WIRELESS COMMUNICATION SYSTEM
Wireless M-Bus

WB169-IR-B

Revision 1.0

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Contents

List of Tables

List of Figures

1 Introduction

This document describes the configuration options of the WB169-IR-B radio module, which is used for remote reading of electricity meters with an IrDA optical interface according to the IEC 62056 standard. The module reads the status of connected electricity meters and forwards the read data to the remote reading system (Automatic Meter Reading - AMR) in the form of radio messages using the standard Wireless M-Bus communication protocol in the 169 MHz band.

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-IR-B module serves for local data collection from electricity meters equipped with an IrDA optical interface and communication according to the IEC 62056-21 (DLMS) protocol. Electricity meters are connected to the module using the IR-15 optical head, which is attached to the optical output of the electricity meter. The module checks the status of preset registers of the electricity meter at configurable intervals and immediately sends the detected values to the superior remote reading system (AMR) in the form of radio messages in the Wireless M-Bus format in the 169 MHz band (hereinafter referred to as "INFO message").

The WB169-IR-B module can be used for reading **up to 6 electricity meters** located in its vicinity (up to a maximum cable length of 3 meters). From each electricity meter, the content of up to four registers can be read, whose addresses are preset according to the conditions of the distributor or market regulator. For each electricity meter, serial communication parameters can be individually set to suit the given type of electricity meter. The reading period can also be set separately for each electricity meter. The module performs reading of the register contents of the given electricity meter with the set period and immediately sends a radio message with the read values in the Wireless M-Bus format to the superior server.

The module has a configuration table for entering up to six electricity meters, which are distinguished by bus identifiers according to the IEC 62056 standard. When querying the status of registers, the module uses these identifiers. If the electricity meters do not support bus addressing, the module queries only using a multicast address and cannot distinguish which electricity meter the response came from. In this case, its use is limited to connecting one electricity meter. The module allows data transmission **in both open and encrypted mode**.

The module can send INFO messages in several versions of M-Bus addressing (see setting of the "Send Mode" parameter in the section "Commands for setting communication with electricity meters"). In addition to INFO messages with data from individual electricity meters, the module can also send its own "operational" messages, which contain parameters of the module itself (uptime, battery status, processor temperature, configuration version and transmission power). Messages are sent in open mode (without encryption) or encrypted using an AES-128 key, at a frequency of 169.4 MHz with a transmission speed of 2.4 kb/s, 4.8 kb/s or 19.2 kb/s. The receiving device can be a WB169-RFE type communication gateway (WMBUS Ethernet GateWay by SOFTLINK manufacturer), or any "Master" type receiving device according to the Wireless M-BUS standard according to EN 13757-3/EN 13757-4 for the 169 MHz band.

The WB169-IR-B module is equipped for **bidirectional communication** and is capable of receiving messages with commands in the Wireless M-Bus format from the 169 MHz network. These messages can be used to set module parameters remotely, from a remote server.

1.3 Module characteristics

The WB169-IR-B module is enclosed in a moisture-resistant plastic box (IP65 protection) and is suitable for use in both indoor and outdoor environments. The box is designed for wall mounting or mounting on any structural element (beam, pipe...). The module can be equipped with additional moisture protection (to IP68 degree) by filling with high-adhesion silicone. If this modification is required from the manufacturer, it must be ordered with a special order code. The module is powered by an internal battery, which allows it to read four electricity meters with a period of one hour for up to ten years. Battery life can be negatively affected not only by a shorter set message sending interval, but also by operating the device in buildings with temperatures outside the recommended operating temperature range. The module can be locally controlled and configured using a configuration cable, or wirelessly, using an optical converter. For optical configuration, the module is equipped with a circular "viewport" to support magnetic attachment of the optical converter. The module can also be configured remotely, using the reverse channel of bidirectional communication. The appearance of the WB169-IR-B module is shown in Figure 1.

Figure 1: Appearance of the WB169-IR-B module

2 Overview of technical parameters

An overview of the technical parameters of the WB169-IR-B module is given in Table 1.

Table 1: Overview of technical parameters of the WB169-IR-Bmodule

Transmission part parameters		
Frequency band *	169.40625 to 169.46875	MHz
Modulation type *	2-GFSK, 4-GFSK	
Channel width *	12.5 or 50	kHz
Transmission power	500	mW
Receiver sensitivity of reverse channel	-109	dBm
Communication protocol	Wireless M-Bus	
Communication mode (according to EN 13757-4)	N1, N2	
Transmission speed *	2400, 4800, or 19200	Baud
Antenna connector	SMA female	
Characteristic impedance of antenna input	50	Ω
Data interface		
Serial interface	InfraRed (according to IEC 62056-21)	(terminals GND, RX, TX
Transmission speed	300 ÷ 19200	Baud
Operation type	asynchronous	
Transmission parameters (basic setting)	7 data bits, 1 stop bit, even parity	
Signal level	CMOS 3.5	V
Optical head power supply	CMOS +3.5V/0.1A	terminal "VCC"
Max. number of connected electricity meters	6	
Configuration interface RS232		
Transmission speed	9600	Baud
Operation type	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, no parity	
Signal level	TTL/CMOS	
Optical configuration interface		
Transmission speed	115 200	Baud
Optical wavelength	870	nm
Optical interface specification	complies with IrPHY 1.4 standard	
Power supply		
Lithium battery voltage	3.6	V
Lithium battery capacity	13	Ah
Mechanical parameters		
Length (without antennas)	200	mm
Width	70	mm
Height	60	mm
Weight	approx. 250	g
Storage and installation conditions		
Installation environment (according to ČSN 33 2000-3)	normal AA6, AB4, A4	
Operating temperature range	(-20 ÷ 40)	°C
Storage temperature range	(0 ÷ 40)	°C
Relative humidity **	95	% (without condensation)
Protection degree **	IP65 or IP68	

* depending on the frequency channel used - see EN 13757-4, Mode N, Physical link parameters (Table 18).

** modules provided with additional sealing by silicone filling are waterproof, with IP68 protection.

3 Configuration of the WB169-IR-B module

Configuration parameters of the WB169-IR-B module can be displayed and changed from the common computer (PC) or smartphone by one of these methods:

- with using of **„USB-CMOS"** converter and configuration cable 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-IR-B 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 the parameters of the WB169-IR-B module using a configuration cable

The following part of the manual describes those parameters of the WB169-IR-B module whose current value can be determined by directly connecting the module to a PC using a configuration cable and possibly changing them with configuration commands (configuration "from the command line").

3.1.1 Listing of configuration parameters and commands of the WB169-IR-B module

We can display the configuration parameters by entering the command **"show"** into the command line and pressing the "ENTER" key. A listing of parameters will appear in the terminal window (see below).

We can display a summary of configuration commands ("HELP") and their parameters by entering the command **"?"** into the command line and pressing the "ENTER" key. A listing will appear in the terminal window as shown in the example below.

An overview of configuration parameters with a brief description of their meaning is given in Table 2 on page 20. The procedure for setting individual parameters and a more detailed explanation of their meaning can be found below.

```
mon#show
----- Configuration -----
 Timezone : 0
 MBUS ID : 00450103
 MBUS manufacturer : SFT
 MBUS manuf. info : ''
 Info send periode : 1440
 MBUS power : 3 (20 dbm)
 MBUS mode    : N2
 WMBUS channel : 3 - 169,43125 Mhz
  No. sent : 2 msg(s)
  No. recv : 0 msg(s)
 Data will be encrypted by AES
 Send mode is 0
---- Configuration 0 ------
  OPTO mode
  Uart init speed 300 7E1
  Max speed : 4800
  Meter address :
  MBUS Reg address : C.1.0
  MBUS version : 22
  MBUS medium : 2
  MBUS manufacturer : SFT
 -- Register 1 --
   Reg value : 1.8.1
   No. decimal digits : 0
   MBUS format : float
   MBUS tarif : 0
   MBUS VIB : 06
 -- Register 2 --
   Reg value : 1.8.2
   No. decimal digits : 0
   MBUS format : float
   MBUS tarif : 1
   MBUS VIB : 06
 -- Register 3 --
   Reg value : 2.8.0
   No. decimal digits : 0
   MBUS format : float
   MBUS tarrif : 0
   MBUS VIB : 86 3c
 -- Register 4 --
   Reg value :
   No. decimal digits : 0
   MBUS format : integer
   MBUS tarrif : 0
   MBUS VIB : 00
  RT : 4 * 50ms
  FT : 1 * 50ms
  Resp : 200 * 50ms
  iDel : 10 * 50ms
  Repeat : 2
  Send periode : 0 min.
  No. sent : 0 msg(s)

---- Configuration 1 ------
  . . .
---- Configuration 5 ------
  . . .
 Conf. version : 1
 SW version 1.12, date Jan 10 2023
mon#
```

```
 --- 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,..]
 --- Configuration ---
show              : Show all configuration
write             : Write configuration to flash
cread             : Read configuration from flash
clear             : Clear configation and load defaults
 --- All profiles [0 - 5] ---
smode             : Send mode
ispeed            : Communication speed
parity            : Parity N,O,E
periode           : Send periode in minute, 0 - disable, -1 external sync.
irt               : rising time * 50ms
ift               : falling time * 50ms
iresp             : responce time * 50ms
idel              : delay time * 50ms
irep              : Repeat readout
iread             : Readout MBUS device
 --- Opto protocol commands per meter [0 - 5] ---
oid               : Meter ID (0 - 99999999)
mid               : MBUS ID (0 - 99999999) or register number
ver               : MBUS version (0 - 255)
medium            : MBUS medium (0 - 255)
manuf             : MBUS manufacturer code (AAA)
mspeed            : Communication max. speed
 --- WMBUS commands ---
power             : Show or set MBUS power (1 - 5)
info              : Show or set MBUS info string (0-30 chars)
mode              : Set WMBUS mode 1 - N1, 2 - N2
chan              : Set WMBUS channel, type ? for help
ekey              : Set encrypt key, point '.' no encrypt
 --- Modem 169Mhz commands ---
mr                : Modem receive mode 0 - off, 1 - on
mt test time      : Set test on modem, 1-TX carrier, 2-TX sync, time is in second, default 10
ms                : Get modem state
mi                : Get modem info
mfreq             : Set or get xtal frequence correction
sfreq             : Set frequence correction from analyzer in Hz, example : 196431200
cfreq             : Set +- frequence correction, 1 = 1Hz
pcorr             : Set +- power correction
 --- Utils ---
tz                : Time offset in hours
ppm               : Set RTC ppm
xtset             : Set Xtal freq for ppm
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
vbat              : Show or set vbat for alarm (vbat min)
uptime            : Show uptime
send [prof]       : Send MBUS message profile [0 - 5]
sens              : Show sensors values
reset             : Reset device
?                 : Show this help
```

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.

The command **"port"** displays the current port settings. This command is intended only for diagnostic purposes by the manufacturer.

