting of 169 MHz RF sub-system, that serves for communication with superior network element (e.g. communication gateway).

The first part of commands serves for setting of basic broadcasting parameters. There are following commands:

power2	*setting of 169 MHz modem transmitting power*
chan2	*setting of 169 MHz modem frequency channel*

The command **„power2"** 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 **"power2"** 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#power2
MBUS power : 3 (20 dBm)
cfg#power2 5
MBUS power changed from 3 to 5 (27 dbm)
cfg#power2
MBUS power : 5 (27 dBm)
cfg#
```

The command **"chan2"** 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 "chan2" command without parameter. Change of channel can be done by entering of desired option as a parameter of the command.

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

```
cfg#chan2
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#chan2 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#chan2
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
...
```

Next part of commands can be used for setting of 169 MHz modem during initial activation, factory setting and diagnostics. There are following commands:

mread2	*reading of 169 MHz modem parameters (factory setting)*
mset2	*writing of 169 MHz modem parameters (factory setting)*
mr2	*switching of 169 MHz modem into receive mode (diagnostics)*
mm2	*broadcasting of test message by 169 MHz modem (factory setting)*
mt2 test time	*activation of 169 MHz modem testing transmission (factory setting)*
ms2	*internal status of 169 MHz modem (diagnostics)*
mi2	*dump of 169 MHz modem internal registers (diagnostics)*
si2xtal	*169 MHz modem frequency constant setting (factory setting)*
si2cap	*169 MHz modem crystal correction (factory setting)*
cfreq2	*169 MHz modem frequency constant correction (factory setting)*

Manufacturer strongly recommends not to use these commands during common operation.

3.1.6 Commands for setting of watermeter reading

Groups of commands „Sensus" and „W-MBUS" are intended for settings, that are necessary for decoding of received messages from watermeters.

The **„Sensus"** group of commands serves for decoding of received messages from **Sensus iPERL** watermeters. There are following commands:

skey	*setting of encryption key for decrypting of iPERL watermeters messages*
sid [index] [value]	*setting of reading list of iPERL watermeters*

The command **"skey"** (Sensus encryption key) is used for setting of the encryption key for decryption of messages from Sensus iPERL watermeter (if the messages are encrypted). The AES-128 encryption key of 16 bytes length is entered by using of **"skey"** command, followed by the string of 16 bytes that can be entered in a decimal or hexadecimal format same way as encryption key for Wireless M-Bus 169 MHz communication (see using of "ekey" command in paragraph 3.1.7 below). All watermeters, that the module reads, must have the data encrypted with the same key.

The **"Set Meter ID"** variable serves for setting of list of watermeters, that is intended to be read by the WB169-430-V module. Each record to the list could be created by using of **"sid [index] [value]"** command, where meter ID (serial number) is linked with meter index (0 - 19).

Eample of command for entering of watermeter with "130551477" serial number into the list of read meters under index "4":

```
cfg#sid 4 130551477
Sensus ID[4] changed from : 0 to : 130551477
mon#
```

Current list of read watermeters is stated in the list of all configuration parameters. The list can be also displayed by using of "sid" command without parameters:

```
cfg#sid
Sensus
 ID[0] 76738781
 ID[1] 76738783
 ID[2] 76738791
 ID[3] 76738794
 ID[4] 76738756
 ID[5] 0
 . . .

 ID[18] 0
 ID[19] 0
mon#
```

The table allows entering up to 20 watermeters. Indexes of ID values are linked with variable indexing system in outgoing messages, where there are two "storages " assigned for each ID index (e.g. for ID "0" there are assigned storages "0" and "1", for ID "1" storages "2" and "3" etc.).

The watermeter can be removed from the list by entering the value "0" for the given index.

The **„WMBUS"** group of commands serves for decoding of received messages from any **Wireless M-Bus** smart watermeters.

There are following commands:

wkey [**index**] [**value**]	*setting of encryption key for decrypting of watermeter messages*
sid [**index**] [**value**]	*setting of watermeter IDs for reading (reading list)*
dib1 [**index**] [**value**]	*setting of DIF and VIF for selection of the first variable*
dib2 [**index**] [**value**]	*setting of DIF and VIF for selection of the second variable*
diba [**index**] [**value**]	*setting of DIF and VIF for selection of alarm variable*
alrb [**index**] [**type**] [**value**]	*assigning the alarm type to the alarm flag value*
wtab	*display of „Table of DIF/VIF Codes" for decoding of compact messages*

The command **"WMBUS encryption key"** is used for setting of the encryption key for decryption of messages from individual watermeter (if its messages are encrypted). The AES-128 encryption key of 16 bytes length is entered by using of **"skey"** command, followed by the string of 16 bytes that can be entered in a decimal or hexadecimal format same way as encryption key for NB-IoT communication (see using of "ekey" command in paragraph 3.1.7).

The **"Set Meter ID"** variable serves for setting of list of watermeters, that is intended to be read by the WB169-430-V module. Each record to the list could be created by using of **"sid [index] [value]"** command, where meter ID (serial number) is linked with meter index (0 - 9). Example of command for entering of watermeter with "76738781" serial number into the list of read meters under index "0":

```
cfg#sid 0 76738781
WMBUS ID[0]  changed from : 0 to : 76738781
cfg#
```

Current list of read watermeters is stated in the list of all configuration parameters. The list can be also displayed by using of "sid" command without parameters:

```
cfg#sid
WMBUS
 ID[0] 22178514
 ID[1] 22178511
 ID[2] 22178586
 ID[3] 22178597
 ID[4] 22178436
 ID[5] 0
 . . .
 ID[18] 0
 ID[19] 0
mon#
```

The table allows entering up to 20 watermeters. Indexes of ID values are linked with variable indexing system in outgoing messages, where there are two "storages " assigned for each ID index (e.g. for ID "0" there are assigned storages "0" and "1", for ID "1" storages "2" and "3" etc.). The watermeter can be removed from the list by entering the value "0" for the given index.

The WB169-430-Vmodule can read from each read device (typically a watermeter) **one or two standard variables**, which it transmits in messages to the superior system, and one **status variable**, which it does not transfer to the superior system, but it can be used as a basis for generating an alarm.

A message in Wireless M-Bus format from a given device type can contain many different variables, from which it is needed to select the two to be transmitted, and one to be used for generating of alarms. The selection can be done by using of "dib1", "dib2" and "diba" commands. At least the variable "dib1" should be set for each device read, the settings "dib2" and "diba" are optional.

The selection is made by setting the DIF and VIF values, which are always unique in the message for a specific variable. Therefore, if the DIF/VIF value is set to "02 5B" as an example, the system selects from the incoming WMBUS message the value of the variable, that is marked in the message by this DIF/VIF combination.

By using of **"dib1 [index] [value]"** command the DIF and VIF of the first read variable can be set. Since the typical reading device is assumed to be a watermeter and the typical reading is the amount of water flowing, this value **is preset to "universal filter"** by default, so that it most likely selects the correct variable.

The universal "water" filter is set as follows:

- DIF value is not checked
- VIF value starts with string "0001 0xxx" (Volume)

The measured water volume is usually referred to as "Volume" in the Wireless M-Bus system. The first 5 bits of the accompanying VIF (Value Information Field) information are always set to "00010" for a variable of "Volume" type, the next 3 bits specify only the multiplier (0,000001 to 10). The module reads the variable if its VIF starts with the string "00010" and adjusts the position of the decimal point according to the next three bits. The default value can be anytime preset by setting DIF/VIF to "00 00".

If some individual watermeter has the required variable marked other than "Volume" (or if the readout device is not a watermeter), the DIF/VIF value must be changed according to the actual designation in the message. Return to the default setting can be done by entering of "00 00" value.

If. in addition to the basic variable "dib1", it is required to read the second variable, use **"dib2 [index] [value]"** command for setting its DIF and VIF. There is no preset filter for the second varaiable. If the DIF/VIF values are set to "00 00", the loading of the second variable is deactivated. The DIF and VIF valuaes are entered separately (first DIF, then VIF) in hexadecimal format. Example of setting the reading of the second variable for devices with index "1" to the value DIF/VIF "02 5B":

