WIRELESS COMMUNICATION SYSTEM
NB-IoT

NB-K430

Revision 2.0

SOFTLINK s.r.o., Tomkova 409, 278 01 Kralupy nad Vltavou, Czech Republic
Phone.: +420 315707111, e-mail: sales@softlink.cz, www.softlink.cz

Contents

List of Tables

List of Figures

1 Introduction

This document describes features, parameters and setting possibilities of the NB-K430 module, which is used either for remote reading of iPERL series watermeters by Sensus equipped with 433 MHz data transmitter, or other watermeters (*) of the "smart" category, equipped with the 433 MHz transmitter working in Wireless M-Bus format. The module receives messages from watermeters and broadcasts the read data to the superior Automatic Meter Reading (AMR) system by using of NB-IoT services of the GSM operator.

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

1.1 NB-IoT mobile data services

Mobile data services NB-IoT are global data services provided by some operators of GSM services. The services are focused on the communication with a huge quantity of devices, that transfer only an extremely limited volume of data. Networks with such purpose and features are commonly labeled as „Internet of Things", or by its acronym "IoT". NB-IoT ("Narrow Band Internet of Things") is an open standard developed by 3GPP organization (3rd Generation Partnership Project) which is concerned with standardization in the GSM network development. NB-IoT is a cellular technology based on the LTE, that was developed specially for wireless communication with terminals of IoT category, that produces only limited volume of data, but they are miniature, inexpensive, with a very low energy consumption and they are commonly installed in the places with high demands on the signal coverage. Typical example of such device is a reading module of the water/gas/electro-meter installed in the basement without electricity, that should be able to run reliably many years on the internal battery even in weak signal conditions, where other services fail.

NB-IoT technology maximally utilizes technological infrastructure of LTE data services in licensed radio band. Combination of narrow frequency band and the most advanced modulation techniques enable increasing of receiver sensibility to the -135 dBm level, so that an existing infrastructure of mobile operator provides global coverage with high signal penetration even in build-up urban areas. Thus, the service is available in the places, where IoT category devices are typically installed - in shafts, distribution boards and cellars.

Terminal devices are identified in the network by standard SIM of GSM operator. Global system of SIM evidence and single communication standard enable providing of international services (roaming). Bi-directional communication is carried by standard Internet protocol with UDP transport layer. Messages are transferred from the GSM operator network to the IoT-terminal operator through the designated data gateway (Access Point - AP) either to public Internet, or to operator's private IP network (i.e. same way as any similar mobile data services). Addressing and routing details depend on the network configuration and policy of particular GSM operator. Typical example of addressing and routing is a solution, when the GSM network automatically assigns private IP addresses to IoT terminals, IP-packets with messages are routed through the private IP network to a single Access Point, where they are re-addressed and resend through a single pre-arranged public IP-address to the public Internet. The IoT terminal assigns packets by target server public IP-address, that is preset in its configuration. Target system can identify original source of the message by using of device unique identifier (IMEI), which is a requisite part of the message content.

1.2 Module usage

The NB-K430 module can be used as local **communication gateway** for remote reading of Sensus iPERL-series watermeters, or other "smart" watermeters with integrated Wireless M-Bus transmitters in the 433 MHz band. The module receives regular radio messages with readings from watermeters in its radio-reach and stores the readings to its memory. In pre-defined intervals the module broadcasts aggregate of received data to the superior remote reading system (AMR) in form of radio-messages of NB-IoT service ("INFO" messages).

The NB-K430 module can by used for remote reading **up to 20 watermeters** placed in its radio-reach (that is up to hundreds meters). Each watermeter transmits the messages with a short, fixed period (e.g. iPERL every 15 seconds). The module receives data from watermeters in regular "receiving windows", that are opened with preset "reading period" (e.g. every 120 minutes). Received data from each receiving window are stored into the module memory. With pre-defined broadcasting period (e.g. 8 hours) the module broadcasts one NB-IoT message with aggregate data from all receiving windows to the superior server. This way of communication is a highly effective, as it is optimized from energy consumption point of view, as well as from point of view of NB-IoT services expenses.