3.1.3 Commands for saving configuration and resetting the module

The module contains two sets of configuration: operational configuration and stored configuration. When the system starts, the module copies the stored configuration into the operational one, which it then works with. If the user changes configuration parameters, this is done only in the operational configuration. If the current operational configuration is not saved to FLASH memory, after a reset the module will "return" to the set of configuration parameters that is stored in FLASH. If we set a parameter only temporarily (for example, we shorten the transmission period for the purpose of verifying range during installation), we don't need to save the operational configuration to FLASH memory (after finishing work, we will set the period back to the original value anyway). However, if we want the currently changed operational parameters to remain set permanently, after setting the given parameter (or multiple parameters), we save the configuration to FLASH memory. If the operational configuration corresponds to the stored set (i.e., there are no differences between the commands in FLASH and in the operational set), the module "reports" with a prompt in the form "mon#". If the operational configuration has been changed so that it no longer corresponds to the stored set, the module reports with a prompt in the form "cfg#". Each time the current configuration is saved to FLASH memory, the value of the "Configuration version" parameter changes so that the configuration number increases by one and the prompt changes to "mon#". Completely erasing the FLASH memory resets the value of the "Configuration version" parameter to zero. We can display the current operational configuration with the **"show"** command (see paragraph 3.1.1):

```
cfg#show
```

We overwrite the current operational configuration to FLASH memory with the **"write"** command:

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

We load the configuration from FLASH memory with the **"cread"** command (in older modifications with the **"read"** command):

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

We erase the configuration from Flash memory with the **"clear"** command:

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

This command erases the configuration parameters from FLASH memory, and it is necessary to set them again. If the module is reset after erasing FLASH memory, after the reset, the default set of parameters that is set in the device program will be written to FLASH memory. The exception is the frequency constant setting, which is preserved at the current value even when FLASH is erased. **We recommend using this command only for users with good knowledge of the system, or after consultation with the manufacturer.** We reset the module using the **"reset"** command.

3.1.4 Commands for setting communication with electricity meters

The WB169-IR-B module reads data from internal registers of the connected electricity meter via the meter's optical interface, to which it connects through the IR-15 optical head. The optical head is connected to the module's input

terminal block via a four-wire cable. The module can read up to 6 electricity meters this way, which are connected in parallel to the input terminal block via a 4-wire bus.

For setting the optical interface parameters, there is a group of parameters listed in the configuration commands under the sections **"All profiles"** and **"Opto protocol commands per meter"**. These are the following commands:

smode	*setting the structure (mode) of the transmitted message*
ispeed	*initial communication speed of the optical interface*
parity	*setting the parity bit of serial communication (none/odd/even)*
periode	*setting the reading/transmission period*
irt	*setting the time interval for turning on the bus "rising time"*
ift	*setting the time interval for turning off the bus "falling time"*
iresp	*setting the timeout for response "response time"*
idel	*setting the minimum gap between commands "delay time"*
irep	*setting repeated reading*
iread	*command for immediate data reading*
oid	*setting the meter identifier on the bus*
mid	*setting the M-Bus ID address (or register from which the ID is read)*
ver	*setting the "addressing version" ("Version" - M-Bus address complement)*
medium	*setting the media code according to the M-Bus standard ("Medium" - M-Bus address complement)*
manuf	*setting the manufacturer code ("Manufacturer" - M-Bus address complement)*
mspeed	*setting the maximum communication speed of the optical interface*

For each connected electricity meter, these commands are set separately, so when entering them, it is always necessary to specify the serial number of the electricity meter ("index") as the first parameter. The only exception is the "smode" command, which is common for setting all electricity meters (see its description below).

Using the **smode** command, we set the mode of structure and addressing of sent messages. The WB169-IR-B module supports these three modes of sent message structure:

- when setting parameter **"0"** (default setting), the module sends messages from individual electricity meters as separate M-Bus messages, where each message has the structure as if it were sent by the given electricity meter. The Wireless M-Bus header contains the full M-Bus address of the electricity meter as set using the "mid", "ver", "medium" and "manuf" commands. The M-Bus header is shortened in this case, without identification. The data content of the message contains data blocks of individual variables;
- when setting parameter **"1"**, the module sends a message with a full M-Bus header, where the Wireless M-Bus header contains the M-Bus address of the WB169-IR-B module given by the manufacturer (ID=serial number, Manufacturer=SFT, Medium=15, Version=Device Subtype) and the M-Bus header contains the full M-Bus address of the electricity meter as set using the "mid", "ver", "medium" and "manuf" commands. The data content of the message contains data blocks of individual variables;
- when setting parameter **"2"**, the module sends a message with a shortened M-Bus header, where the Wireless M-Bus header contains the M-Bus address of the WB169-IR-B module given by the manufacturer (ID=serial number, Manufacturer=SFT, Medium=15, Version=Device Subtype), the M-Bus header is short, without identification, and the data blocks of variables are distinguished between individual electricity meters using the "storage" parameter. The receiving system thus receives all messages with the same M-Bus address (the module's address) and data from individual electricity meters are decoded as different "storage" numbers.

Example of setting the message mode/structure to value "1":

```
mon#smode 1
Send mode is 1
cfg#
```

The setting of the message mode/structure is common for all connected electricity meters, so this command is the only one from this group of commands that is always used without a meter index.

Using the command **"ispeed [index] [value]"**, we set the initial bit rate of the optical interface. The module sends a data connection request to the electricity meter at this speed. Based on data exchange, the transmission speed can automatically increase to a value supported by the given type of electricity meter (the electricity meter "agrees" with the module on a higher transmission speed). Using the command **"mspeed"**, we limit the automatic speed increase to the maximum transmission speed allowed by the currently used optical head model. Example of

checking current values and then setting the initial and maximum transmission speed for an electricity meter with index "2":

```
mon#ispeed 2
Init speed [2] : 300 bps
mon#ispeed 2 600
Init speed [2] changed from 300 to 600 bps
cfg#mspeed 2
Max speed [2] : 4800 bps
cfg#mspeed 2 9600
Max speed [2] changed from 4800 to 9600 bps
cfg#
```

The commands **"irt"**, **"ift"**, **"iresp"**, **"idel"** and **"parity"** are used to set the parameters of serial data transmission via the optical interface. They are factory set to suit the connection of electricity meters commonly found on the market. We recommend changing their settings only in specific cases, based on the documentation of the connected device. Parameter changes should always be made only by a qualified person with knowledge in the field of serial data transmission.

Using the command **"irep [index] [value]"**, we set the number of attempts to read data from the given electricity meter. The value of this parameter is preset to "2" from the factory, which means that if the data completeness check fails after the first reading, the module will repeat the attempt to read the data once more. This significantly increases the probability of obtaining a correct reading. Increasing the number of repetitions results in extending the bus activation time, which can have a slight effect on battery life. Example of checking current values and then reducing the number of data reading attempts for an electricity meter with index "0":

```
mon#irep
Repeat[0] : 2
Repeat[1] : 2
Repeat[2] : 2
Repeat[3] : 2
Repeat[4] : 2
Repeat[5] : 2
mon#irep 0 1
Repeat[0] changed from 2 to 1 * 50ms
cfg#
```

The command **"iread [index]"** is used for immediate reading of current values from the electricity meter registers. Using this command, we can immediately test the functionality of the connection and check the status of the read variables after connecting the electricity meter to the module. Example:

```
cfg#iread 1
Reading configuration 1 ...
Reading opto...
 Enable uart on speed 300 7E1
 Send init id '' .. Recv 18 bytes : '/ZPA4ZE110.v30_012'
 ack 4 (4800)
 set 4 (4800)
 Set uart speed to 4800
: 'F.F(000000)'
: 'C.1.0(05837224)'
 *Mid : 05837224
: 'C.90(837224)'
: '1.8.1(0000008.9#kWh)'
 *Reg1 : '1.8.1' -> 8.900
: '2.8.1(0000000.0#kWh)'
: 'C.9.3(19-10-17 08:23)'
: 'C.7.0(0074)'
: '0.3.3(00250.000*i\kWh)'
: '0.2.1(ZE110_DE_30)'
: 'C.8.1(00000096:16#h:min)'
: 'C.82.1(00000000:00#h:min)'
: 'C.50(00000583:32*h:min)'
: '31.6.0(002.382*A)'
: '21.6.0(00.371*kW)'
: '!'
 BCC 0x43 (0x43)
Flags 80
Recv end, 290 bytes
cfg#
```

In the listing, values that are loaded into the sent message are marked with an asterisk. In this case, these are only the values "Mid" (register C.1.0, value 05837224) and T1 (register 1.8.1). The electricity meter does not provide register values for active consumption according to tariff T2 (1.8.2) and active reverse supply (2.8.0).

Using the command **"oid [index] [value]"**, we set a unique bus identifier (OID) for the given index of the electricity meter according to the IEC 62056-21 standard. This command identifies the electricity meter index from the range (0 to 5) in the WB169-IR-B module configuration with a specific electricity meter. The module uses the OID identifier to address the query to a specific electricity meter.

IMPORTANT NOTE! If the OID value is not entered for a given index, the module queries using a broadcast address and stores the response it receives. If multiple electricity meters are connected to the module, the module cannot distinguish which one the response came from. Therefore, if multiple electricity meters are connected to the WB169-IR-B module and bus identifiers are not entered for all of them, data cannot be read. **In case the bus identifiers are unknown or the electricity meter does not respond to them (i.e., they are not stored in the electricity meter configuration), only one electricity meter can be connected to the WB169-IR-B module.**

We can find out the bus identifier from the electricity meter documentation or by querying its manufacturer. It is often identical to the serial number, or it is a designated part of the serial number (but this is not a rule). In the register listing above, the "oid" value (837224) is stored in register C.90, but for other types of electricity meters, it may be in a different register (or in none).

Example of setting a unique bus identifier for an electricity meter to index "1" and checking data reading using OID:

```
cfg#oid 1 837224
Meter ID [1] changed from  to 837224
cfg#iread 1
Reading configuration 1 ...
Reading opto...
 Enable uart on speed 300 7E1
 Send init id '837224' .. Recv 18 bytes : '/ZPA4ZE110.v30_012'
 ack 4 (4800)
 set 4 (4800)
 Set uart speed to 4800
: 'F.F(000000)'
: 'C.1.0(05837224)'
 *Mid : 05837224
: 'C.90(837224)'
: '1.8.1(0000008.9#kWh)'
 *Reg1 : '1.8.1' -> 8.900
: '2.8.1(0000000.0#kWh)'
. . .
```

From the example, it is clear that the OID is set correctly because the electricity meter responds to a specific query using the given OID.

The commands **"mid"**, **"ver"**, **"medium"** and **"manuf"** are used to set the electricity meter addressing in the Wireless M-Bus remote reading system.

The Wireless M-Bus protocol uses a system of unique combination of four components of the M-Bus address for unambiguous device identification: "M-BUS ID", "Version", "Medium" and "Manufacturer". For devices with a fixed configuration of these parameters, the uniqueness of identification is ensured by the device manufacturer. For devices with adjustable identification parameters, depending on the specific identification rules used, the serial number of the connected meter can be used (in combination with its type, model and manufacturer), or the serial number of the radio module (in combination with its type and manufacturer). The use of an "independent" number series is only possible if the system operator has its own manufacturer code and is able to ensure that in combination with this code, the identification of each device will be unique.

Electricity meters with optical interface and IEC 62056 protocol typically do not have an M-Bus address assigned by the manufacturer, so when incorporating them into the Wireless M-Bus reading system (which uses M-Bus addressing), the individual components of the M-Bus address must be set using the following commands:

- using the command **"mid [index] [value]"**, we set the identification (serial) number
- using the command **"ver [index] [value]"**, we set the generation/version number of the device
- using the command **"medium [index] [value]"**, we set the media code according to the M-Bus standard
- using the command **"manuf [index] [value]"**, we set the manufacturer code according to the M-Bus standard

The WB169-IR-B modules are factory set as follows:

- as **"M-Bus ID"**, the content of register "C.1.0" (serial number) of the given electricity meter is read (*)
- as **"version"**, the modification number ("subtype") of the WB169-IR-B module is read
- as **"medium"**, the value "02" (electricity) is set
- as **"manufacturer"**, the manufacturer code of the module is set (SFT = Softlink)

Important note: These parameters can only be changed by a company/institution with its own manufacturer code that is able to ensure worldwide uniqueness of the set combination. The exception is manual correction of the "M-Bus ID" value in case the electricity meter serial number in register "C.1.0" has an unsuitable format for use in the M-Bus address.