```
cfg#dib2 1 0x02 0x5b
DIF/VIF [1/2] : 02 5b
cfg#
```

With this setting, the second variable will be read from the device with index "1" (in addition to the first variable), namely the one marked in the WMBUS message by a pair of auxiliary codes DIF=02 and VIF=5B, where the individual codes mean:

- DIF=02 means that the data in 16 bit integer format
- VIF=5B means variable of "Flow Temperature" type in whole °C

This is obviously the temperature of the water flowing through the watermeter.

If the read watermeter (or other device) has in its message a variable that carries the **status value** (so-called "alarm flag"), by using of **"diba [index] [value]"** command can be selected the value of that variable. Thus, the module can generate alarm messages based on the changes of the value. The principle and procedure of the settings are exactly the same as for the commands "dib1" and "dib2". Find out the DIF/VIF code of the "flag" value and set these values using the "diba" command for the index corresponding to the given device.

The **"alrb [index] [type] [value]"** command can be used for "mapping" of the numeric status of the read device to the standardized *wacoSystem* alarm types used within the system. If the read device has a status variable in its message, and the module reads this value from the message (see using the "diba" command in the previous paragraph), by using of "alrb" command the read values can be "translated" into the alarm types supported by module. The module can generate the following types of alarms:

- **type "0"** = "Leak" - state of uninterrupted flow, indicating leakage
- **type "1"** = "Burst" - state of longer lasting overflow limit, indicating breakdown
- **type "2"** = "Battery" - low voltage of device battery
- **type "3"** = "Back Flow" - reverse direction of measured flow

Example of mapping of statuses for device with index "0" to *wacoSystem* alarms and back check of the settings made:

```
cfg#alrb 0 0 2
WMBUS alarm bits [0] :
 Burst - 2
cfg#alrb 0 1 1
WMBUS alarm bits [0] :
 Leak - 1
cfg#alrb 0 2 4
WMBUS alarm bits [0] :
 Baterry - 4
cfg#alrb 0 3 3
WMBUS alarm bits [0] :
 Back flow - 3
cfg#
. . .
cfg#alrb 0
WMBUS alarm bits [0] :
 Burst - 2,  Leak - 1,  Baterry - 4,  Back flow - 3
cfg#
```

The status "0" is always considered as the basic "fault-free" status. With this setting, the "Burst" alarm is issued when the status is changed from any to "2" (for example, when the status was "0" in the previous message and it is "2" in the new one). Similarly, the "Leak" alarm is generated when the status changes to "1", the "Battery" alarm when the status changes to "4", and the "Back Flow" alarm when the status changes to "3". When the status changes to "0", an "OK" alarm is generated.

Current status of settings of all devices can be displayed by entering of "alrb" command without parameters:

```
cfg#alrb
WMBUS alarm bits :
 [0] -  Burst - 2,  Leak - 1,  Baterry - 4,  Back flow - 3
 [1] -  Burst - 2,  Leak - 1,  Baterry - 4,  Back flow - 3
 [2] -  Burst - 1,  Leak - 2,  Baterry - 3,  Back flow - 0
 [3] -  Burst - 1,  Leak - 2,  Baterry - 3,  Back flow - 0
 [4] -  Burst - 0,  Leak - 0,  Baterry - 0,  Back flow - 0
. . .
 [18] -  Burst - 0,  Leak - 0,  Baterry - 0,  Back flow - 0
 [19] -  Burst - 0,  Leak - 0,  Baterry - 0,  Back flow - 0
cfg#
```

The example shows a situation where statuses are read from four watermeters, the first two being of a different type than the second two.

By using of the **"wtab"** command the current content of the „Table of DIF/VIF Codes" for decoding of „compact WMBUS messages" can be displayed.

Most Wireless M-Bus devices broadcasts standard messages with a short or long WMBUS header, marked CI-Byte "72" (Long Header) or "7a" (Short Header). However, some manufacturers use so-called „compact messages" on their devices, which do not contain accompanying DIF/VIF data and use CRC protection. These messages are marked with CI-Byte "79" (Compact Frame) and there is necessary to know their DIF/VIF values for their decoding. Therefore, the device also sends a „Full Frame" message (CI = 78) with a certain frequency, which contains DIF/VIF data. Until the module captures at least one full message, it is not able to decode the received data. After receiving the full message, the module stores DIF/VIF values of all variables into the „Table of DIF/VIF Codes" and use them when decoding compact messages.

The current content of the Table of DIF/VIF Codes can be displayed by entering the command "wtab" without parameters:

```
mon#wtab
-- Dif Vif table --
01 Man : KAM, Med 22, Ver 27, CRC 0xa8ed, len 11
 02 ff 20 04 13 44 13 61 5b 61 67                 .. ..D.a[ag
mon#
```

As can be seen from the example, the record contains DIF/VIF values for the device from the manufacturer "KAM" (Kamstrup), which sends 4 variables with the specified DIF/VIF values. The table is for diagnostic purposes only.

3.1.7 Commands of „Utils" group for setting of module basic functions

This group of commands is intended for control and setting of other common functions of the module. There are following commands:

tz	*setting of time zone (UTC + n)*
time	*real time (RTC) displaying/setting (hh:mm:ss)*
date	*real time (RTC) displaying/setting (RR.MM.DD)*
uptime	*show system uptime from last reset*
sens	*show current values of internal sensors (temperature, voltage..)*
med	*setting of media code („Medium" - supplement of M-BUS address)*
vers	*setting of „addressing version" („Version" - supplement of M-BUS address)*
periode	*setting of regular messages broadcasting period*
ekey	*setting of encryption key "." - encryption disabled)*
info	*setting device name*
send	*immediate sending of Wireless M-Bus message with current values*
reset	*command for module reset*
?	*show list of configuration commands („Help")*

By using of **"tz"** command the current **Time Zone** can be preset. The module supports **only one** time zone, that is set in number of hours from UTC.

Example of setting of "UTC+1" Time Zone (Central-European Time):

```
cfg#tz 1
Tz change from 0 to 1
cfg#
```

Current setting of Time Zone displays in the configuration summary as follows:

```
Timezone : 1
```

Current setting of RTC can be displayed by entering of **"time"** or **"date"** command (without parameter). Example:

```
cfg#time
RTC time : 15:30:17 2019-01-30
 systime 1548858617 : 2019-01-30, 15:30:17+01
cfg#
```

RTC value can be entered by using of **time** and **date** commands as follows:

```
cfg#time 0x182555
RTC time : 18:25:55 2019-01-30
 systime 1548869155 : 2019-01-30, 18:25:55+01
cfg#date 0x190128
RTC time : 18:26:58 2019-01-28
 systime 1548696418 : 2019-01-28, 18:26:58+01
cfg#
```

As it is clear from the example, "time" value should be entered in "0x**hhmmss**" format, "date" value should be entered in 0x**RRMMDD** format.

NOTE: *setting of RTC (including time zone setting) is not important for the module common operation. No current module application requires RTC setting.* By using of **"uptime"** command the time since last module restart (switch on or reset) can be displayed. Using of this command can help with module diagnostics. From current „Uptime" value it is clear, when the module went through the last restart. The variable is of „read only" type. Example:

```
cfg#uptime
Uptime 0d, 0:13:26
cfg#
```

The **"sens"** command can be used for displaying of current values of A/D converters measuring battery voltage and processor temperature. This command is intended only for module checking and diagnostics.

```
cfg#sens
-- Sensors --
CPU : 25.8 °C
VDA : 3.586 V
mon#
```

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" value (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 checking and subsequent setting to "02" value (electricity):

```
mon#med
Medium is 7
mon#med 2
Medium is 2
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 settable and can be changed by using of **"vers"** command. Assigned version number can be displayed by **„vers"** command (without parameter). Example of version setting to "2" value:

```
mon#vers 2
Version is 2
mon#
```

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. The WB169-430-V module has fixed values of „M-BUS ID" and „Manufacturer" address components, that are displayed in the list of configuration parameters and cannot be changed. Uniqueness of these two address components is guaranteed by producer. Address components „Version" and „Medium" can be edited by user according to the project requirements.*

„Periode" command serves for setting of broadcasting period of regular info messages. The value of the parameter is factory preset to **"0" value**, that means **disabled transmitter**. 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.
```

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 encryption 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 encryption 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 3.1.1)

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

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

In this case an information ***„Data will be unencrypted"*** appears in the list of configuration parameters.

„Info" command can be used for setting of device name that is a part of each broadcasted message (see paragraph 3.4). Setting of this parameter is optional, factory setting is "empty" (no 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
Manuf. info  : ''
cfg#info K433
Change manuf. info from : '' to : 'K433'
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.

During common operation the module automatically broadcasts information messages with preset transmitting period. By using of **"send"** command the message can be transmitted immediately („out od turn"). that can be used for example for checking of radio signal availability during the system installation.

An example of immediate sending of Wireless M-Bus message by "send" command:

```
cfg#send
Sent 55 bytes
cfg#
```

The command **"reset"** performs the module reset. After each reset the system starts with the parameters that are stored in FLASH memory. If the current configuration should be used after reset, it is necessary to store it into the FLASH before reset (see paragraph 3.1.3). Example of using of "reset" command:

```
cfg#reset
 -- Reset code 0x14050302 --
 SFT Reset
 SW version 1.01, date Jun 15 2021
Monitor started ..
mon#
```

By **"?"** command the list of all configuration commands with their brief description ("Help") can be displayed. Example of using this command can be found in the initial part of section 3.1.

3.1.8 Displaying of other operational entries in the list of parameters

In the upper part of the list of configuration parameters there are module identification details and basic settings that are described above (period, encryption...). In the middle part of the dump there is a list of read meters. In the lower part of the dump there are**operational statistics of both modems**, length of receiving window and information about the module software version. The operational statistics have following meaning:

- "No. sent" is a number of sent messages since last reset
- "No. recv" is a number of received messages since last reset
- "No. recv error" is a number of received error messages since last reset

The statistics can be used for module diagnostics.

In the **"Conf. version"** row there is a current version (number) of configuration set, that increases with each storing of the configuration into the FLASH memory. The number is cleared by erasure of FLASH memory. In the **"SW version"** row there is a module software version and release date.

3.2 Setting of parameters by using of optical converter

The module i equipped with the „IRDA" infrared optical interface, that can be used for configuration through the **„USB-IRDA"** converter (USB-to-optic) or through the **„BT-IRDA"** converter (Bluetooth-to-optic).

All parameters that is necessary to set-up during common operation can be configured by **„USB-IRDA"** converter. The settings can be performed 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).

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

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*
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*

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

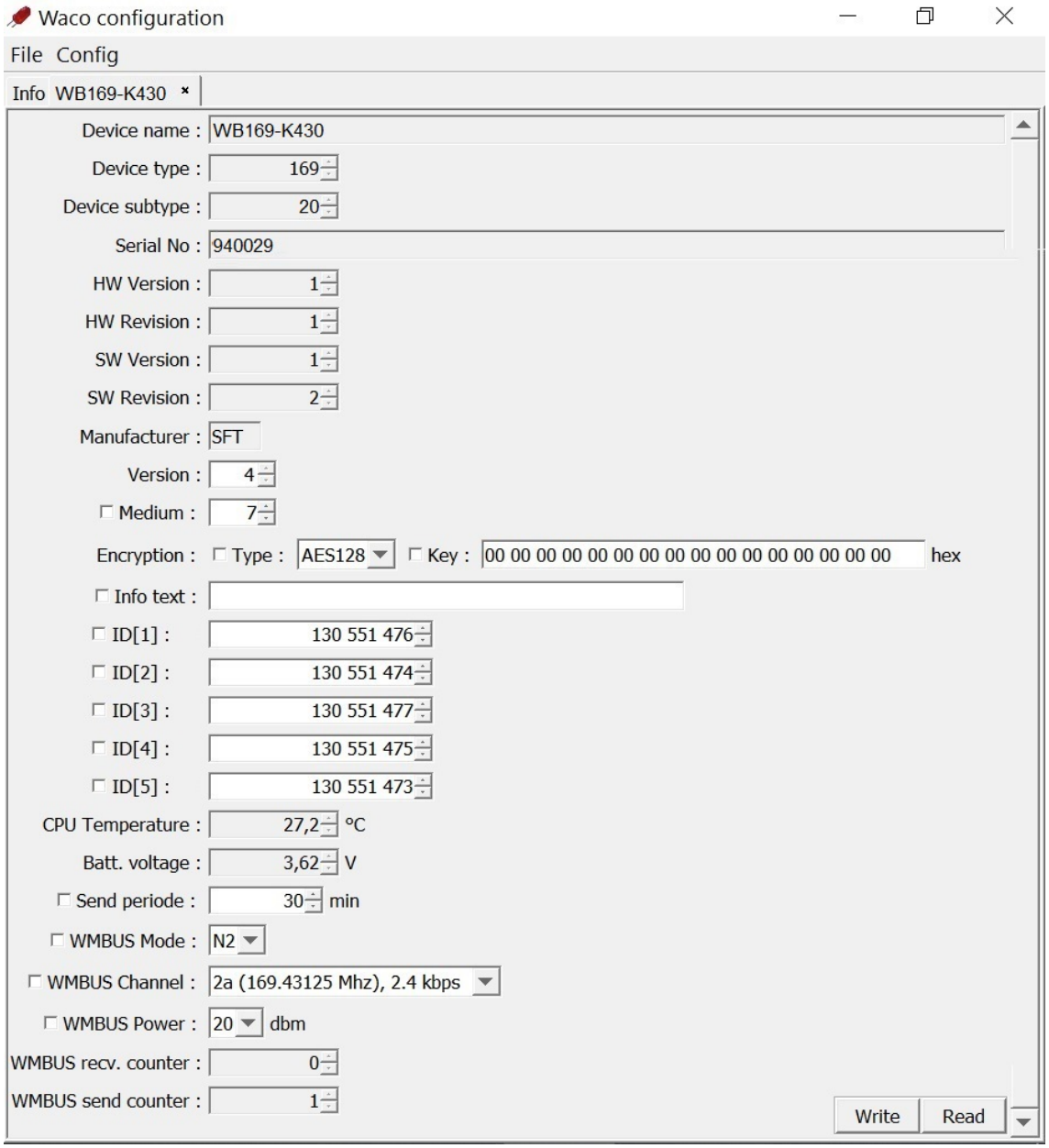


Figure 2: WB169-430-V module configuration table

In the **middle section of the table** there is a group of commonly used configurable parameters of the WB169-430-V module. There are following parameters:

Version	*MBUS-Version in M-Bus address*
Medium	*MBUS-Medium code in M-Bus address*
Encryption	*encryption key setting*
Info text	*device type information*
Meter ID	*entering of watermeter ID to the reading list*

he **"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 WB169-430-V, the default value is 07 ("Water"). More detailed description of the variable and possibilities of its setting are explained in details in section 3.1.7 „Commands of „Utils" group for control of basic module functions".

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.

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 3.4). Default setting of this variable is „none (no entry)". More detailed description of the variable and possibilities of its setting are explained in details in section 3.1.7 „Commands of „Utils" group for control of basic module functions".

The **"Sensus ID"** is a list of Sensus iPERL watermeters, that are intended to be read by the WB169-430-V module. It contains 5 editable fields (index 1 - 5), where watermeter IDs (serial numbers) can be preset. Any received messages. Received messages from any other watermeters (that are not in the table) are ignored.

In the **lower section of the table** there are current values of internal sensors (temperature, voltage...) and broadcasting parameters. There are following parameters:

CPU Temp.	*current value of processor temperature (read only)*
Batt. voltage	*current value of 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 **"CPU Temp."** 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 3.4 „Structure of WB169-430-V 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. Broadcasting is disabled by setting this parameter to zero value. More detailed description of this variable and possibilities of its setting are explained in details in section 3.1.7 „Commands of „Utils" group for control of basic module functions"..

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 3.1.5 „Commands of „169 Commands" group for setting of communication via 169 MHz network".

The **"WMBUS Mode"** parameter indicates WMBUS communication mode of the module. Factory setting is "N2" and the setting cannot be changed.

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 WB169-430-V 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.

Most of module parameters can be configured also by using of „BT-IRDA" converter and **„SOFTLINK Configurator"** mobile application. This way of configuration can be used for the parameters, that are included in some of configuration forms of the application. Current version of „SOFTLINK Configurator" application supports fulfilment of all settings, that should be performed at the installation site, including basic tests. In the figure 3 there is an identification form of WB169-430-V module (bordered by grey colour), page for form selection (bordered by yellow colour), administration form (bordered by blue colour) and form for module basic setting (bordered by red colour).

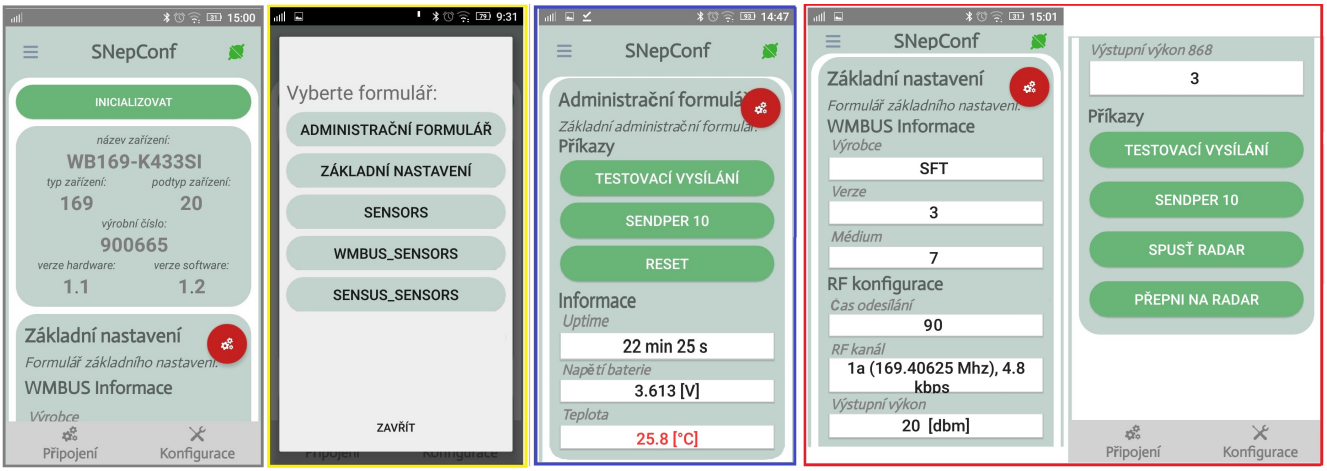


Figure 3: Configuration forms of WB169-430-V module in „SOFTLINK Configurator” application

In the figure 4 there is a description of procedure of entering of meters into the reading list in „Sensus iPERL” mode (bordered by violet colour) and view of analogous setting for „WMBUS” mode (bordered by orange colour).

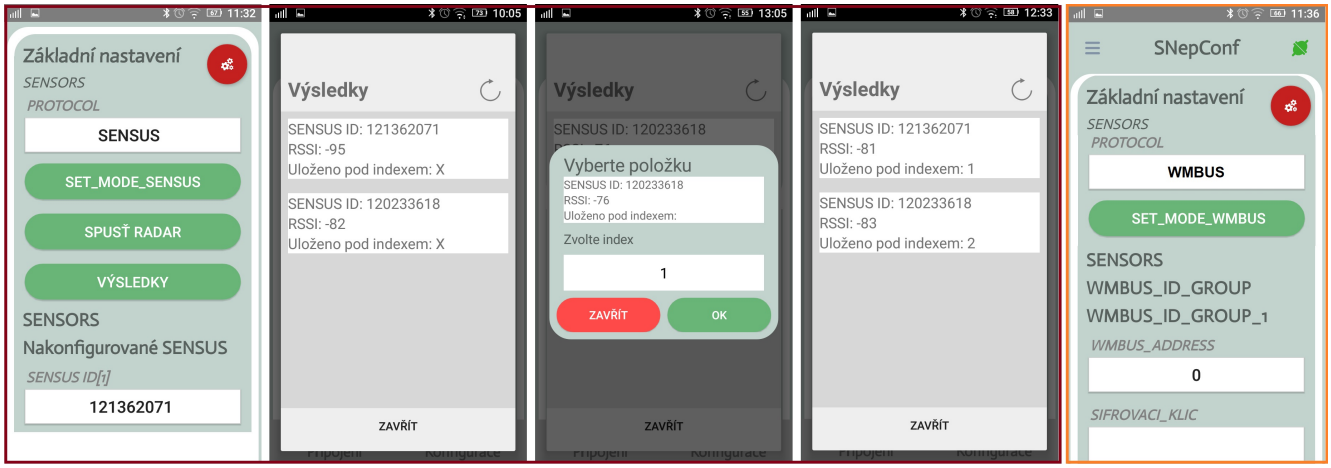


Figure 4: Setting of meter reading list

To set up the list by using the mobile application, proceed as follows:

1. Select the form ”WMBUS SENSORS” or ”SENSUS SENSORS” (depending on the mode, in which the devices are read;
2. Use the ”SET MODE MBUS/SENSUS” button to turn on the desired mode (if it is not turned on);
3. Use the ”RADAR” button to turn on the ”Radar” function;
4. Wait about a minute and press the ”RESULTS” button to display a list of devices within range of the module (see the second picture from the left);
5. Make clear which devices the module should read (there may be ”foreign” devices in the table);
6. For devices intended for reading, set the indexes by holding your finger on the record in the ”Radar” table and setting the index in the window that opens by holding your finger (see the third picture from the left);