The module can also work in **on-line mode**, when the data are broadcasted immediately after each receiving window. This mode is suitable in situations, when a minimum information delay is required, or when the number

of meters read is so high that the amount of measured data fills the entire NB-IoT data packet anyway and it has no practical sense to aggregate the data.

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

Content of INFO-messages is configurable. The messages contain identification and current statuses of module parameters (uptime, battery voltage, processor temperature..), list of read watermeters, timestamps of reading periods, and counter values of all watermeters in each reading period (including alarm flags). As **up to 110 readings** can be transmitted within one communication session, one message can contain results from up to 5 measurement intervals even in case of reading maximum number of 20 water meters.

The messages with aggregate data are handed over to the application server with using of NB-IoT service of GSM provider. The data are transferred in form of standard IP/UDP packets, that are routed to the server of remote reading application operator through the designated Access Point of GSM provider. Application server receives the messages and performs their decoding, storing and further processing.

The NB-K430 module supports **bi-directional communication** and it is able to receive through the network messages of "SET" type, generated by remote computer. These messages can be used for setting of module parameters from the remote server.

1.3 Hardware features and power supplying

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

The module is power supplied by internal battery with up to 6 years lifetime for measurement frequency of 2 hours and broadcasting interval of 8 hours. One message can contain up to 110 readings. Battery lifetime can be negatively influenced by shorter broadcasting period, or by storing and operation in sites with the temperatures exceeding the recommended range.

The module is equipped with a SIM-holder for "Micro-SIM" (3FF) format of SIM-card (15 x 12 x 0,76 mm). SIM-holder is placed inside the module on the PCB. The module can be ordered with embedded SIM (chip-SIM) of chosen GSM operator.

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

External appearance of the NB-K430 module is shown in the figure 1.

Figure 1: View of the NB-K430 module

2 Technical parameters overview

Overview of NB-K430 module technical parameters is shown in the Table1 below.

Table 1: Overview of NB-K430 module technical parameters

RF subsystem parameters		
Frequency band 800 MHz (RX/TX)	791-821 / 832-862	MHz
Frequency band 850 MHz (RX/TX)	869-894 / 824-849	MHz
Frequency band 900 MHz (RX/TX)	925-960 / 880-915	MHz
Modulation	GMSK, 8PSK	(adaptive)
Bandwidth	180	KHz
Transmitting power	200	mW
Receiver sensitivity	135	dBm
Communication protocol	NB IoT	(bi-directional)
Transmission speed	0,35 ÷ 240	Kbps (adaptive)
Antenna characteristic impedance	50	Ω
Antenna connector	SMA female	
Parameters of 433 MHz transceiver		
Carrier frequency	433	MHz
Antenna connector	SMA female	
Supported communication protocols	Sensus iPERL, Wireless M-Bus	
Max. number of read watermeters	20	
Configuration interface RS232		
Transmission speed	9600	Baud
Operation mode	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, none parity	
Signal level	TTL/CMOS	
Optical configuration interface		
Transmission speed	115 200	Baud
Optical wavelength	870	nm
Optical interface specification	IrPHY 1.4 standard	
Power supplying		
Lithium battery voltage	3,6	V
Lithium battery capacity	17	Ah
Weight and dimensions		
Length (w/o antennas)	200	mm
Width	70	mm
Height	60	mm
Weight	cca 250	g
SIM-card format	(15x12x0,76)mm)	„Micro-SIM”
Storage and installation conditions		
Installation environment (by ČSN 33 2000-3)	normal AA6, AB4, A4	
Operation temperature range	(-20 ÷ 40)	°C
Storage temperature range	(0 ÷ 40)	°C
Relative humidity *	95	% (w/o condensation)
Degree of protection *	IP65 or IP68	

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

3 Configuration of the NB-K430 module

Configuration parameters of the NB-K430 module can be displayed and changed from the common computer (PC) by one of these methods:

- with using of **„USB-CMOS"** converter and configuration cable connected to the module;
- wirelessly, with using of **„USB-IRDA"** or **„BT-IRDA"** converter;
- **remotely**, by using of bi-directional communication system.