Example of checking set parameters and making a change to M-Bus ID:

```
mon#
mon#mid 1
MBUS reg ID [1] : C.1.0
mon#ver 1
MBUS version [1] : 22
mon#medium 1
MBUS medium [1] : 2
mon#manuf 1
MBUS [1] manufacturer : SFT
mon#mid 1 12345678
MBUS ID [1] changed from C.1.0 to 12345678
```

(*) Using the "mid" command, you can set either a reference to the IEC 62056 register from which the identifier should be read, or directly enter the ID (serial number) of the meter. The module recognizes both cases automatically, based on the format of the set value.

The command **"periode [index0] [value]"** is used to set the period for reading the state of the electricity meter with the given index and sending a message with the read values (the module sends the message immediately after reading). For each of the six read electricity meters (with index 0 to 5), a different reading/sending period can be set, when entering **value "0"**, the given electricity meter is **not read**. The zero value is factory set for all electricity meters.

The "periode" command **with index "6"** is used to set the transmission period of operational messages that the WB169-IR-B module sends on its own behalf. The content of these messages is operational data of the module (uptime, processor temperature, battery voltage...). From the factory, the period for sending operational messages is set to 1440 minutes (24 hours).

Example of checking the setting of all transmission periods, setting the period of the first electricity meter to 1 hour and subsequent checking of the transmission period of the first electricity meter:

```
mon#periode
Periode [0] is 0 min.
Periode [1] is 0 min.
Periode [2] is 0 min.
Periode [3] is 0 min.
Periode [4] is 0 min.
Periode [5] is 0 min.
Periode [6] is 1440 min.
mon#periode 0 60
Periode [0] changed from 0 to 60 min.
cfg#periode 0
Periode [0] is 60 min.
cfg#
```

3.1.5 Commands of the "WMBUS commands" and "Modem 169Mhz commands" groups for setting up communication via the 169 MHz network

This group of commands is used to set the parameters of the 169 MHz modem, which is used for radio communication with the superior network element (for example, a communication gateway).

The first part of the commands is used to set the basic transmission parameters. These are the following commands:

power	*setting the transmission power (value 1 - 5)*
info	*setting the device name/description "INFO" (0 - 30 characters)*
mode	*setting the WMBUS communication mode (1 - N1, 2 - N2)*
chan	*setting the WMBUS frequency channel (value 1 - 7)*
ekey	*setting the encryption key for message encryption*

Using the **"power"** command, we set the **transmission power** of the module. We can set the transmission power to one of the following 5 levels using parameters 1 to 5:

- value "1" for power 14 dBm (25 mW)

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

During production, the module is set to a medium power of 100 mW. Using the **"power"** command (without parameters), the current setting value can be displayed. The currently set value is marked with an asterisk. Example of checking the current transmission power setting and changing the setting to 500 mW:

```
mon#power
  1 -> 4 dbm
  2 -> 17 dbm
* 3 -> 20 dbm
  4 -> 24 dbm
  5 -> 27 dbm
mon#power 5
MBUS power changed from 3 to 5 (27 dbm)
cfg#
```

The **"Info"** variable is used to set the device name. The device name is then part of the operational message that the module sends for itself (see section 3.5). No value is set in the module from the factory, so in the default state, the device name is not sent in the operational message. Using the **"info"** command (without parameters), the current setting value can be displayed. If we enter any string as a parameter after the "info" command, the device will report with this name in operational messages. The maximum length of the string is 29 characters. Only the basic character set can be used (without diacritics). Example of checking the current setting and changing the device name:

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

The **"Communication mode"** variable is used to select the communication mode of the module. The module supports communication modes N1 and N2. Using the **"mode"** command (without parameters), the current setting value can be displayed. We change the communication mode by entering the desired option as a parameter after the "mode" command. Communication modes are defined by the Wireless M-BUS standard, the specific offer of module communication modes is listed in the "Help" for the "mode" parameter (see section 3.1). Example of checking the setting and changing the communication mode:

```
cfg#mode
Mode N2
cfg#mode 1
Mode changed from 2 to 1
cfg#
```

Using the **"chan"** command, we select the **transmission channel** of the module. Transmission channels for individual frequency bands are defined by the Wireless M-Bus standard, seven frequency channels can be used for this type of module (7 options). The current setting is always marked with an asterisk in the list of options. We can check the current setting by entering the "chan" command without parameters, we change the frequency channel by entering the number of the desired option as a parameter after the "chan" command. Example of checking the current setting and changing the transmission channel:

```
cfg#chan
Help :
  1 - 169,40625 Mhz
  2 - 169,41875 Mhz
* 3 - 169,43125 Mhz
  4 - 169,44375 Mhz
  5 - 169,45625 Mhz
  6 - 169,46875 Mhz
  7 - 169,43750 Mhz
cfg#chan 1
Channel changed from 3 to 1 : 169,40625 Mhz
cfg#
```

The **"Encryption code"** variable is used to set the encryption key for encrypting messages using the AES-128 key. We enter the 16-byte encryption key using the **"ekey"** command followed by a string of 16 bytes, which can be entered in decimal or hexadecimal format (see examples).

Example of entering the encryption key in hexadecimal format:

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

Example of entering the encryption key in decimal format:

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

After entering the encryption key, the information about encryption being turned on ***"Data will be encrypted by AES"*** is displayed in the list of set parameters (see section 3.1.1).

We turn off encryption by entering the parameter "." (dot) after the **"ekey"** command:

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

After turning off encryption, the information ***"Data will be unencrypted"*** is displayed in the parameter list (see section 3.1.1).

The next part of the commands is used only for setting the parameters of the 169 MHz modem during activation and setting of the module in the production process. These are the following commands:

mr	*turning on the 169 MHz modem into receiving mode (setting)*
mt test time	*setting the modem to test transmission (setting)*
ms	*system prints out internal status of the radio modem (diagnostics)*
mi	*system prints out internal status of the radio modem (diagnostics)*
mfreq	*setting the frequency constant of the transmitter (setting)*
sfreq	*setting the frequency constant according to the analyzer data (setting)*
cfreq	*correction of the frequency crystal capacity (setting)*
pcorr	*correction of the transmission power setting (setting)*

We strongly recommend not to use these commands during device operation.

3.1.6 Commands of the "Utils" group for setting and checking basic module functions

This group of commands is used to set and check other functions of the module. These are the following commands:

tz	*setting the time zone (UTC + n)*
ppm	*setting RTC crystal correction (setting)*
xtset	*connecting RTC generator to control output (setting)*
time	*display/set hh:mm:ss real time RTC*
date	*display/set YY.MM.DD real time RTC*
uptime	*display time since last reset ("Uptime")*
sens	*display current values of temperature and voltage sensors*
vbat	*setting battery voltage threshold for generating alarm (setting)*
send [prof]	*immediate transmission of Wireless M-Bus message from given electricity meter*
reset	*command to perform module reset*
?	*list configuration commands ("Help")*

Using the command **"tz"**, we set the **time zone** (Time Zone) in which the remote reading system operates. The module supports **only one** time zone, which is set in hours from UTC. Example of setting the time zone to UTC+1 (Central European Time):

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

In the configuration listing, the set time zone value is displayed as:

```
Timezone : 1
```

The commands **"ppm"** and **xtset** are used for fine-tuning the frequency of the RTC (Real Time Clock) signal oscillator during module production. This operation is not performed in the current version of the module production, as no application requires RTC setting. Using the command **"time"** or **"date"**, we can display the current RTC setting. By entering any of these commands without parameters, we display the current RTC value of the module. Example:

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

We set the RTC value using the commands **time** and **date** 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 evident from the example, the "time" value is given in the format "0x**hhmmss**", the "date" value is given in the format 0x**YYMMDD**.

Note: *Setting the RTC (including setting the time zone) is not necessary for normal functionality of the module, no current application of the module requires RTC setting.* Using the command **"uptime"**, we display the time since the module was turned on or since its last reset. We use this command only when checking and diagnosing the module. From the "Uptime" value, we can tell when the last module reset occurred. The variable is "read only" type. Example:

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

Using the command **"sens"**, we display the values of the module's A/D converters for measuring processor temperature and battery voltage. We use this command only when checking and diagnosing the module.

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

Using the command **"vbat"**, we can adjust the setting of the battery voltage threshold at which the module sends a "Low Battery" alarm. The threshold value of 3.1 V (3100 mV) is set from the factory. We recommend changing this value only in justified cases, after consultation with the manufacturer. Example of checking the current setting and changing the threshold value to 3.2 V:

```
cfg#vbat
Vbat alarm for 3100 mV
cfg#vbat 3200
Vbat alarm for 3200 mV
mon#
```

During normal operation, the module automatically sends information messages for all connected electricity meters with the required measurement/sending period. Using the command **"send [index]"**, we can send an information message from the required electricity meter immediately, which can be useful, for example, when checking the introduction of a new electricity meter into the reading system.

Example of sending a Wireless M-Bus information message from the electricity meter under index "0" using the "send" command:

```
mon#send 0
Send [0] ...
 send [0] msg 37 bytes
mon#
```

Using the command **"reset"**, we perform a module reset. After performing the reset, the stored set of configuration parameters is loaded from FLASH memory. If we want to keep the currently created configuration, before performing the reset, it is necessary to save the working set of configuration to FLASH memory (see paragraph 3.1.3). Example of using the command for module reset:

```
mon#reset
mon#
 -- Reset code 0x14050b00 --
 PIN Reset
 SFT Reset
 SW version 1.11, date Apr 21 2022
Monitor started ..
mon#
```

Using the command **"?"**, we display a list of module configuration commands with their brief description ("Help"). An example of this command is given in the introductory part of section 3.1.

3.1.7 Displaying additional data in the module's configuration parameter listing

The initial part of the configuration parameter listing displays the module's identification data and some setting parameters whose meaning was described above (period, power, channel, encryption...).

The middle part of the listing shows the configurations of individual inputs (electricity meters). The module allows connection of up to six electricity meters, so the configuration listing contains 6 sections ("Configuration 0" to "Configuration 5"). Each section contains settings for communication via the optical head (communication protocol, initial and maximum data rate, meter identification and its complete M-Bus address) and settings for reading individual registers from which the required values are read. The registers are set permanently to read only values approved by the owner/operator of the electricity meters. For operation in the Czech Republic, these registers are set:

- electricity meter serial number (C.1.0)
- current status of active consumption counter according to tariff T1 (1.8.1)
- current status of active consumption counter according to tariff T2 (1.8.2)

- current status of active reverse supply counter (2.8.0)

In case of a request to read other registers according to the IEC 62056 (DLMS) standard, contact the module manufacturer, who can set the reading of any four parameters according to the specified standard for the ordered production series.

At the end of each meter's section, there is a listing of timer settings, information about the setting of the repeat period for reading, and operational statistics of sending messages from the given meter.

At the end of the configuration listing, the line **"Conf. version"** displays the number of the set of configuration parameters, which increases with each new configuration save to memory. The number is reset by erasing the FLASH memory. The line **"SW version"** displays the software version and its release date.

3.2 Setting module parameters using an optical converter

The module is equipped with an "IRDA" infrared optical interface, which is used for configuration using the **"USB-IRDA"** converter (from optics to USB cable), or using the **"BT-IRDA"** converter (from optics to Bluetooth radio). For easy attachment of the optical converter, the module is equipped with a circular recess ("viewport") for attaching the converter with a retaining magnet.