7. After setting all indexes, save the settings using the ”WRITE CONFIGURATION” function in the menu of the sensor settings form;
8. Check the settings by using the ”Radar” function again. Indexes must be displayed for all devices to be read (see the fourth picture from the left).

Alternatively, this setting can be made by editing the individual windows of the ”SENSORS” table in the lower part of the ”WMBUS/SENSUS SENSORS” form.

The device can operate either only in the mode for receiving messages from Sensus iPERL (”SENSUS”) devices, or only in the mode for receiving of Wireless M-Bus messages (”WMBUS”).

As evident from both pictures, the application enables performing of following settings:

- setting of transmitting period of INFO messages
- setting of 169 MHz WMBUS frequency channel
- setting of 169 MHz WMBUS transmitting power
- switching of 169 MHz encryption and entering of encryption key
- starting of one-time testing transmission
- starting of multiple (10 times) transmission series (SENDPER 10)
- switching of RADAR mode for 60 seconds (LAUNCH RADAR)
- displaying of RADAR function results (RESULTS)
- switching of 433 MHz receiving mode
- entering of identifiers and encryption keys of read devices
- sending of RESET command to the module

As the „SOFTLINK Configurator" application is continuously developed and improved, the screen previews of WB169-430-V module configuration forms can vary in time.

3.3 Remote setting of module parameters through reverse channel

Wireless M-Bus communication protocol enables also delivering of messages to terminal devices (so called **„reverse channel"**. Reverse channel can be used for setting of some module parameters from remote server.

The WB169-430-V module is permanently working in **bidirectional communication mode N2** and can receive **Wireless M-Bus „Request" messages** from superior server. On the base of these messages the module can remotely change its following parameters:

- setting of transmitting power;
- setting of transmitting period;
- setting of info-text;
- switching of 433 MHz receiving mode (iPERL/WMBUS);
- setting of meter ID into the reading list;
- setting of encryption key to the meter.

In addition to the above mentioned settings, it is possible to use reverse channel for delivery of reset command, or make a request for current list of read meters, or current content of „Radar" table.

Reception of „Request" messages is under way during assigned time window of 500 ms after transmitting of regular info-message (that are of „User Data" type). In this time interval the WB169-430-V module has 169 MHz receiver in active mode and it is able to receive possible message of „Request" type. The module confirms receiving of „Request" message by sending of „Acknowledgment" message.

More detailed description of „Request" messages can be found in section 3.4.3 („Setting messages") of this manual.

3.3.1 Overview of module configuration parameters

Overview of configuration parameters that can be used for user settings of the WB169-430-V module is shown in the Table 2 below. The parameters are presented in the same order as they appear in the List of all configuration parameters (see paragraph 3.1.1).

Table 2: Overview of WB169-430-V module configuration parameters

Item	Name	Type	Description	Default.
1	Timezone	number	Time zone (time from UTC)	1
2	MBUS ID	0 - 99999999	Serial number (M-Bus address)	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 Version	0 - 255	Generation or version (M-Bus address suppl.)	1
6	MBUS Power	1 - 5	Transmitting power	3 (20 dbm)
7	WMBUS Channel	1 - 7	Frequency channel	3
8	Send periode	0 - 65535	Broadcasting period in minutes	0
9	Sensus/WMBUS meters	ID	list of read watermeters	
10	Encryption	code	Encryption key	disabled
11	No. sent	curr. status	No of sent messages from reset	read only
12	No. recv	curr. status	No of received messages from reset	read only
13	No. recv error	urr. status	No of received error messages from reset	read only
14	Receive window	number	receiving window in seconds	0
15	Conf. version	curr. status	No of stored images since last FLASH erasure	read only
16	SW version	curr. status	version number and date of issue	read only

In the **„Type"** column there is a data type of the parameter. „Code" indication in this field means that the value is displayed in hexadecimal code (couple of hexadecimal characters means 1 Byte) with one exception - IP-address is indicated in common form (four decimal octets separated by dots). "Curr. status" indication means that the field contains current value of operational parameter that cannot be influenced. Range of numbers means that there could be a number from mentioned range.

In the **„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 set 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 or BT-IRDA optical converter** as described in details in chapter 3.2 „Setting of parameters by using of optical converter".

Statistics of sent and received messages are stated separately for 433 MHz modem (that in common operation only receives), and separately for 169 MHz modem (that in common operation mostly transmits).

3.4 Structure of module data messages

The WB169-430-V module transmits following two types of messages:

- standard **information message** with status of all variables, broadcasted periodically
- short **alarm message** sent immediately when alarm status has been detected

The module generates these messages either in open, or in encrypted mode.

3.4.1 Iinformation message

Information message of the module consists from the Wireless M-BUS header („WMBUS Header"), short 4 Byte M-Bus header and a data block of at least eight data segments with length of at least 39 Byte (it could vary in reliance on the number of read watermeters and setting of "INFO" field).

Structure of Wireless M-BUS message header of the WB169-430-V module is described in the Table 3.

Table 3: Structure of Wireless M-BUS message header of the WB169-430-V 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 of 8 - 25 data segments, each of them carries data of one variable. List of variables transmitted in the information message of WB169-430-V module can be found in the Table No. 4:

Table 4: Description of variables of WB169-430-V module info-message data block

Order	Variable (description)	Unit	Type	Data format
1	User module description (location)	text	Inst.	Variable (*)
2	Internal battery voltage	V (10^{-3})	Inst.	16 bit Integer
3	Processor temperature	°C (-1)	Inst.	16 bit Integer
4	Transmitting power setting	W (10^{-3})	Inst.	16 bit Integer
5	"Uptime" from last reset	seconds	Inst.	32 bit Integer
6	Value 1	m^3 (10^{-3})	Inst.	32 bit Integer
7	Value 2	as set	Inst.	32 bit Integer