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

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

The description and meaning of all configuration parameters that can be checked and changed by cable can be found in the section 3.1 „Setting of NB-K430 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 **NB-IoT back channel** can be found in paragraph i 3.3 „Remote setting of module parameters through the NB IoT back channel".

3.1 Setting of NB-K430 module parameters by configuration cable

In following part of the document there is a description of these parameters of the NB-K430 module, that can be displayed and examined from PC connected to the module by configuration cable. Some of the parameters can be changed by configuration commands entered „from the console".

3.1.1 List of NB-K430 module configuration parameters and commands

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

```
mon#show
----- Configuration -----
 Timezone : 1
 Server IP : '172.168.0.20'
Ping IP : '10.0.0.1'
 Server port : 4242
 My src port : 2000
 Reply to server : no
 APN : ''
 Max session time 172800 sec - 2d, 0:00:00
 Send periode : 240
 Hist. periode : 60 min.
   each meter 4 records, max. is 120 recs
Send mask is 3 : SID, Alarm
Next send : 239 min.
Data will be unencrypted
 Sensus meters :
  ID[0] : 130551475
  ID[1] : 130551473
  ID[2] : 130551474
  ID[3] : 130551476
  ID[4] : 130551477

-- 433Mhz modem --
  No. sent : 0 msg(s)
  No. recv : 2 msg(s)
  No. recv error : 0 msg(s)
  Receive window : 40 sec.
-- Narrow band modem --
Next send : 239 min.
  No. sent : 3 msg(s)
  No. recv : 0 msg(s)
Modem state : 4 - ready
Session count : 1
Session timeout : 172664 sec - 1d, 23:57:44
Modem IMEI : 867724031580613
  SIM CCID : 898823900000036330010
  SIM IMSI : 901288001028645
 Last RSSI : -79 dBm
 Conf. version : 19
 SW version 1.01, date Apr  1 2020
mon#
```

Overview of configuration parameters with short description of their meaning can be also found in table 2 on the page 24. The meaning of individual parameters and detailed description of their usage can be found below.

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

```
mon#?
 --- System commands ---
deb               : Show or set debug level
ta                : Show tasks
mb                : Show mail boxes
du addr           : Dump memory
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,..]
show              : Show info
write             : Write configuration to flash
cread             : Read configuration from flash
clear             : Clear configuration and load defaults
 ---  433 commands --- ---
power             : Show or set 433 power (1 - 5)
mread             : Modem properties read, params : group, index, count
mset              : Modem properties set, params : group, index, data
mr                : Modem receive mode 0 - off, 1 - on
mm                : send test msg
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
mode              : Set/Get recv. protocol : 0 - iPerl, 1 - WMBUS
recvwin           : Set receive window in sec.
recvsec           : Modem receive on sec
radar             : show radar
clradar           : clear radar
hdata             : show history data
sicap             : Set or get xtal capacity correction
sixtal            : Set or get xtal frequency
cfreq             : Set xtal from analyzer
 --- Narrow band ---
server            : Server IP address
sport             : Server UDP port
testip            : Ping IP address
sreply            : Send reply to server
apn               : Access Point Name
sess              : Set max session time in minutes
band              : Set NB band, default 20 - Europe
tshort            : Set modem short timeout
tlong             : Set modem long timeout
tconn             : Set modem connection timeout
sping             : Send ping
at                : modem command
 --- Sensus ---
skey              : Set decrypt key Sensus
sid [index] [value] : Set Sensus meter ID
 --- W-MBUS ---
wkey              : Set decrypt W*-MUBS key
sid [index] [value] : Set WMBUS meter ID
dib1 [index] [value] : Set WMBUS DIF/VIF 1, 00 00 - water in m3
dib2 [index] [value] : Set WMBUS DIF/VIF 2, 00 00 - disabled
diba [index] [value] : Set WMBUS DIF/VIF for alarm flags
alrb [index] [type] [value] : Set WMBUS alarm flags bits
wtab              : Show know vif dif table
...
```

```
...
 --- Utils ---
tz               : Time offset in hours
ppm              : Set RTC 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
uptime           : Show uptime
sens             : Show sensors
sendp            : Send x NB messages
send             : Send NB message
smask            : Send mask bits, 0 - SID, 1 - Alarm, 2 - RSSI ,default 7 - all
periode          : Change periode of send  0 - disable, >0 periode in minutes
hist             : History periode 0 - disable, >0 periode in minutes
ekey             : Set encrypt key NEP, point '.' no encrypt
info             : Show or set manuf. info string (0-30 chars)
reset            : Reset device
?                : Show this help
mon#
```