The advantage of setting via the optical converter is the possibility of configuration through the "viewport" in the plastic cover of the module, without the need to open the cover. This is of great importance especially in cases where we use the module in a humid environment and it is sealed with additional silicone sealing, or filled with silicone filling (additional modification to meet the conditions of IP68 protection degree).

Using the **"USB-IRDA"** optical converter, you can display a listing of the current settings of all module parameters. We display the listing of all parameters by clicking on the **"Walk"** button in the "WACO OptoConf" program window.

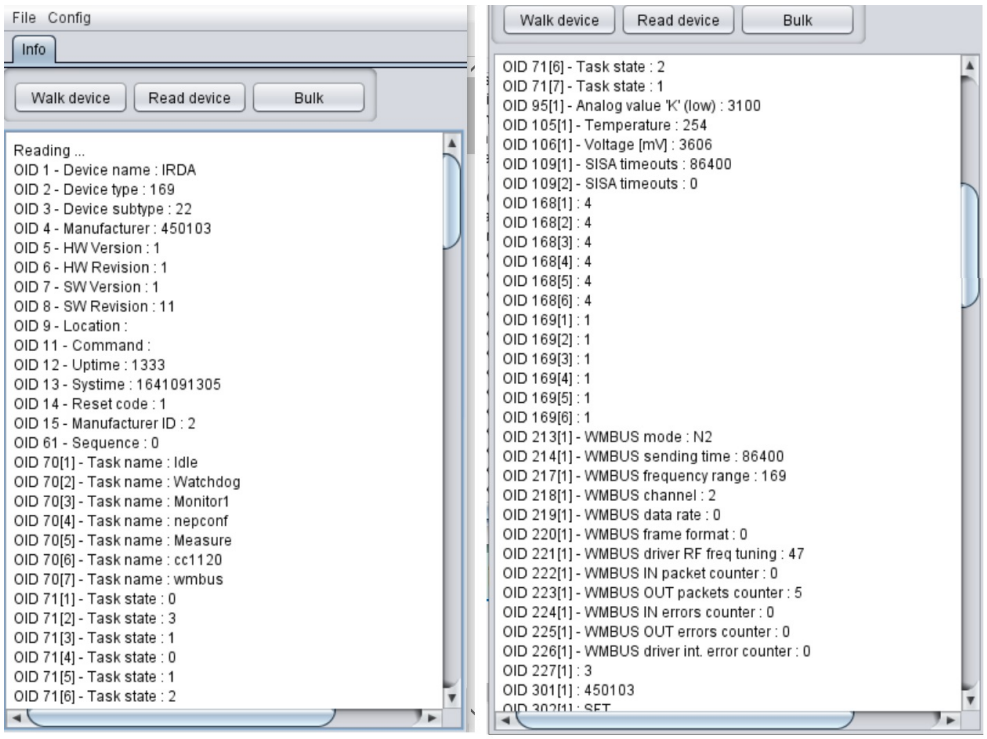


Figure 2: Parameter listing of the WB169-IR-B module

The **"Read"** button in the "WACO OptoConf" program is used to display the module's configuration table, through which it is possible to make changes to the settings of individual types of modules. However, this table is not available for all types and modifications of modules and its functionality is being replaced by configuration from a mobile phone via the "BT-IRDA" converter.

Using the **"BT-IRDA" optical converter**, you can set those parameters that are included in any configuration form of the **"SOFTLINK Configurator"** mobile application. The current version of the "SOFTLINK Configurator" application supports the configuration of all basic module parameters, as well as performing those

basic tests that need to be performed at the installation site. Figure 3 shows the identification form of the WB169-IR-B module (in the green frame), the list of available forms (in the yellow frame), the administration form (in the purple frame) and the form for basic module settings (in the red frame).

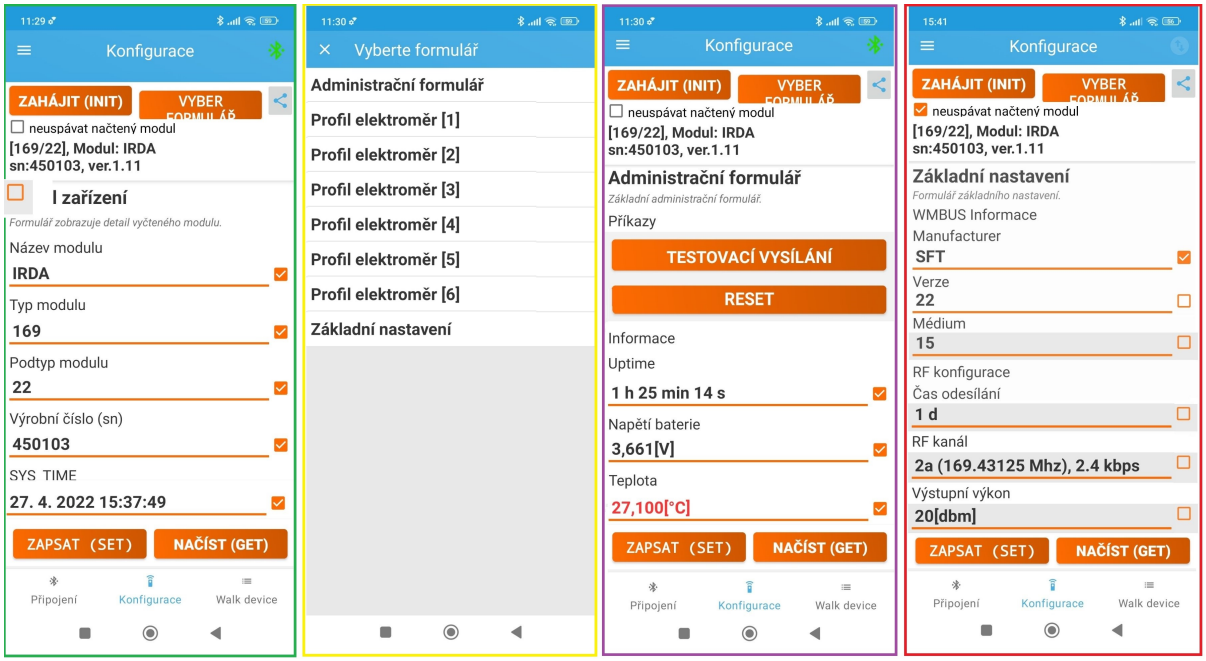


Figure 3: Forms of the WB169-IR-B module in the "SOFTLINK Configurator" application

The **identification form** displays basic information about the module (type, modification, serial number, system time) and a button for selecting the configuration form.

The **administration form** displays operational data of the module (uptime, battery voltage, processor temperature). There are buttons for resetting and turning on test transmission.

The **basic settings form** contains configuration fields for setting additional Wireless M-Bus address data of the module itself (Manufacturer, Version, Medium) and configuration fields for setting the frequency channel, transmitter power and period of sending operational messages.

Figure 4 shows the procedure for setting up data reading from individual electricity meters connected to the module.

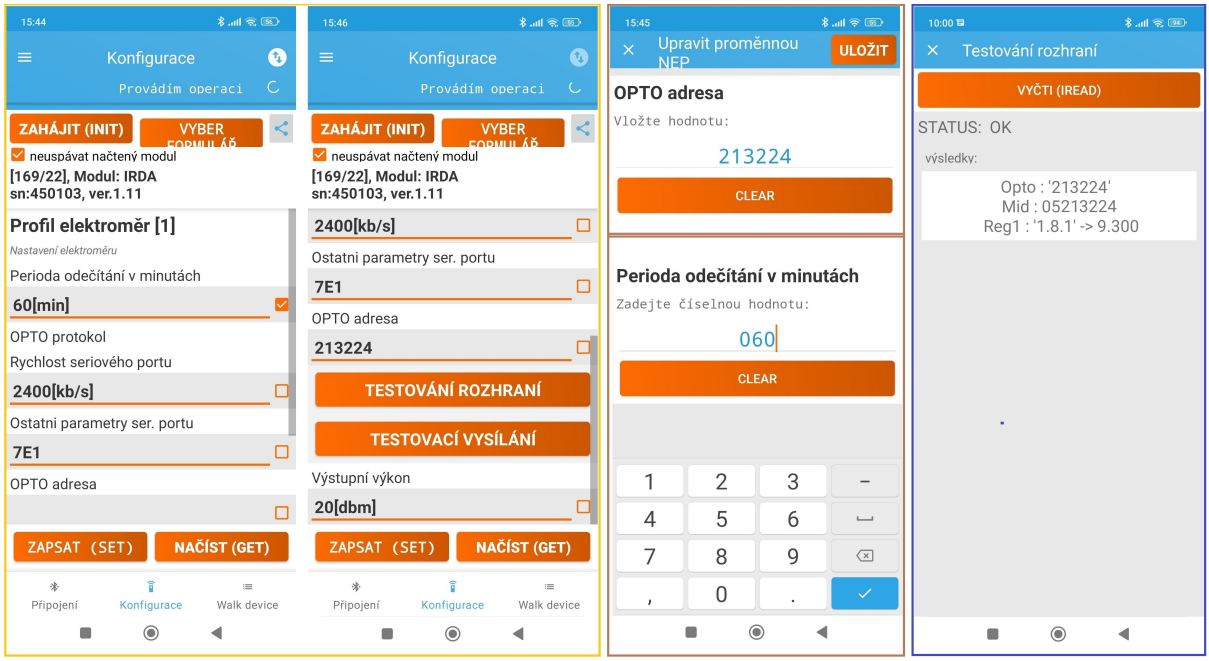


Figure 4: Forms for setting up data reading from electricity meters

For setting each electricity meter, there is a form marked with the sequence number of the electricity meter configuration (Electricity meter profile 1 to 6). For each electricity meter, the following parameters can be set:

- setting the period for sending WMBUS information messages
- setting the initial data transfer rate via the optical head
- setting serial communication parameters (7 data bits / even parity / 1 stop bit)
- bus identifier of the electricity meter according to IEC 62056 standard

In addition to the above parameters, information about the module's transmission power setting is displayed here.

The purple frame shows the procedure for editing individual items. By clicking on the desired field, an editing window opens, in which we set the value and click on the "Save" button in the top bar of the window, which closes the editing window. After editing all fields, we click on the "Write" button at the bottom of the form for setting the electricity meter. The mobile application sends setting updates to the module and indicates confirmation of the write to the configuration by checking the square box on the right.

Using the **"Interface Testing"** button, you can immediately read the preset registers from the given electricity meter. After clicking on this button, a new window opens with the "Read (IREAD)" button at the top. Clicking on this button performs a meter reading and after a few seconds, the "OPTO" interface status changes to "OK" and the status of the required registers is displayed. The blue frame on the right shows a preview of the variable reading window with the read value "Mid" and "Reg 1.8.1".

Using the **"Test Transmission"** button, you can immediately send a message with the last read data.

The "SOFTLINK Configurator" mobile application is continuously being developed and improved, so the above previews of information and configuration forms of the WB169-IR-B module may change over time.

3.3 Setting module parameters from a remote computer using the reverse channel

The Wireless M-Bus radio communication protocol also allows the transmission of messages to end devices (the so-called **"reverse channel"**. The reverse channel is used for remote setting of a selected set of configuration parameters from a remote server.