(*) The message contains this data segment only if the "Info" string is set. Length of the segment depends on the number of characters in „Info" string.

The **"Value 1"** and **"Value 2"** variables may appear repeatedly in the message, depending on the number of read meters (maximum 20 devices, up to two read values from each meter). In **„iPERL"** mode there are two variables transferred from each meter: counter status and original alarm flag.

In **„WMBUS"** mode the two preselected variables from each meter are transferred, in which case their DIF/VIF values are respected.

In the figure 5 there is an example of INFO message of WB169-430-V module, received and decoded by *WMBUS AN4* Wireless M-BUS signal analyzer:

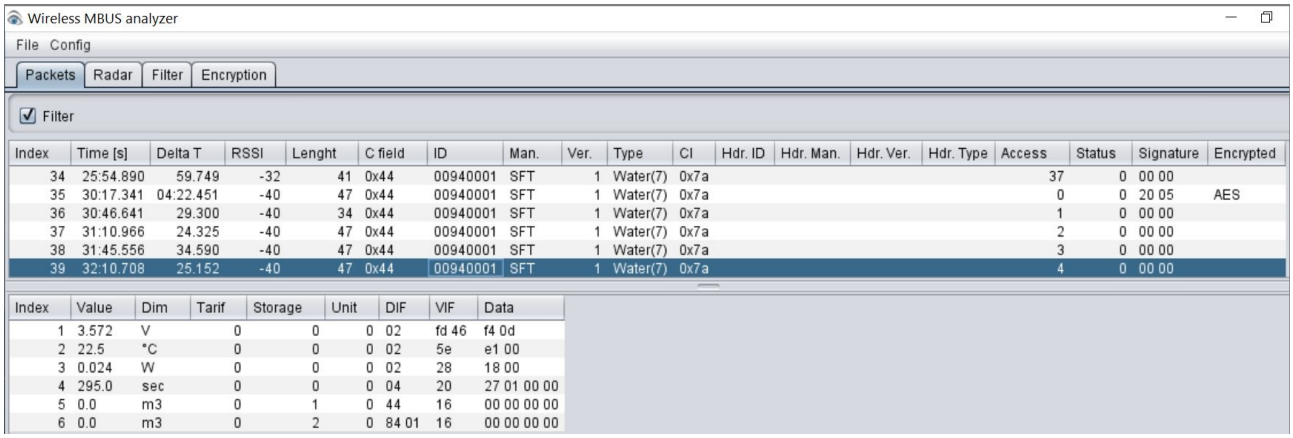


Figure 5: View of WB169-430-V module information message received by *WMBUSAN4* analyzer

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 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. 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 WB169-430-V module with two control segments at the beginning and several other "2F" blocks at the end is shown in the Figure 6. This way the length of message data block is rounded to 64 Byte.

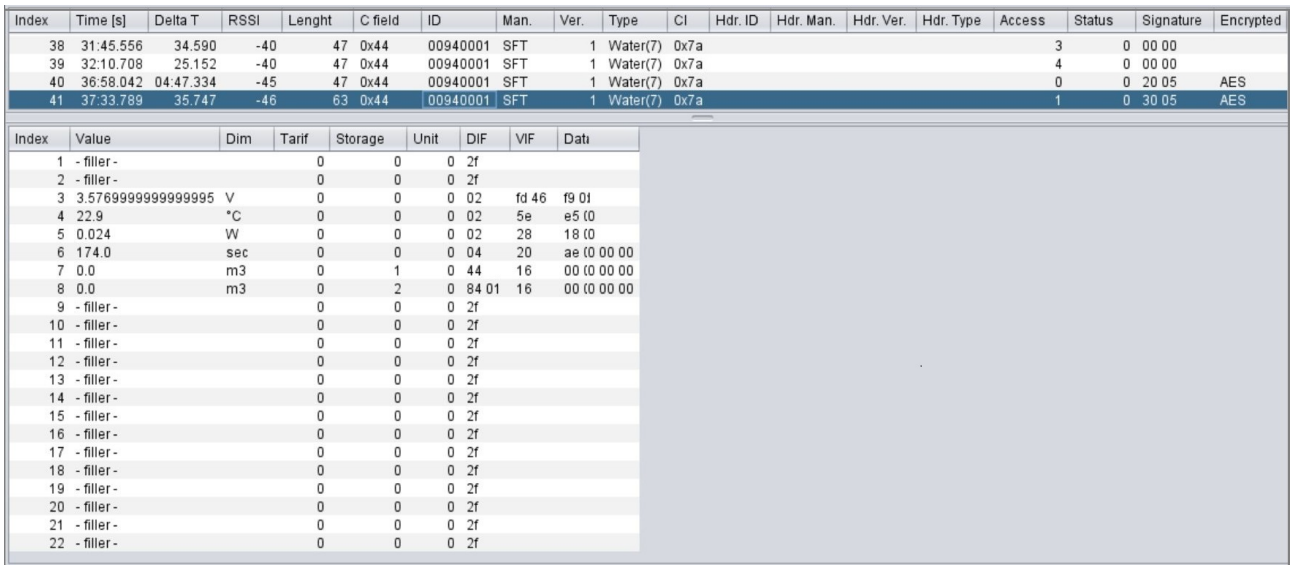


Figure 6: Encrypted and decrypted message of the WB169-430-V module

3.4.2 Alarm message

Alarm message of the module is transmitted immediately after some of the supported alarm types arises. Current version of the WB169-430-V module supports following types of events:

- event of "RESET" type (alarm type "0")
- event of "CONFIGURATION CHANGE" type (alarm type "1")
- watermeter in "LEAK" status - alarm state (alarm type "15")
- watermeter in "NO LEAK" status - normal state (alarm type "16")
- watermeter in "BURST" status - alarm state (alarm type "17")
- watermeter in "NO BURST" status - normal state (alarm type "18")
- watermeter in "LOW BATTERY" status - alarm state (alarm type "19")
- watermeter in "BATTERY OK" status - normal state (alarm type "20")
- watermeter in "REVERSE FLOW" status - alarm state (alarm type "25")
- watermeter in "FLOW OK" status - normal state (alarm type "26")

Event of "RESET" tyoe is generated by the module whenever the module went through reset (immediately after startup). Event of "CONFIGURATION CHANGE" type is generated by the module whenever after writing of configuration into the FLASH memory.

Other types of events are generated by the module based on changes in numerical statuses of individual watermeters (see setting the "alrb" parameter in paragraph 3.1.4 "Commands for setting the reading of the status of water meters". If the module works **in the "iPERL"** mode, the linking of individual alarm types to status changes is pre-defined in the module software, according to the iPERL documentation.

Each alarm message has Wireless M-BUS header („WMBUS Header") and short 4-Byte M-Bus header. The only difference between regular information message header and alarm message header is in setting of **"CI" field** (Application Type), where the field in alarm message is always set to **"74"** value („Alarm from meter with short transport layer").

Each alarm message has three data segments, that contain **alarm category and type** according to the *wacoSystem* categorization and *accompanying numeric value*, specifying the condition or reason. The variable also carries the information to which meter the alarm message belongs („storage"). Complete code-list of supported types of alarms is available on the public WEB address NEP Page. All alarm messages from WB169-430-V module are of "0" category (Generic).

Accompanying value of "RESET" type of event is a **„Reset Code"** carrying information about reset cause. In the NEP coding table there are following types of reset:

- value "0" - Cold start
- value "1" - Warm start
- value "2" - Watchdog reset
- value "3" - Error reset
- value "4" - Power reset

Accompanying value of "CONFIGURATION CHANGE" type of event is a **„Configuration status"** carrying information about the configuration state after the event (in this case there is always value "2", that in NEP-coding means "configuration stored").

In the figure 7 there is an example of decoded alarm message of the WB169-430-V module about the module reset with reset code "0" („Cold start"): As evident from the example, "CI" bit in the message header is set to "74"

Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI
24	04:34.468	06.951	-76	47	0x44	00500530	SFT	31	Unknown Medium(15)	0x7a
25	04:41.576	07.108	-40	31	0x44	00940001	SFT	1	Water(7)	0x74

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	- filler -		0	0	0	2f		
2	- filler -		0	0	0	2f		
3	0.0	?	0	0	0	02	7a	00 00
4	0.0	?	0	1	0	42	7a	00 00
5	0.0	?	3	0	0	34	7a	00 00 00 00

Figure 7: Structure of alarm message about the reset of WB169-430-V module

value. Data block consists of three segments: alarm category, alarm type and reset code.

Auxiliary DIF/VIF information are set as follows:

for „alarm category": DIF = 02 (instant value, 16 bit integer, storage "0")
for „alarm type": DIF = 42 (instant value, 16 bit integer, storage "1")
for „reset cause": DIF = 34 (average value, 32 bit integer, storage "0")
VIF = 7A for all variables (dimensionless value "NO VIF")

This setting of DIF/VIF values is commonly used by producer within whole WB169 product range.

3.4.3 Setting messages

Within the *wacoSystem* product range modules, messages in the reverse direction (from the center to the terminal device) are marked as **„setting messages"**, because there are commonly used for setting of device parameters.

The WB169-430-V module is permanently set for working in the **bidirectional communication mode N2** of the Wireless M-Bus protocol, which also enables the transmission of messages to terminal devices via the so-called **„reverse channel"**. The reverse channel is used for delivery of commands to the reading modules, especially

for remote setting of a selected set of configuration parameters. The superior smart metering system sends a setting message of **„Request"** type addressed to the module, which is passed to it by its superior communication gateway at a suitable moment (time window). The module acknowledges receipt of the setup message by sending an „Acknowledgment" message, which its superior communication gateway transmits to the central system.

The „Request" message is always received by the WB169-430-V module in a dedicated time window of 500 ms after a regular "User Data" (INFO) information message has been transmitted. During this time window, the module has the receiver switched on and is able to receive a possible „Request" message. The module immediately confirms the receipt of the „Request" message by sending an „Acknowledgment" message.