3.1.2 „System commands" group for general diagnostics

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

3.1.3 „Configuration" group of commands for writing of configuration

The module contains two sets of configuration: operating configuration and saved configuration. At the start of the system the module copies saved configuration to operating configuration, with which continues to work. If the user changes configuration parameters, it does so only in operating configuration.

If the current operating configuration was not stored to FLASH memory, the module returns to the saved configuration after reset. If the parameter should be changed only temporarily (for example shorten of the broadcasting period during installation), it is not necessary to save operating configuration into FLASH memory (after finishing a work the module can be returned to normal configuration by its reset). If the parameter should be changed permanently, there is necessary to save configuration to FLASH memory.

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

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

Current operating configuration can be displayed by using of **"show"** command (see paragraph 3.1.1):

```
cfg#show
```

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

```
cfg#write
Writing config ...  OK, version 13
mon#
```

Reading of the configuration from FLASH memory can be done by using of **"cread"** command:

```
cfg#cread
Reading config ...  OK, version 13
mon#
```

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

```
cfg#clear
Clearing config ...  OK, version 13
mon#
```

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

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

3.1.4 Commands for setting of communication with the NB-IoT network

This group of commands enables setting of subsystem for communication with the NB-IoT network. There are following commands:

server	*setting of target server IP-address*
sport	*setting of target server port number*
testip	*setting of IP-address for ICMP "ping" test*
sreply	*redirection of replies to target server*
apn	*setting of private network Access Point Name (APN)*
sess	*maximum session time*
band	*setting of NB-IoT frequency band (default "20" = Europe)*
tshort	*timeout for NB-IoT modem responses (short)*
tlong	*timeout for NB-IoT modem responses (long)*
tconn	*timeout for setup of connection to the superior NB-IoT server*
sping	*send ICMP "ping" to the requested address*
at	*send command to the NB-IoT modem (according to the modem documentation)*

The module broadcasts messages wrapped into UDP packets of Internet Protocol to the pre-configured **target server**, where the remote reading application is running. Following commands are intended for setting of **target server IP-address and target application port number** and for setting of the **name of communication gateway** between the GSM operator network and Internet (so called "APN" = Access Point Name).

IP-address of target server can be pre-configured by using of **"server"** command. The address can be entered in commonly used decimal format.

Example of setting of the target server IP address to "92.89.162.105" value and follow-up checking of the setting:

```
cfg#server 92.89.162.105
Server changed from '0.0.0.0' to '92.89.162.105'
cfg#
cfg#server
Server is : '92.89.162.105'
cfg#
```

Number of UDP port can be pre-configured by using of **"sport"** command. The UDP port number should correspond with the remote reading application port number. Example of setting of UDP port number to value "2000" and follow-up checking of the setting:

```
cfg#sport 2000
UDP port changed from 0 to 2000
cfg#sport
UDP port : 2000
cfg#
```

By using of **"testip"** command the **IP address for ICMP ping test**. The address is entered in decimal format in the usual way. The ping query is sent at the end of the maximum connection timeout (see the previous parameter "sess") and it is addressed to the "testip" address, that should be an address of a suitable computer within the accessible IP network (any computer that reliably responds to ping query). If there is a response to the ping query, the connection to the NB-IoT network is verified and it is not necessary to re-establish it.