If the WB169-IR-B module is set for operation in the **bidirectional communication mode N2**, it can receive **"Request" type messages** from the superior system or "Master" device according to the Wireless M-Bus standard, based on which it is possible to remotely adjust not only the module parameters, but also the communication settings parameters with individual electricity meters. The following module parameters can be set:

- setting the transmission power ("power");
- setting the transmission period of operational messages ("periode");
- setting the module's info-text ("info");
- setting the structure (mode) of the transmitted message ("smode");
- remote execution of module reset ("reset");

For each connected electricity meter, the following parameters can be set:

- setting the bus identifier ("oid");
- setting the register address for reading the M-Bus address ("mid");
- setting the register addresses of read variables (up to 4 registers);
- setting DIF/VIF data for read variables
- setting the transmission period of information messages ("periode")
- setting bus timers
- setting serial communication (parity/data bits/stop bits)

Reception of a "Request" type message always takes place in a dedicated time window of 500 ms after sending a regular "User Data" type information message. In this time window, the WB169-IR-B module has its receiver turned on and is capable of receiving a possible "Request" type message. The module confirms the receipt of a "Request" message with an "Acknowledgment" type message. A more detailed description of "Request" type messages is given in section 3.5.5 "Setting messages").

3.4 Overview of Module Configuration Parameters

An overview of the configuration parameters used for user settings of the WB169-IR-B module is given in Table 2. The parameters are listed in the table in the same order as they appear in the configuration listing (see paragraph 3.1.1).

Table 2: Overview of configuration parameters of the WB169-IR-Bmodule

No.	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 manufacturer (M-Bus address supplement)	read only
4	MBUS Manuf. Info	text	Info text for device	-
5	MBUS Medium	code	Medium (M-Bus address supplement)	15
6	MBUS Version	0 - 255	Generation or version (M-Bus address supplement)	read only
7	Send periode	1 - 65535	Transmission period in minutes	0
8	MBUS Power	1 - 5	Transmission power	3 (20 dbm)
9	MBUS Mode	N1, N2	Communication mode	N2
10	WMBUS channel	1 - 7	Frequency channel	3
11	Send mode	code	Structure of sent messages	0
12	Encryption	code	encryption key	disabled
13	No. sent	curr. state	number of messages sent since reset	read only
14	No. recv	curr. state	number of messages received since reset	read only
15	Conf. version	curr. state	serial number of stored configuration	read only
16	SW version	curr. state	software version number and release date	read only
Settings for connected electricity meters 1 - 6				
16	Init speed	300-19200	Initial bit rate	300
17	Parity	code	Serial line parity bit	e
18	Periode	65535	Reading period in minutes	0
19	Rising time	0 - 255	Bus power-on timeout	4
20	Falling time	0 - 255	Bus power-off timeout	1
21	Response time	0 - 255	Timeout for command response	200
22	Delay time	0 - 255	Timeout for gap between commands	10
23	Max speed	300-19200	Maximum bit rate	4800
24	Meter ID	15 characters	Bus address according to IEC 62056	-
25	MBUS ID	0 - 99999999	Serial number (M-Bus address), or register	C.1.0
26	MBUS Version	0 - 255	Generation or version (M-Bus address supplement)	
27	MBUS Medium	code	Medium (M-Bus address supplement)	02
28	MBUS Manufacturer	code	Device manufacturer (M-Bus address supplement)	SFT
29	No. sent	curr. state	number of messages sent from given electricity meter	read only

In the **"Type"** column, the type of value for the given parameter is indicated. The designation "code" means that the set value is displayed in the form of a hexadecimal code, where a pair of hexadecimal characters always represents one Byte. The designation "curr. state" means that the given data is an operational value that cannot be influenced. A numerical range means that the given value is a number from the specified range.

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

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

Yellow highlighting in the "No." column indicates those parameters that can be set using the **USB-IRDA or BT-IRDA optical converter** as described in detail in section 3.2 "Setting module parameters using the optical converter".

3.5 Structure of module data messages

The module transmits 5 types of messages:

- information message in **mode "0"** with WMBUS header of the given electricity meter (shortened);
- information message in **mode "1"** with WMBUS header of the module and M-Bus header of the electricity meter (long);
- information message in **mode "2"** with WMBUS header of the module (shortened);
- **operational message** with module data with WMBUS header of the module (shortened)
- **alarm message** with module data with WMBUS header of the module (shortened)

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

3.5.1 Information messages

The format of the **information message** is set using the "smode" command (see paragraph 3.1.4 "Commands for setting communication with electricity meters"). When setting **mode "0"** (default setting), the module sends a message for each connected electricity meter as if it were a message from the given electricity meter:

- it is sent with the set period for the given electricity meter
- the WMBUS header contains the M-Bus address of the electricity meter
- the shortened M-Bus header does not contain an address
- in the data content, only the states of read registers of the given electricity meter are as M-Bus variables

An example of an information message from electricity meter "837224" in mode "0" is shown in Figure 5.

Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI
34	06:56.007	10.467	-55	63	0x44	00003411	SFT	5	Water(7)	0x7a
35	07:04.947	08.940	-50	21	0x44	05837224	SFT	22	Electric...	0x7a
36	07:08.868	03.921	-37	143	0x44	00900010	SFT	6	Water(7)	0x7a

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	9699.999809265137	Wh	0	1	0	45	06	33 33 1b 41

Figure 5: Display of information message of module WB169-IR-B in mode "0" in the *WMBUSAN4* analyzer

When setting **mode "1"**, the module sends a "long" message for each connected electricity meter with both addresses:

- it is sent with the set period for the given electricity meter
- the WMBUS header contains the M-Bus address of the module
- the full M-Bus header also contains the address of the given electricity meter
- in the data content, only the states of read registers of the given electricity meter are as M-Bus variables

An example of an information message from electricity meter "837224" sent by module "450103" in mode "1" is shown in Figure 6.

Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI	Hdr. ID	Hdr. Man.	Hdr. Ver.	Hdr. Type	Access	Status	Signature
10	03:44.185	50.438	-76	63	0x44	00007872	SFT	5	Water(7)	0x7a					235	0	30 05
11	03:45.153	00.968	-51	30	0x44	00450103	SFT	22	Unknown Medium(15)	0x72	05837224	SFT	22	2	79	0	00 00

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	9699.999809265137	Wh	0	5	0	c5 02	06	33 33 1b 41

Figure 6: Display of information message of module WB169-IR-B in mode "1" in the *WMBUSAN4* analyzer

As evident from the figure, the message has a full version of the M-Bus header, which also includes the M-Bus address of the electricity meter for which the module is sending data.

When setting **mode "2"**, the module sends a message for each connected electricity meter with the WMBUS address of the module. The source electricity meter is identified using the "Storage" parameter:

- it is sent with the set period for the given electricity meter
- the WMBUS header contains the M-Bus address of the module
- the shortened M-Bus header does not contain the address of the given electricity meter
- in the data content, only the states of read registers of the given electricity meter are as M-Bus variables

- the electricity meter is identified by the range of "storage" (*) of accompanying data of the variable

(*) variables with storage numbers 1-4 belong to the electricity meter on the first input, storage numbers 5-8 belong to the electricity meter on the second input, etc.

An example of an information message from the electricity meter on the first input of the WB169-IR-B module with serial number (ID) "450103" in mode "2" is shown in Figure 7.

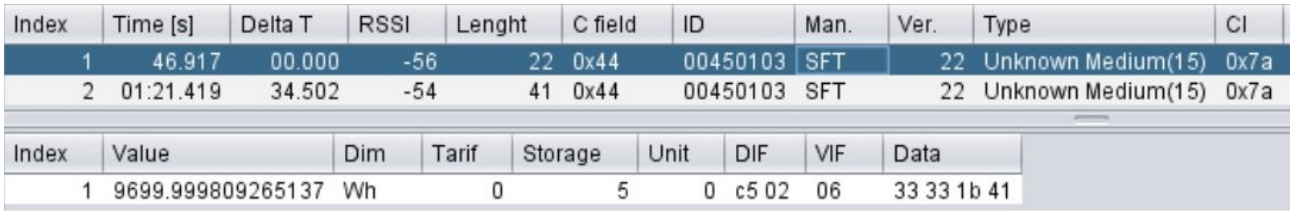


Figure 7: Display of information message of module WB169-IR-B in mode "2" in the *WMBUSAN4* analyzer

As evident from the figure, the WB169-IR-B module sends this message "on its own behalf". From the accompanying data "storage"=5, it is clear that the data is from the electricity meter on the second input of the module.

3.5.2 Operational message

The operational message of the module contains basic operational data of the module. It consists of a Wireless M-BUS header ("WMBUS Header"), a shortened M-Bus header of 4 bytes, and a data block with five or six data segments of individual variables (depending on whether the "INFO" field is set).

The structure of the Wireless M-BUS module message header is shown in Table 3. The Wireless M-BUS header

Table 3: Structure of the Wireless M-BUS module WB169-IR-Bmessage header

Name	Length (Byte)	Description/meaning
Message length (L)	1	Message length in Bytes
Packet type (C)	1	"Spontaneous User Data"
Manufacturer ID (M)	2	"SFT" (Softlink manufacturer code)
Serial number (A)	4	Module identification according to M-BUS standard (configurable)
Version (V)	1	Module generation/version according to M-BUS standard (configurable)
Medium (T)	1	Type of measured medium according to M-BUS standard (configurable)
Application type (Cl)	1	"Slave to Master, 4-Byte header, variable data format"

contains complete device identification according to the M-BUS standard (manufacturer/medium/version/serial number) and information about the message type and its content format. The header length is 10 Bytes (or 11 Bytes including the "Length" field). The shortened 4-Byte header of the M-Bus application layer message contains the following data:

- The "Sequence number" (Access No) item will increase with each sent message;
- The "Status" item is zero in normal state, value "04" ("Low Power") indicates low battery voltage;
- The "Signature" item contains the encryption type and parameter (if without encryption, then "00 00").

The "Signature" message item is modified to "01 XX" when the message is repeated by a repeater (the lower bit of the first Byte is changed from "0" to "1").

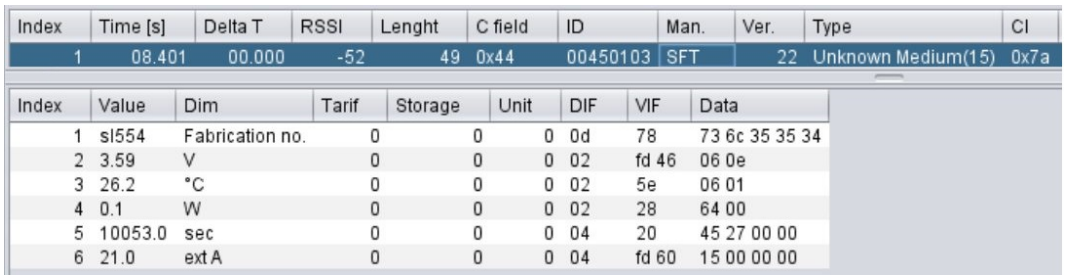
The list of variables that the WB169-IR-B module sends in its data message is shown in Table 4: (*) The message

Table 4: Description of variables in the data block of the operational message of the WB169-IR-Bmodule

Order	Variable (meaning and description)	Unit	Type	Data format
1	User designation of the module (INFO)	text	Inst.	Variable (*)
2	Internal battery voltage	V (10^{-3})	Inst.	16 bit Integer
3	Processor temperature	°C (10^{-1})	Inst.	16 bit Integer
4	Transmission power setting	W (10^{-3})	Inst.	16 bit Integer
5	"Uptime" since last reset	seconds	Inst.	32 bit Integer
6	Number of module restarts	number	Inst.	32 bit Integer

contains this data segment only if the "Info" string is set. The length of this data segment depends on the number of characters in the "Info" string.

An example of displaying an operational message of the module, captured and decoded using the *WMBUSAN4* type Wireless M-BUS radio signal analyzer, is shown in Figure 8.



Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI
1	08.401	00.000	-52	49	0x44	00450103	SFT	22	Unknown Medium(15)	0x7a

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	sl554	Fabrication no.	0	0	0	0d	78	73 6c 35 35 34
2	3.59	V	0	0	0	02	fd 46	06 0e
3	26.2	°C	0	0	0	02	5e	06 01
4	0.1	W	0	0	0	02	28	64 00
5	10053.0	sec	0	0	0	04	20	45 27 00 00
6	21.0	ext A	0	0	0	04	fd 60	15 00 00 00

Figure 8: Display of operational message of module WB169-IR-B using the *WMBUSAN4* analyzer

3.5.3 Message encryption

If encryption of sent messages using the AES-128 encryption key is enabled, two "control" segments "2F" must be inserted before the data segments of individual variables, which are used to check the correctness of decryption. These blocks do not carry any information and the decoding system ignores them. When encryption is enabled, the total number of bytes of the data block must also be "aligned" to a multiple of 16 bytes, i.e., so that the number of bytes of the data block is 16, 32, 48, 64... etc. The "alignment" is done by supplementing the message with additional "2F" control blocks.

3.5.4 Alarm message

An alarm message of the module is generated in case of occurrence of some type of alarm supported by the module. The current variant of the WB169-IR-B type module supports the following types of events:

- "RESET" type event (alarm type "0")
- "CONFIGURATION CHANGE" type event (alarm type "1")
- module in "LOW BATTERY" state - alarm state (alarm type "19")
- module in "BATTERY OK" state - normal state (alarm type "20")

The "RESET" type event is always generated by the module after it has gone through a reset (immediately after start-up). The "CONFIGURATION CHANGE" type event is generated by the module always after saving the configuration to FLASH memory. The "LOW BATTERY/BATTERY OK" type events are generated based on periodic measurement of battery voltage by the internal A/D converter and comparison of the measured value with the threshold value set by the "vbat" command (see paragraph 3.1.6 ("Commands of the "Utils" group for setting and checking basic module functions").

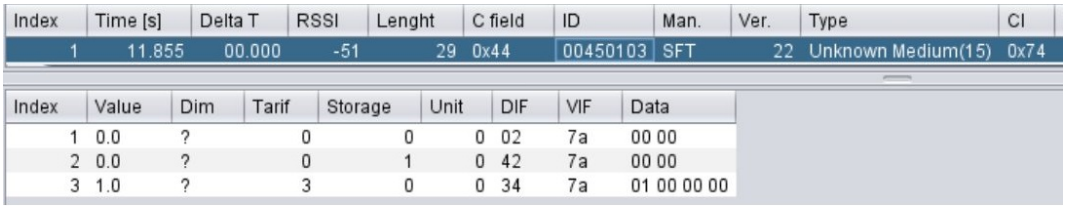
Each alarm message has a Wireless M-Bus header ("WMBUS Header") and a shortened M-Bus header of 4 bytes. In the **WMBUS header** of the alarm message, the **"CI" parameter** (Application Type) is always set to the value **"74"** ("Alarm from meter with short transport layer"), otherwise the header of the alarm message does not differ from the header of the information message.

Each alarm message has three data segments, which contain the **alarm category and alarm type** according to the *wacoSystem* categorization and an **accompanying numeric value**, specifying the state or reason. A complete list of supported alarm types is available at the public WEB address NEP Page. All alarm messages from the WB169-IR-B module are of category "0" (Generic).

The alarm type for the **"RESET" type event** is "0". The accompanying value for the "RESET" type event is the **"Reset Code"**, which carries information about what caused the reset. In NEP coding, these reset types are defined:

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

Figure 9 shows a decoded alarm message of the WB169-IR-B module about a performed reset with reset code "0" ("Cold start"):



Index	Time [s]	Delta T	RSSI	Lenght	C field	ID	Man.	Ver.	Type	CI
1	11.855	00.000	-51	29	0x44	00450103	SFT	22	Unknown Medium(15)	0x74

Index	Value	Dim	Tarif	Storage	Unit	DIF	VIF	Data
1	0.0	?	0	0	0	02	7a	00 00
2	0.0	?	0	1	0	42	7a	00 00
3	1.0	?	3	0	0	34	7a	01 00 00 00

Figure 9: Structure of alarm message of module WB169-IR-B about module reset

As evident from the figure, the message has the "CI" bit in the header set to value "74". The data block has three segments, after two segments with the alarm category and type follows a segment with the reset code.

The accompanying DIF/VIF information is set as follows:

- for "alarm category": DIF = 02 (instantaneous value, 16 bit integer, storage number "0")
- for "alarm type": DIF = 42 (instantaneous value, 16-bit integer, storage number "1")
- for "reset type": DIF = 34 (average value, 32 bit integer, storage number "0")
- for all variables: VIF = 7A (without physical meaning)

This setting of accompanying information for alarm messages is a generally valid convention for modules of the WB169 type series, chosen by the manufacturer.

The alarm type for the **"CONFIGURATION CHANGE" type event** is "1". The accompanying value for the "CONFIGURATION CHANGE" type event is the **"Configuration status"**, which carries information about the configuration state after the given event (in this case, the value is "2", which in NEP coding means "configuration saved").

The alarm type for the **"LOW BATTERY" type event** is "19". The accompanying value for the "LOW BATTERY" type event is the **numerical value of the battery voltage**. The alarm type for the **"BATTERY OK" type event** is "20". The accompanying value for the "BATTERY OK" type event is also the **numerical value of the battery voltage**.

3.5.5 Setting messages

"Setting messages" in the *wacoSystem* series modules are messages in the reverse direction (from the center to the end device) that are used to set module parameters.

Passing messages to end devices through the so-called **"reverse channel"** is only possible if the WB169-IR-B module is set to work in the **bidirectional communication mode N2** of the Wireless M-Bus protocol. The reverse channel is used to pass commands to the module, especially for remote setting of a selected set of configuration parameters. The superior remote reading system sends a setting message of the **"Request"** type to the module, which its superior communication gateway passes to it at a suitable moment (time window). The module confirms the receipt of the setting message by sending a message of the "Acknowledgment" type, which its superior communication gateway passes to the central system.

Receipt of a "Request" type message always takes place at the WB169-IR-B module in a dedicated time window of 500 ms after sending a regular information message of the "User Data" (INFO) type. In this time window, the WB169-IR-B module has its receiver turned on and is able to receive a possible "Request" type message. The module confirms the receipt of the "Request" message by immediately sending an "Acknowledgment" type message.

In coding messages of the "Request" type, common principles of coding variables according to the M-Bus standard were used, the messages have a shortened Wireless M-Bus header with settings corresponding to messages of the "Request" type (C-byte ="53", CI-byte = "5A") and for each set variable, the "Request" message contains one data block with the appropriate DIF/VIF parameter settings and the required value.

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

The WB169-IR-B module supports the setting messages listed in Table 5, where for individual types of messages, the meaning of variables and the method of setting accompanying DIF/VIF parameters are also described.

(*) For setting parity, data bits and stop bits, the variable value is coded as: 0 =no, 1 =odd , 2 =even, +4 =7data bits, +8 =2stop bits.

In the first part of the table are parameters that relate to the WB169-IR-B module as a whole. They are always sent with storage value "0".

Table 5: Table of variables in setting messages of the WB169-IR-Bmodule

Name	DIF	VIF	Value
Send Mode	0x01	0xfd62	0, 1, or 2 (see "smode")
Info	0x0d	0xfd10	info-string, max 29 characters
Reset	0x01	0xfd60	value greater than 0 resets the module
Power	0x02	0x28	transmission power 169 MHz in mW
Electricity meter ID	0x04+storage	0x7a	32 bit Integer (see "oid")
IDREG	0x1d+storageReg	0x7e	string (see "mid")
REG	0x0d+storageReg	0x6e	string (see "smode")
VIB	0x1d+storageReg	0x6e	setting DF+VIF for mode "2"
Period	0x02+storage	0xfd35	transmission period (see "periode")
Timers	0x3d+storage	0x6e	4 byte timers (see "irt", "ift", "iresp", "idel")
Parity	0x01+storage	0xfd62	coded setting (*)

In the second part of the table are parameters that relate to individual electricity meters ("storage"), or to registers of electricity meters ("storageReg"). These parameters are assigned to the appropriate electricity meters (and possibly to their various registers) using the "storage" flag.

For parameters that relate only to electricity meters (in the table they have "storage" listed in the "DIF" column), storage numbers from the range 0 to 6 are used, where:

- storage "0" contains the value for the module (for example, for "periode" it is the transmission period of the operational message)
- storage "1" to "6" contain values for electricity meters on inputs 1 - 6

For parameters that relate to registers of individual electricity meters (in the table they have "storageReg" listed in the "DIF" column), storage numbers from the range 0 to 23 are used, where:

- storage "0 to 3" contain values of up to four registers for the electricity meter on the first input
- storage "4 to 7" contain values of up to four registers for the electricity meter on the second input
- storage "8 to 11" contain values of up to four registers for the electricity meter on the third input
- storage "12 to 15" contain values of up to four registers for the electricity meter on the fourth input
- storage "16 to 19" contain values of up to four registers for the electricity meter on the fifth input
- storage "20 to 23" contain values of up to four registers for the electricity meter on the sixth input

The range of parameters that can be set remotely via the reverse channel is gradually expanding. For more detailed information about the remote configuration system of the WB169-IR-B module using the reverse channel, contact the module manufacturer.

4 Operating Conditions

This part of the document provides basic recommendations for transport, storage, installation and operation of radio modules of type WB169-IR-B.

4.1 General Operational Risks

The WB169-IR-B radio modules are electronic devices powered by their own internal battery, which register the status of counters of connected consumption meters.

During operation of the device, the following risks are particularly present:

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-IR-B/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-IR-B module can be provided only by a person with necessary qualification in electrical engineering.

4.5 Environmental protection and recycling

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

4.6 Installation of Modules

The WB169-IR-B radio modules are enclosed in plastic boxes with IP65 or IP68 protection, prepared for wall or pipe mounting. The battery switch, configuration connector, antenna connector and terminal block for connecting optical heads are located on the printed circuit board, so access to them is only possible after opening the box.

Modules with additional silicone filling sealing (IP68 protection rating) have antennas connected during production and are supplied with power turned on. **We recommend opening these modules during operation only when absolutely necessary and proceeding with maximum caution**. We recommend performing installation, replacement, or configuration of these modules exclusively using the USB-IRDA optical converter as described in section 3.2 "Setting module parameters using the optical converter".

Figure 10 shows the WB169-IR-B module disassembled into individual components.