The „Request" messages are coded by using of standard Wireless M-Bus coding principles; the messages have an abbreviated Wireless M-Bus header with settings corresponding to „Request" messages (C-byte = "53", CI-byte = " 5A ") and for each variable to be set, the „Request" message contains one data block with the corresponding DIF/VIF parameters and requested value.

The „Acknowledgment" (ACK) message has a Wireless M-Bus header corresponding to this message type (C-byte = "00", CI-byte = "8A"), the value "Access No" in the short M-Bus header corresponds to the "Access No" value of received „Request" message. The ACK confirmation message does not contain any data block.

The WB169-430-V module supports setting messages listed in Table No. 5, where the meaning of the variables and the method of setting the accompanying DIF/VIF parameters are also described for individual message types.

Table 5: Table of variables in setting messages of WB169-430-V module

Description	DIF	VIF	Value
433 MHz mode	0x01	0xfd3a	0-iPERL, 1-WMBUS
Meter ID	0x04+storage	0x7a	32 bit Integer
Encryption key	0x0d+storage	0x6e	0x10 +16 Byte key
Radar	0x11	0xfd3a	value "x" = start radar for x seconds
Info	0x0d	0xfd10	info-string, max 29 characters
Reset	0x01	0xfd60	value higher than 0 resets module
Periode	0x02	0xfd35	broadcasting period in minutes
Power	0x02	0x28	169 MHz transmitting power in mW

Value of **„Radar" setting message** means required opening time of the 433 MHz receiver in seconds ("recvsec" parameter). The module opens the receive window for the required time and after closing the window sends content of**„Radar" table** to the center. This message contains the identifiers of meters, whose messages were received by the module during the receive window.

An example of a message with the content of „Radar" table is shown in Figure 8.

Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI	H
55	1:42:02.765	39.823	-53	63	0x44	00940001	SFT	1	Water(7)	0x7a	
56	1:43:38.232	01:35.467	-52	63	0x44	00940001	SFT	1	Water(7)	0x7a	
57	1:44:21.392	43.160	-51	95	0x44	00940001	SFT	1	Water(7)	0x7a	

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	- filler -		0	0	0	2f		
2	- filler -		0	0	0	2f		
3	1.20233618E8	Parameter set identification	1	0	0	14	fd 0b	92 9e 2a 07
4	1.0	Error flags	1	0	0	11	fd 17	01
5	-86.0	ext A	1	0	0	11	fd 62	aa
6	1.21362071E8	Parameter set identification	1	1	0	54	fd 0b	97 d6 3b 07
7	2.0	Error flags	1	1	0	51	fd 17	02
8	-83.0	ext A	1	1	0	51	fd 62	ad
9	103.0	Parameter set identification	1	2	0	94 01	fd 0b	67 00 00 00
10	0.0	Error flags	1	2	0	91 01	fd 17	00
11	-37.0	ext A	1	2	0	91 01	fd 62	db
12	100679.0	Parameter set identification	1	3	0	d4 01	fd 0b	47 89 01 00
13	0.0	Error flags	1	3	0	d1 01	fd 17	00
14	-42.0	ext A	1	3	0	d1 01	fd 62	d6
15	- filler -		0	0	0	2f		

Figure 8: Structure of message with the content of „Radar" table

As it is clear from the picture, the module sends the following triplet of variables for each record in the „Radar" table (i.e. for each captured meter):

- meter serial number (ID), VIF = FD 0B (Identification)
- number of record in SID table (index), VIF = FD 17 (Error Flag)
- radio signal strength (RSSI) from the meter, VIF = FD 62 (Control Signal)

The values are marked in the "DIF"parameter as „maximum value" (for a clearer distinction from normally sent instant values), the data format of "ID" is 32-bit Integer, other variables have 8-bit Integer format. The "storage" value gradually grows with each record in the table (it is not important for the table content evaluation). Records of meters, that are not entered in the „SID" table, have "0" value in the second variable.

If the **value "0"** has been sent in the setting message of „Radar" type, the module responds with a „SID" message, that contains a **current list of read watermeters** assigned to individual „storages" (content of „SID" table). An example of a „SID" message is shown in figure 9.

Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI
53	1:41:02.694	01:17.004	-52	47	0x44	00940001	SFT	1	Water(7)	0x7a
54	1:41:22.942	20.248	-48	47	0x44	00940001	SFT	1	Water(7)	0x7a
55	1:42:02.765	39.823	-53	63	0x44	00940001	SFT	1	Water(7)	0x7a

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	- filler -		0	0	0	2f		
2	- filler -		0	0	0	2f		
3	3.564	V	0	0	0	02	fd 46	ec 0d
4	21.8	°C	0	0	0	02	5e	da 00
5	0.024	W	0	0	0	02	28	18 00
6	4120.0	sec	0	0	0	04	20	18 10 00 00
7	1.20233618E8	?	0	0	0	04	7a	92 9e 2a 07
8	1.21362071E8	?	0	1	0	44	7a	97 d6 3b 07
9	- filler -		0	0	0	2f		

Figure 9: Structure of message with the content of „SID" table

As seen from the picture, the module sends a list of watermeter IDs assigned to individual „storages" (the storage number corresponds to the „index" of the given water meter in the SID table). The DIF value is set in the usual way (instant value, 32-bit Integer, storage according to the meter index). VIF values are always set to "7A", which is used within the *wacoSystem* product line to indicate values without physical meaning.

Using the „Radar" setting message it is possible to remotely find out which watermeters are in the radio range of given WB169-430-V module, or obtain a list of read watermeters of the module. Using the „Water meter ID" setting message the list of read watermeters can be remotely modified by entering or removing of meters.

4 Operational conditions

This section of the document describes basic recommendations for transportation, storing, installation and operation of WB169-430-V 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.

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 cables that connect the radio modules with the meters, sensors, or external antennas. 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.: "WB169-430-V/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 WB169-430-V 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 WB169-430-V module installation

WB169-430-V 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. Battery switch, configuration connector as well as antenna connectors 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 mounted antennas, and with battery switch in "ON" position. Configuration of the module should be performed by USB-IRDA/BT-IRDA optical converter as described in section 3.2 „Setting of parameters by using of optical converter". **It is recommended do not open the casing during operation until it is really necessary, and if so, do it very carefully.**

In the figure 10 there is displayed the WB169-430-V module dismantled into individual components

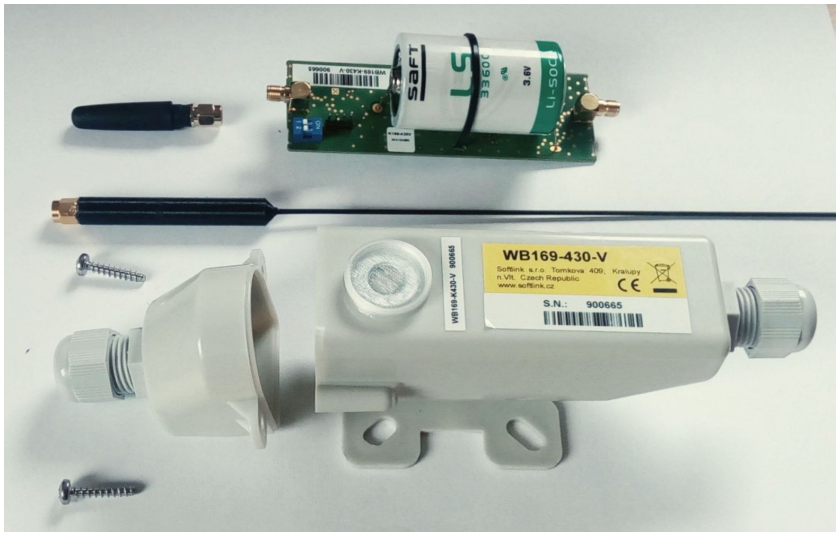


Figure 10: Set of WB169-430-V module components with rod antenna

In the figure 11 there is displayed the detail of WB169-430-V module printed circuit board with configuration connector marked by red colour, 169 MHz antenna connector marked by blue colour, 433 MHz antenna connector marked by light-blue colour and battery switch marked by yellow colour. Module serial number on the label must always match with the number on the small auxiliary label on the PCB (bordered by orange colour). Appearance of the module PCB could slightly vary in dependence on the module modification.