Example of setting the IP address of the computer for testing by "ping" test to the "10.0.0.1" value:

```
mon#testip 10.0.0.1
Test ip changed from '10.0.0.8' to '10.0.0.1'
mon#
```

The accessibility of selected computer for the "ping" test can be verified by using of the **"sping [address]"** command. By entering this command, the system sends a control ping and displays the result.

The **"sreply"** command can be used for specification of **reverse channel communication** settings (see paragraph 3.3 „Setting of module parameters from remote computer by using of reverse channel"). In some NB-IoT networks/services there is possible to send reverse channel messages only from different IP address, than preset standard IP address of target server used for sending of INFO messages. If the setting is "Reply to server : no", the module reply to reverse channel requests regularly - that means send answers to the address from which the request came. If the setting is "Reply to server : yes", the module always replies to the preset IP address of target server (see "server" command setting). For setting "yes" use "1" parameter, for setting "no" use "0" parameter of the command.

Example of setting reverse channel communication and follow-up checking of the setting:

```
cfg#sreply
Reply to server : no
cfg#sreply 1
Reply to server : yes
cfg#
```

If the GSM operator providing NB-IOT services transfers data from the modules to the IoT service provider through the virtual network, the **name of the communication gateway** between GSM and Internet (Access Point Name - APN) should be entered to the module configuration by using of **"apn"** command. APN is assigned by GSM operator. Setting of APN can be deleted by entering of "." value (dot).

Example of setting of APN-name to "cms.softlink" value:

```
cfg#apn cms.softlink
APN changed from '' to 'cms.softlink'
cfg#apn
APN is : 'cms.softlink'
cfg#
```

Current setting of target server and communication gateway displays in the configuration summary as follows:

```
 Server IP : '92.89.162.105'
 Server port : 2000
 My src port : 2000
 APN :  'cms.softlink'
```

The "My src port" value is a number of module UDP port. This value is read only and cannot be changed.

By using of **"sess"** command the **maximum session time** with GSM network server can be set. The timeout should be set in minutes. As some operators charge each creating of session, setting of session before each transmitting of message could significantly increase service expenses (and it also increases broadcasting time). On the other hand, if the network server interrupts (loses) session, the module is not notified about it and all broadcasted messages after that moment are lost. By setting of "sess" parameter the session time is limited and after that limit the module closes pending session and sets up new one with broadcasting of next message. Factory setting of this parameter is **two days** (172800 seconds, 2880 minutes), what is reasonable compromise between expenses and reliability of message delivery. If GS operator does not charge each session, the parameter can be set to lower value (even to zero, when the session is set-up before each broadcasting), but it is recommended to keep factory setting always in this situation because creating of session increases broadcasting time.

Current setting of maximum session time appears in the in the configuration summary as follows:

```
Max session time 172800 sec - 2d, 0:00:00
```

Example of setting of maximum session time to 2880 minutes:

```
cfg#sess 2880
Max session time : 2880 min.
cfg#
```

By using of **"tconn"** command the **connection setup timeout** can be set. If the GSM network server does not react on the module's session setup request, the GSM sub-module is switched to idle mode and next attempt of session setup is performed before next broadcasting. Factory setting of this parameter is **5 minutes** (300 seconds). It is recommended to change this parameter only if the GSM operator guarantees significantly different response of its network.