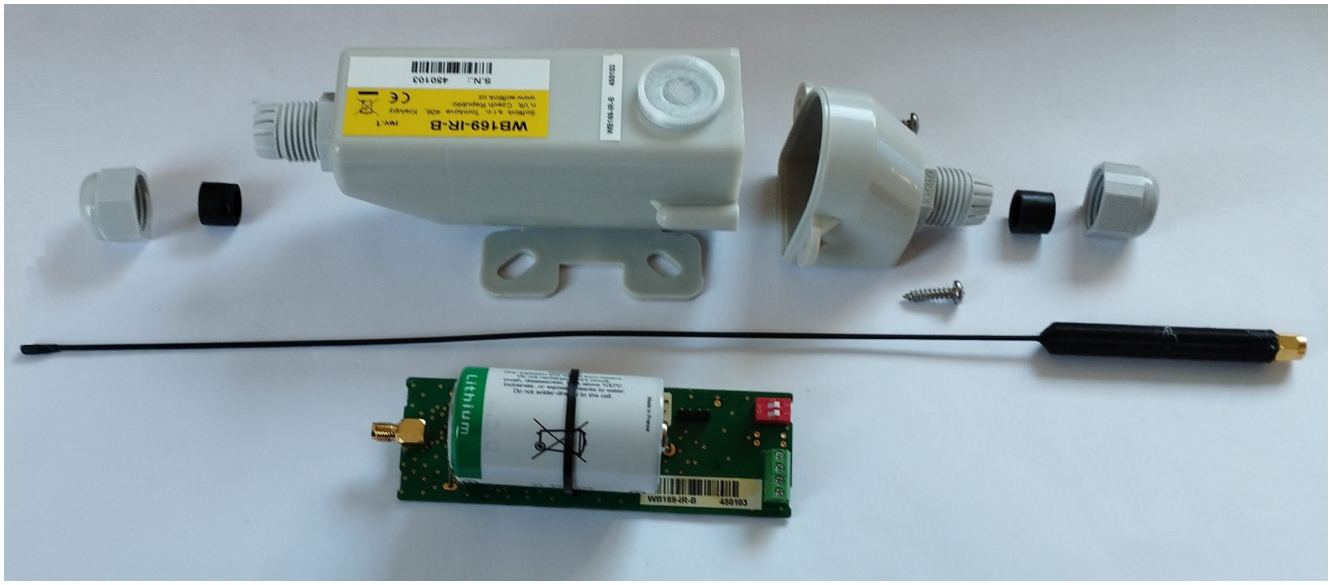


Figure 10: Assembly of the WB169-IR-B module with rod antenna

Figure 11 shows a detail of the module's printed circuit board with the location of the configuration connector (outlined in red), the 169 MHz radio antenna connector (marked in blue), the terminal block for connecting optical heads (marked in purple) and the battery switch (marked in yellow). The serial number on the module label must always correspond to the serial number on the auxiliary label stuck on the printed circuit board (data marked in orange). The bottom right inset shows a detail of the IR-15 optical head. The appearance of the printed circuit board may vary slightly depending on the modification of the module.

Figure 11: Detail of the printed circuit board of the WB169-IR-B module

Figure 12 shows a detail of connecting the IR-15 optical head to the module's terminal block.

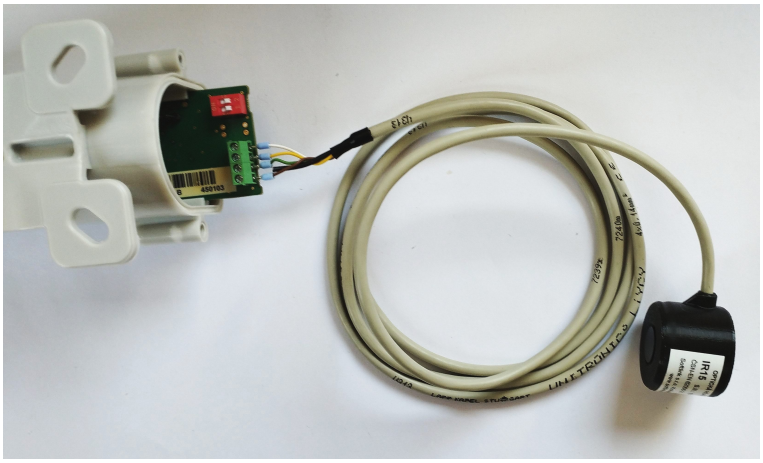


Figure 12: Connecting the optical head to the terminal block of the WB169-IR-B module

The box consists of two parts:

- module housing, into which the printed circuit board is inserted. On this part of the box is a label, a viewing window for magnetic attachment of the USB-IRDA/BT-IRDA converter, a cable gland, and moldings for mounting the module;
- box lid, closing the housing. There is a second cable gland on the lid.

Installation of the module, which is already assembled (including antenna and optical head, or bus), pre-configured and turned on, is performed as follows:

- attach the module to a suitable fixed object (on the wall, to a pipe...) using four screws, or using a cable tie. The moldings on the bottom side of the module housing are used for mounting. The recommended position for mounting is vertical, with the lid at the bottom;
- place the optical heads on the electricity meters according to the prepared wiring diagram. **The optical head must be placed on the electricity meter so that the cable to the optical head points straight down**;
- using the USB-IRDA/BT-IRDA converter and the mobile application "SOFTLINK Configurator", check the configuration of the module and use the "Read" button to read all connected electricity meters;
- check the tightening of the cap nuts on both cable glands;
- if the installation procedure or the customer's internal rules require sealing of the module (as protection against possible tampering), seal the module in the specified manner (for example, by sticking an adhesive seal across the joint between the two parts of the box).

Before installing a module that is not yet assembled, or is not turned on, or needs to be configured using a cable (*), we must first open the module, assemble it, turn it on and configure it. These operations are performed as follows:

- completely loosen the cap nuts of the cable glands at both ends of the module;
- unscrew the two screws on the sides of the box to release and remove the module lid;
- carefully slide the printed circuit board (PCB) out of the module housing. Either slide the board out completely (if it is necessary to screw on the 169 MHz antenna), or only partially so that the configuration connector gets outside the housing (see Figure 11). If the 169 MHz transmitter antenna is already mounted, help yourself by gently pushing the antenna into the module when sliding out the PCB;
- if the 169 MHz antenna was not mounted on the printed circuit board, screw it to the antenna connector at the end of the module;
- loosen the screws on the terminal block for connecting the optical head, thread the optical head cable through the grommet of the module lid and connect all four wires of the optical head cable to the corresponding terminals of the terminal block. The terminal description is on the top side of the box lid;
- if connecting more than one electricity meter to the module, we recommend connecting only one cable to the input terminal block, which we use to bring out the bus to a suitable space near the electricity meters (for example, to the distribution board with electricity meters). At the end of this cable, connect a more massive auxiliary distribution terminal block, suitable for connecting multiple cables. Connect the cables from the individual optical heads to the distribution terminal block in parallel (see Figure 13;

- by switching the red micro-switch ("jumper") located on the printed circuit board to the "ON" position, we connect power to the module;
- perform basic diagnostics of the module and possibly its configuration (parameter setting) using the cable according to the procedure described in section 3 "Module parameter configuration". If the module was pre-configured in the preparatory phase of installation, we recommend performing at least a test reading of all connected electricity meters using the "Read" button in the mobile application;
- insert the printed circuit board into the module housing. Insert the board so that the battery micro-switch is on the open side of the housing (i.e., on the side where the lid will be screwed on). The cap nut of the cable gland of the housing must be completely loosened so that the antenna (or antenna cable) can easily slide out through the gland from the housing. Push the board with finger pressure on the edge of the PCB (do not push on the terminal block or micro-switch) all the way to the stop. In the correct position, the printed circuit board should protrude from the edge of the box housing by only about 7 mm.
- check the integrity of the rubber seal on the edge of the housing and make sure that the cap nut on the lid is completely loosened and the cable to the optical head(s) moves freely through it;
- carefully slide the lid onto the box housing. The cable to the optical head(s) gradually slides out through the grommet of the lid. Attach the lid to the housing by screwing in and tightening both screws;
- tighten the cap nuts on both cable glands to seal both glands;
- if the installation procedure or the customer's internal rules require sealing of the module (as protection against possible tampering), seal the module in the specified manner (for example, by sticking an adhesive seal across the joint between the two parts of the box).

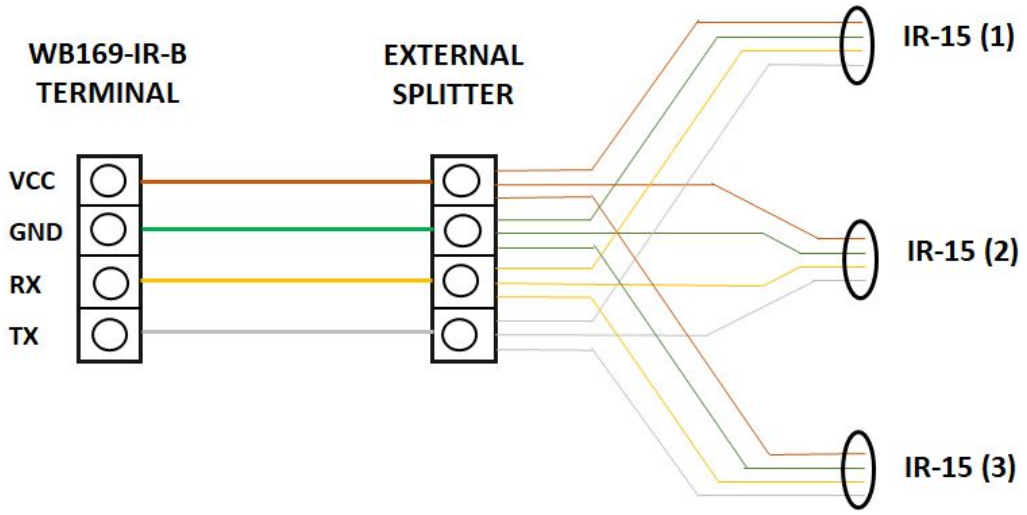


Figure 13: Connecting multiple optical heads using a distribution terminal block

(*) CAUTION! *For modules with additional sealing with silicone filling with IP68 moisture resistance rating, do not disassemble the new module during installation under any circumstances! The module configuration needs to be done using the USB-IRDA/BT-IRDA optical converter*

In general, the module has the declared degree of moisture resistance (IP65 or IP68) only if it is properly assembled and sealed. Waterproof modules with IP68 protection rating must be professionally sealed with silicone filling. When installing modules with IP65 moisture resistance rating, it is necessary to observe these principles:

- that the cable glands are properly sealed;
- that the joint between the two parts of the box is sealed with an undamaged rubber seal (supplied).

After installation, record the status of the read electricity meters in the installation protocol and possibly verify once again the functionality of the module and the correctness of the output values of the module (whether they correspond to the readings on the electricity meter counters), preferably by the "end-to-end" method, i.e., by checking the display of consumption data and operational parameters of the module directly in the remote reading system When selecting the installation location of the module, the type and location of the antenna, and the length of the antenna cable, it is necessary to consider both the protection of the module from possible mechanical damage (installation outside operationally exposed areas), but especially the conditions for radio signal propagation at the installation site. These conditions can either be determined (estimated) empirically, based on previous experience, or by measuring the signal strength using a control transmitter/receiver.

4.7 Replacement of the module and replacement of the read electricity meter

When replacing the module due to a module failure, or due to battery capacity depletion, proceed as follows:

- if the module was sealed, check if the seal is intact before dismantling the module. Handle seal damage according to the internal rules applicable to the given customer/project;
- loosen the mounting screws (or cable tie) that hold the module on the wall, pipe, or other surface and remove the module;
- if replacing the entire set (module with integrated 169 MHz antenna with already connected optical head, or multiple optical heads), just replace the module "piece-for-piece" and connect the optical heads of the new module to the individual electricity meters;
- visibly mark the original module as "defective", possibly fill out the appropriate form (installation sheet) or other prescribed documentation for module replacement;
- perform a functionality check on the new module according to the procedure described in section 4.6. Pay particular attention to correctly setting the configuration parameters, especially the transmission period and communication settings with electricity meters;
- write down the serial number and seal number of the new module and possibly also the status of the counters of the read electricity meters;
- if possible, immediately ensure that the new serial number is entered into the collection system database.