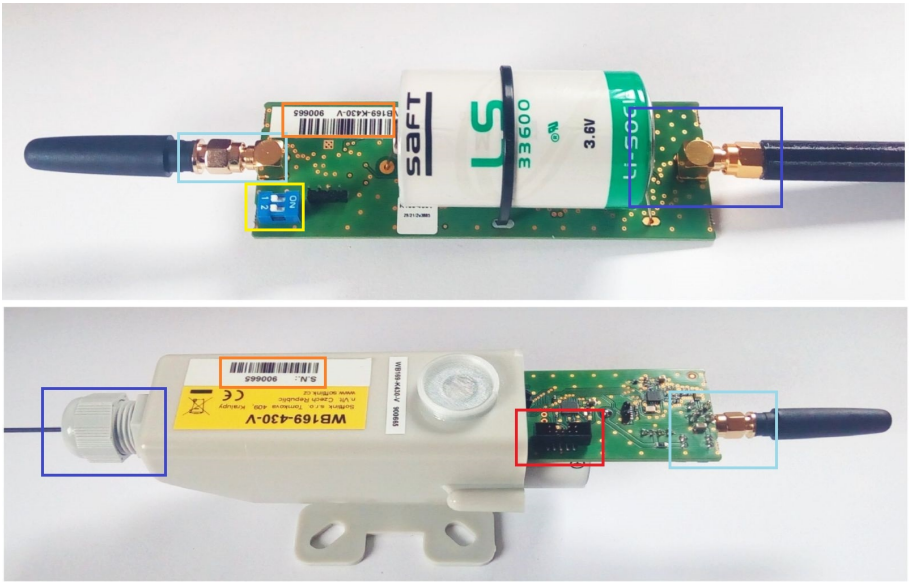


Figure 11: Detail of WB169-430-V module PCB

The case of WB169-430-V module consists of two parts:

- housing of the module to which the printed circuit board is inserted. On this part of the box there is a label, circular peephole for the magnetic attachment of the USB-IRDA / BT-IRDA converter, cable gland with bushing, and mounts (mouldings) for mounting the module;
- box cap that covers the housing. There is a second cable gland on the cap.

To install a module that is already assembled (including both antennas), preconfigured and turned on, follow these steps:

- attach the module to a suitable firm object (wall, pipe) by four screws or by a clamping tape. There are mounts by the casing bottom side intended for the attachment. The recommended position of the mounted module is vertical, with the with the lid underneath;
- perform an elementary module check by using of USB-IRDA/BT-IRDA optical converter. Check in "RADAR" mode whether all watermeters, that should be read by the module, are in the reach of its 433 MHz receiver;

- check the tightening of the antenna/cable gland nuts of both antennas;
- 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.

Before mounting a module that is not yet assembled, or is not switched on, or it is necessary to configure by using a cable (*), it is necessary to open the module, assemble it, turn it on and configure. These operations can be performed by following this steps:

- completely loosen the sealing nuts of the cable glands at both ends of the module;
- unscrew the two screws on the sides of the box to release the module cap;
- carefully slide out the cap of the module, while the antenna of the 433 MHz receiver (if it is already mounted) slides inside the cover. Help yourself by pushing the antenna slightly into the module;
- after removing the cover, carefully slide the printed circuit board (PCB) out of the module housing. Either extend the board completely (if it is necessary to screw on the 169 MHz antenna), or only partially so that the configuration connector gets out of the housing (see figure 11). If the 169 MHz antenna is already mounted, help yourself by slight pushing the antenna into the module;
- if the antennas were not mounted on the printed circuit board, screw them to the antenna connectors at both ends of the module. An 433 MHz receiver antenna is located at the end of the PCB with the battery switch, and a 169 MHz antenna is located at the opposite end of the PCB;
- connect the power supply to the module by switching the blue micro-switch ("jumper") located on the printed circuit board to the "ON" position;
- 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 in "RADAR" mode whether all watermeters, that should be read by the module, are in the reach of its 433 MHz receiver;
- insert the printed circuit board into the module housing. Insert the board so that the blue battery micro-switch is on the open side of the case (i.e. on the side where the lid is screwed on). The sealing nut of the cable gland must be fully loosened so that the antenna (or antenna cable) can easily slide out of the housing through the bushing. Push the board with the pressure of your finger on the edge of the PCB completely to the stop (do not push on the antenna connector or on the micro-switch). In the correct position, the printed circuit board should protrude only approx. 1 mm beyond the edge of the box housing.
- check the integrity of the rubber seal on the edge of the housing and make sure that the cable gland sealing nut on the lid is completely loose;
- carefully slide the lid onto the housing. The antenna of the 433 MHz receiver is gradually pushed out through the cable gland. Attach the lid to the case by screwing in and tightening both screws;
- tighten the sealing nuts on both cable glands to seal both glands;
- 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! Module configuration could be performed by USB-IRDA/BT-IRDA optical converter .*

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:

- cable bushing 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.

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;
- loosen the fixing screws (or clamping tape) that hold the module on the wall, pipe or other pad and dismantle the module;
- completely loosen the sealing nut of the cable gland at the cap;
- unscrew two screws on the sides of the module casing, loosen the cap of the module and slide out the cap from the casing. Help yourself by slight pushing the antenna into the module;
- by switching of micro-switch („jumper") placed on the PCB into the „OFF" position disconnect the module from the battery power supply;
- if an external 169 MHz antenna used, loosen the sealing nut of the cable gland at the casing and carefully slide out PCB from the casing to have an access to the antenna connector;
- disconnect the cable of the external antenna from antenna connector;
- 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 setting of basic parameters, namely broadcasting period and communication with watermeters;
- write down the serial number and seal number of the new 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! *Pay attention to the completing of the correct casing with the appropriate PCB. The correct module completion can be checked out according to the auxiliary label with the serial number glued on the PCB.*

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

- do not open the module, if not really necessary! Rewrite ID (serial number) of original meter to the ID of new meter with using of USB-IRDA/BT-IRDA converter;
- check in "RADAR" mode, whether the new meter is in radio reach of the module and whether the read value corresponds to watermeter mechanical counter;
- if wireless configuration is not possible, check the antifraud seal and open the module by following the procedure set out in the paragraphi 4.6;
- connect to the module with a configuration cable and use the "sid [index] [value]" command to set the serial number of the new water meter by overwriting the original value (see paragraph 3.1.4 "Commands for setting the meter reading");
- when replacing a watermeter transmitting in WMBUS mode for the device that is a different type than the original watermeter, use "wkey" command to set its decryption key and set DIF/VIF parameter and alarm interpretation by using of "dib1", "dib2", "diba" and "alrb" commands;
- by using of "recvsec" and "radar" commands (see paragraph 3.1.4 check, whether the new meter is in radio reach of the module and whether the read value corresponds to watermeter mechanical counter;