Example of changing of connection setup timeout from 200 to 300 seconds (5 minutes):

```
mon#tconn
Connection timeout is 200 sec
mon#tconn 300
Connection timeout is 300 sec
cfg#
```

Both above described parameters ("sess" and "tconn") have significant influence on the energy consumption and ***battery lifetime****. If, as an example, the module sets up connection before each broadcasting, it increases broadcasting period when the GSM sub-module is in active mode and consumes lots of energy. If the connection setup timeout is too long, the internal modem is pointlessly active during waiting for connection setup. From this point of view the best solution is setting of long "sess" time and short "tconn" time. But such setting could* ***decrease the reliability of message delivery****, because in case of session interruption on the network side all the messages are lost until expiration of "sess" timeout, and too short "tconn" timeout can cause that the module did not manage to setup session and the message is not transmitted. Setting of both parameters should be reasonable compromise between energy consumption and reliability of message delivery.*

The **"band"** command can be used for setting of the **NB-IoT frequency band** of the modem. Default setting is "20", what means "B20" (the most frequently used frequency band in Europe). The embedded modem can support multiple frequency bands, in which case it is possible to switch the module to another frequency band. But the different production series of the NB-K430 module use different embedded modem modifications (depending on the current availability and price). **In case of possible usage of the module for other frequency band than B20 (300 MHz), it is necessary to contact manufacturer before ordering**.

The **"tshort"** and **"tlong"** commands are intended for setting of timeouts for the embedded modem response for processor commands. These parameters are used to adapt the communication interface between the module processor and the modem for an individual modification of the NB-IoT embedded modem. The "tshort" command sets the timeout for commands related to the modem itself, the "tlong" command sets the timeout for commands related to the network. Both commands are intended only **for initial setup of the module in the production process**.

By using the **"at"** command any AT-command for the modem (according to the modem documentation) can be manually entered. The command is intended **only for diagnostic purposes**.

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

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

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

The first part of commands can be used for setting of 433 MHz modem during initial activation, factory setting and diagnostics. There are following commands:

power	*setting of 433 MHz modem transmitting power (factory setting)*
mread	*reading of 433 MHz modem parameters (factory setting)*
mset	*writing of 433 MHz modem parameters (factory setting)*
mm	*broadcasting of test message by 433 MHz modem (factory setting)*
mt test time	*activation of 433 MHz modem testing transmission (factory setting)*
ms	*internal status of 433 MHz modem (diagnostics)*
mi	*dump of 433 MHz modem internal registers (diagnostics)*
sixtal	*433 MHz modem frequency constant setting (factory setting)*
sicap	*433 MHz modem crystal correction (factory setting)*
cfreq	*433 MHz modem frequency constant correction (factory setting)*

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

Next group of commands is used for setting and checking of communication with watermeters. These commands are common for receiving both types of messages. There are following commands:

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

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

Example of opening and closing of receive mode:

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

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

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

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

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

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

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

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

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

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

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

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

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

```
cfg#radar
Show radar :
 id 76738789, rssi -69, time 2021-01-01, 5:22:03+01
 id 28282831, rssi -98, time 2021-01-01, 5:21:53+01
 id 28283277, rssi -106, time 2021-01-01, 5:21:52+01
 id 28300055, rssi -92, time 2021-01-01, 5:21:52+01
 id 63871815, rssi -69, time 2021-01-01, 5:21:51+01
 id 28300060, rssi -110, time 2021-01-01, 5:21:51+01
mon#
```

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

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

```
mon#clradar
Cleared 25 rec(s)
mon#
```

In the "history" mode the module receives readings from watermeters with higher frequency than the data are broadcasted (see the description of the "hist" command in paragraph **??** "Commands of the "Utils "group for setting and checking the basic functions of the module"). Reading records are stored to the "history" table that is emptied after broadcasting. Current records in "history" table can be browsed by using of **"hdata"** command. Example:

```
cfg#hdata
Show history data :
 ID[3] 130551476, val 226, alarm 0x00, rssi -73, time 2019-01-01, 0:10:00+01
 ID[1] 130551473, val 3369, alarm 0x00, rssi -71, time 2019-01-01, 0:10:00+01
 ID[2] 130551474, val 10, alarm 0x00, rssi -81, time 2019-01-01, 0:10:00+01
 ID[0] 130551475, val 0, alarm 0x00, rssi -67, time 2019-01-01, 0:10:00+01
 ID[4] 130551477, val 887, alarm 0x00, rssi -55, time 2019-01-01, 0:10:00+01
 ID[3] 130551476, val 229, alarm 0x00, rssi -67, time 2019-01-01, 0:20:00+01
 ID[1] 130551473, val 3370, alarm 0x00, rssi -72, time 2019-01-01, 0:20:00+01
  . . .
```