If not replacing the entire set (including antenna and optical heads), proceed with the replacement as follows:

- loosen the cap nut on the lid side;
- unscrew the two screws on the sides of the box to release the module lid and carefully slide the lid out of the module. The cable to the optical head(s) is pushed inside the lid;
- turn off the module by switching the micro-switch ("jumper") located on the printed circuit board to the "Off" position;
- disconnect the cable(s) to the optical head(s) from the module terminal block;
- if the module is equipped with an external 169 MHz antenna, loosen the cap nut on the module housing and carefully slide the printed circuit board out of the housing so that we have access to the antenna connector;
- disconnect the antenna cable from the antenna connector;
- reassemble the original module by screwing the lid to the housing (*). Visibly mark the module as "defective", possibly fill out the appropriate form (installation sheet) or other prescribed documentation for module replacement;
- attach a new module in place of the original one and proceed further according to the procedure described in section 4.6. Pay particular attention to correctly setting the configuration parameters, especially the transmission period and communication settings with electricity meters;
- write down the serial number and seal number of the new module and possibly also the status of the counters of the read electricity meters;
- if possible, immediately ensure that the new serial number is entered into the collection system database.
- before leaving the installation site, check once more that no optical head has been disconnected or its position changed during handling. All optical heads must be placed on the electricity meters so that the cable to the optical head points straight down.

(*) CAUTION! *When assembling the module, always make sure that the box housing is not mixed up, i.e., that we always put the box housing with the correct label on the module PCB. The serial number on the module housing must always correspond to the serial number on the auxiliary label that is stuck on the printed circuit board.*

When replacing an electricity meter read by the WB169-IR-B module, where the reason for replacement is a meter failure, expired verification period, or other reason on the meter side, proceed as follows:

- if possible, do not open the module, use the USB-IRDA/BT-IRDA converter and mobile application to overwrite the "OPTO address" identifier of the original electricity meter with the identifier of the new electricity meter and set the reading repeat period;
- use the "Read" button in the mobile application to check if the new electricity meter responds to queries and if the read values match the data on the display or counters of the electricity meter;

- if wireless configuration is not possible, check if the adhesive seal is intact and open the module according to the procedure described in section 4.6;
- connect to the module using the configuration cable and use the command "oid [index] [value]" to set the identifier of the new electricity meter by overwriting the original value (see paragraph 3.1.4 "Commands for setting communication with electricity meters".
- use the command "iread [index]" (see paragraph 3.1.4 to check if the new electricity meter responds to queries and if the read values match the data on the display or counters of the electricity meter;
- complete the prescribed documentation for meter replacement (installation sheet), especially carefully write down the status of the counters of the new meter;
- cover and seal the module according to the procedure described in section 4.6, or wait for the first reading to be performed;
- If possible, immediately ensure the replacement of the electricity meter identification data in the collection system.

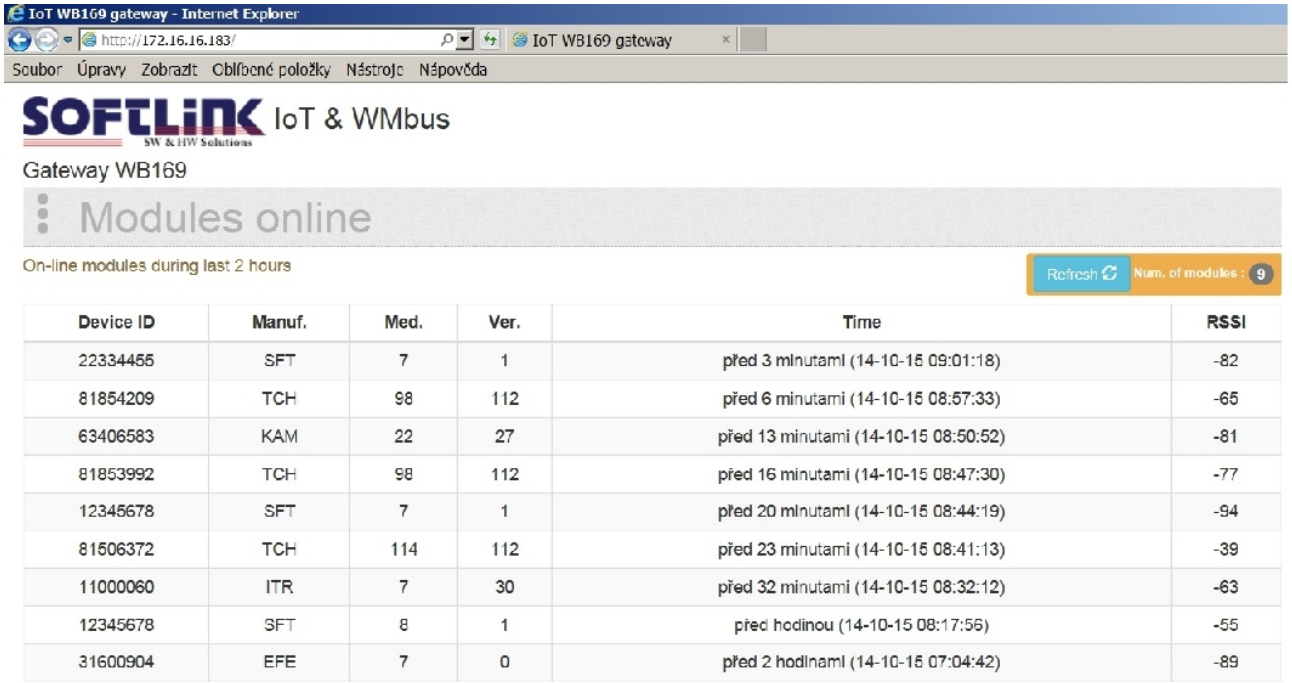
4.8 Dismantling the module

When dismantling, remove the module from the wall (pipe, other surface..), open it, turn off the battery and possibly disconnect the antenna cable. Reassemble the module by putting the lid on the housing, properly mark it as dismantled and fill out the appropriate documentation prescribed for this case by internal regulations. If possible, immediately ensure deactivation of the module in the collection system.

4.9 Checking Module Functionality

After putting the module into operation (or after each repair and replacement of the module) we recommend checking the functionality of its transmission using a "Master" receiving device, control receiver, signal analyzer, or other suitable device.

If the module is connected to a remote collection system via the WB169-RFE communication gateway, we can **check the transmission functionality in "Radar" mode**. This check is performed using a web browser, which we use to log in to the IP address of the WB169-RFE communication gateway and view the table of records of received messages from surrounding modules, where we verify the presence of records from the installed WB169-IR-B module. To display the "Radar" table, we open any web browser, enter the gateway's IP address in the form "**http://ip_address/**" in the URL address field and start the search. If there is IP connectivity between the computer and the communication gateway, the "Radar" web page of the given gateway will be displayed (see Fig. 14), showing records of the last messages from all devices that transmit in the gateway's radio reception area with the corresponding frequency and 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 14: Example of displaying the "Radar" table of the WB169-RFE gateway

The record of each device is displayed in one row, showing the following data:

- device identification data
- time of reception of the last message from the device
- indication of the strength of the radio signal with which the message was received (RSSI = Received Signal Strength Indicator)

If we display the "Radar" table after a sufficiently long time from putting the WB169-IR-B module into operation (or from its restart), records of messages from meters and sensors connected to the installed module should appear in the "Radar" table, including an evaluation of the quality of the received signal. The "Radar" table only displays records captured by the communication gateway in the last 2 hours.

We check communication with electricity meters using the "iread" and "send" commands via the configuration cable, or via the mobile application using the "Test transmission" and "Read" buttons.

4.10 Operating the WB169-IR-B Module

Remote reading of electricity meter status and sending radio messages with readings is performed by the WB169-IR-B module completely automatically. Given that the transmission system according to the Wireless M-Bus standard does not contain any protection against mutual interference during transmission (signal collision, which occurs when two modules transmit simultaneously), temporary data outages from some modules may commonly occur when operating a large number of reading modules in one radio network. These outages can last several hours to days.

The greatest risks of permanent transmission failure of the radio module are associated with the activities of the facility user. These are mainly the following risks:

- risk of temporary or permanent shading of the antenna (for example, due to building modifications);
- risk of damage to the module, antenna cable or antenna when handling objects at the installation site.

To eliminate these risks, we recommend paying great attention to selecting the installation location of the module and selecting the type and location of the antenna installation so that a suitable compromise is found between the quality of the radio connection between the module and the communication gateway and the degree of risk of mechanical damage to the module, the cable between the module and the electricity meter, the antenna cable, or the antenna. The installation itself needs to be done carefully, using quality cables and mounting elements.

We also recommend regularly monitoring the functionality of electricity meter readings, processor temperature values and battery voltage values. This data allows preventive measures to be taken in case any of the operating parameters are outside the recommended limits. If any discrepancy is detected, we recommend contacting the user of the installation facility and determining the cause of the anomaly, or performing a physical check at the installation site.

5 Troubleshooting

5.1 Possible causes of system failures

During operation of the WB169-IR-B device, failures, functionality outages, or other operational problems may occur, which can be divided into the following categories according to their cause:

5.1.1 Power 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

Transmitter functionality is indicated by the flashing of the yellow "TXA" LED on the printed circuit board. Data packet transmission is manifested by a brief flash of this LED, which can be observed after removing the module cover.

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 Communication failures with electricity meters

Failures in the functionality of communication with electricity meters via optical heads generally manifest as missing readings from some electricity meters in the incoming data. In this case, we proceed to determine the probable cause of the failure as follows:

- Visually check the condition of the connected electricity meter, optical head, and cable between the electricity meter and optical head. **The optical head must be attached to the electricity meter so that the cable to the optical head points straight down**;
- If messages from some electricity meter are not coming at all, check if the identifier of the given electricity meter is correctly entered into the module configuration (see paragraph 3.1.4 "Commands for setting communication with electricity meters");
- Check the loading of messages from electricity meters using the "iread" command (see paragraph 3.1.4 "Commands for setting communication with electricity meters");
- If there are doubts about the functionality of the WB169-IR-B module or optical head, try reception using a spare device. If the module is faulty, replace it according to paragraph 4.7. Replace the optical head by simple "piece for piece" exchange.

5.2 Procedure for determining the cause of failure

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

1. If data is not being loaded from any electricity meter connected to the WB169-IR-B module, we recommend checking the functionality of individual module subsystems in this order:
   - check the correctness of the module settings in the remote reading system database;
   - check the functionality of the power supply according to paragraph 5.1.1 "Power supply failures";
   - check the system functionality according to paragraph 5.1.2 "System failures";
   - check the functionality of data transmission and reception according to paragraph 5.1.3 "Transmitter and receiver failures";
   - check the functionality of correct reception of radio messages from electricity meters according to paragraph 5.1.4 "Communication failures with electricity meters".
2. If data is not being loaded only from some read electricity meter, we recommend checking the functionality of individual module subsystems in this order:
   - check the correct attachment of the optical head. The cable to the optical head should point straight down;
   - check the functionality of the electricity meter itself;
   - check the correctness of setting the identifier of the given electricity meter in the module configuration and consistency with the electricity meter identification setting in the collection system;
   - check the functionality of communication with the electricity meter according to paragraph 5.1.4 "Communication failures with electricity meters".
3. Data from some connected electricity meter is incorrect. In this case, we recommend checking the functionality of the given electricity meter and the correctness of setting the read registers of the electricity meter (see paragraph 3.1.4 "Commands for setting communication with electricity meters").
4. Data from the module comes irregularly, with periodic outages. In this case, we recommend checking the functionality of individual module subsystems in this order:
   - check the functionality of data transmission and reception according to paragraph 5.1.3 "Transmitter and receiver failures";
   - check the functionality of the power supply according to paragraph 5.1.1 "Power supply failures".

WARNING: The WB169-IR-B module is a reliable device of relatively simple and durable construction, so there is a high probability that any possible failure is caused by external circumstances of installation, especially mechanical damage, moisture ingress, battery discharge, or radio interference at the installation site. With each module replacement due to failure, we recommend verifying, if possible, whether the cause of the failure was not one of these circumstances and possibly taking measures to eliminate it.

6 Additional information

This manual is focused on description, parameters and configuration options of radio modules WB169-IR-B, 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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