- 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 seal it according to the instructions in paragraph 4.6. Alternatively wait for the first reading and cover the module afterwards.
- if possible, arrange making of all appropriate changes in the database of the remote reading system immediately.

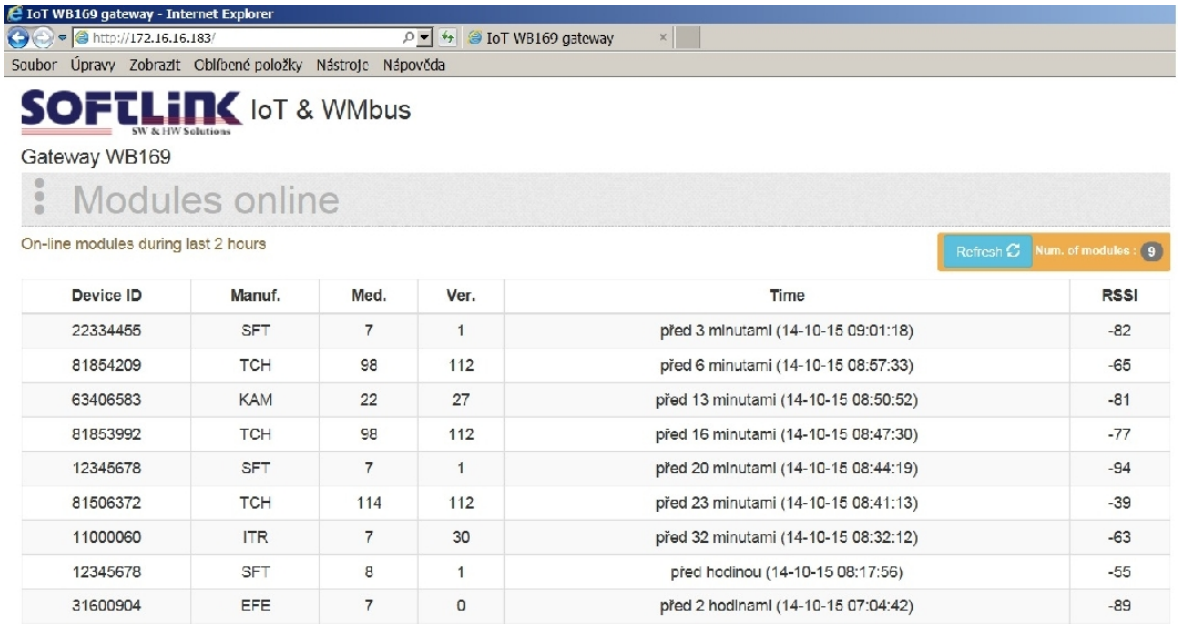
4.8 Module dismantling

When dismantling, disassemble the module from the wall, pad, or pipe. Open the module, switch off battery and possibly disconnect antenna cable. Put the module parts back together by mounting of the cap on the module base. 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, RF analyzer, or any other convenient device.

If the WB169-430-V 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 12), 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).



Device ID	Manuf.	Med.	Ver.	Time	RSSI
22334455	SFT	7	1	před 3 minutami (14-10-15 09:01:18)	-82
81854209	TCH	98	112	před 6 minutami (14-10-15 08:57:33)	-65
63406583	KAM	22	27	před 13 minutami (14-10-15 08:50:52)	-81
81853992	TCH	98	112	před 16 minutami (14-10-15 08:47:30)	-77
12345678	SFT	7	1	před 20 minutami (14-10-15 08:44:19)	-94
81506372	TCH	114	112	před 23 minutami (14-10-15 08:41:13)	-39
11000060	ITR	7	30	před 32 minutami (14-10-15 08:32:12)	-63
12345678	SFT	8	1	před hodinou (14-10-15 08:17:56)	-55
31600904	EFE	7	0	před 2 hodinami (14-10-15 07:04:42)	-89

Figure 12: Example of „Radar" application table

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

- 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 WB169-430-V 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.

Survey of radio signal reception form watermeters can be performed in "RADAR" mode by using of "recvsec" and "radar" commands, either through configuration cable, or equivalent functions of optical converter;

4.10 Operation of the WB169-430-V module

The WB169-430-V 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.

5 Troubleshooting

5.1 Possible causes of module failures

If during operation of WB169-430-V module some anomaly, malfunctions or other troubles are recognized, the possible causes of the failures can be classified by following categories:

5.1.1 Power supplying failures

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

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

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

5.1.2 System failures

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

5.1.3 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 after removal of module casing.

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 reverse 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 reverse 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 169 MHz RF modem parameters) 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 watermeters

Failures of receiving of radio-messages broadcasted by watermeters every generally show themselves as missing readings from some of read watermeters. In this case proceed with troubleshooting of the malfunctioning in following steps:

- if there are no messages from some watermeter, check its ID (serial number) in the table of read watermeters (see paragraph 3.1.4 „Commands for communication with watermeters");
- check receiving of watermeter messages in "RADAR" mode with the suitable receiving window (see paragraph 3.1.4 „Commands for communication with watermeters");
- visually check condition of the watermeter (mechanical damage, flooding by water, low battery). Follow troubleshooting instructions in watermeter documentation, in any doubt replace the watermeter;
- visually check surrounding of the watermeter installation site to find out if there are any changes that can influence radio signal (e.g. new objects, things, machines...). If there are such negative circumstances, solve the trouble by reorganization of the object or by relocation of the WB169-430-V module or its antenna (if external antenna used) to the place with better signal from the watermeter;
- if there are any doubts about functioning of WB169-430-V module 433 MHz receiver, try receiving of signal by using of spare device. If the module is not working properly, replace it according to the paragraph 4.7.

5.2 Troubleshooting procedure

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

1. No data are available from any watermeter read by the WB169-430-V module. In this case it is recommended to check functionality of the module subsystems in following order:
   - check correctness of setting of the module in the central system database;

- check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures";
- check functionality of the system as described in the paragraph 5.1.2 „System failures";
- check functionality of transmitting and receiving as described in the paragraph 5.1.3 „Transmitter and receiver failures";
- check functionality of receiving of BUP messages from watermeters as described in paragraph 5.1.4 „Failures of communication with watermeters".

2. Readings from some of watermeters read by the module are not available. In this case it is recommended to check functionality of the module subsystems in following order:
   - check functionality of watermeter itself;
   - check correctness of central application configuration related to the watermeter, especially compliance with setting of its ID and index in the table of read watermeters in the WB169-430-V module configuration;
   - check functionality of receiving of messages from watermeters as described in paragraph 5.1.4 „Failures of communication with watermeters".
3. Data values from some of watermeters read by the module are incorrect. In this case it is recommended to check functionality of the watermeter.
4. Data from the module come irregularly, with periodical breakdowns. In this case it is recommended to check functionality of the module subsystems in following order:
   - check functionality of transmitting and receiving as described in the paragraph 5.1.3 „Transmitter and receiver failures";
   - check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures".

NOTE: WB169-430-V module is a reliable device with relatively simple and resilient construction, so that any possible failure of the device is very likely caused by external circumstances, especially mechanical damage, excessive humidity, discharging of internal battery, or local radio-interferences in the installation site. 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 WB169-430-V, 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 (Wireless M-BUS), WM868 (WACO), WS868 (Sigfox) or NB (NB-IoT) series of the modules can be found on the manufacturer website:

www.wacosystem.com
www.softlink.cz

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

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