It is evident from the dump, that there were two reading periods since last broadcasting (at "0:10:00" and at "0:20:00") and five watermeters were read in each period. Each record contains meter ID, read value (val), read alarm code (alarm), radio-signal strength (rssi) and timestamp of reading (time).

3.1.6 Commands for setting of watermeter reading

The „Sensus" and „W-MBUS" group of commands are intended for setting of decoding received messages from watermeters.

„Sensus" group of commands serves for reading of data in **"iPERL" mode** from Sensus iPERL watermeters. There are following commands:

skey	*setting of encryption key for decrypting of watermeter messages*
sid [index] [value]	*setting of watermeter IDs for reading (reading list)*

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

The **"Set Meter ID"** variable serves for setting of list of watermeters, that is intended to be read by the NB-K430 module. Each record to the list could be created by using of **"sid [index] [value]"** command, where meter ID (serial number) is linked with meter index (0 - 19).

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

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

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

```
cfg#sid
Sensus
 ID[0] 76738781
 ID[1] 76738783
 ID[2] 76738791
 ID[3] 76738796
 ID[4] 0
 . . .
 ID[18] 0
 ID[19] 0
mon#
```

The table allows entering up to 20 watermeters. The ID value is used to determine the "storage number" in the outgoing message, where there are two storages reserved for each ID value (... for ID "0" there are "0" and "1" storages, for ID "1" there are "2" and "3" storages, etc.). The meter is removed from the list by entering the value" 0 "for the given index.

The „W-MBUS" group contains commands intended for decoding data from watermeters in **"WMBUS" mode** (for devices transmitting in Wireless M-Bus format). There are following commands:

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

The command **"WMBUS encryption key"** is used for setting of the encryption key for decryption of messages from individual watermeter (if its messages are encrypted). The AES-128 encryption key of 16 bytes length is entered by using of **"skey"** command, followed by the string of 16 bytes that can be entered in a decimal or hexadecimal format same way as encryption key for NB-IoT communication (see using of "ekey" command in paragraph 3.1.4 below).

The **"Set Meter ID"** variable serves for setting of list of watermeters, that is intended to be read by the NB-K430 module. Each record to the list could be created by using of **"sid [index] [value]"** command, where meter ID (serial number) is linked with meter index (0 - 9). Example of command for entering of watermeter with "76738781" serial number into the list of read meters under index "0":

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

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

```
cfg#sid
WMBUS
 ID[0] 22178514
 ID[1] 22178511
 ID[2] 22178586
 ID[3] 22178520
 ID[4] 0
 . . .
 ID[18] 0
 ID[19] 0
mon#
```

The table allows entering up to 20 watermeters. The ID value is used to determine the "storage number" in the outgoing message, where there are two storages reserved for each ID value (... for ID "0" there are "0" and "1" storages, for ID "1" there are "2" and "3" storages, etc.). The meter is removed from the list by entering the value" 0 "for the given index.

The NB-K430module can read from each read device (typically a watermeter) **one or two standard variables**, which it transmits in messages to the superior system, and one **status variable**, which it does not transfer to the superior system, but it can be used as a basis for generating an alarm.

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

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

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

The universal "water" filter is set as follows:

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

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

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

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

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

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

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

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

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

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

The module can generate the following types of alarms:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

tz	*setting of time zone (UTC + n)*
ppm	*correction of RTC generator during factory setting*
time	*real time (RTC) displaying/setting (hh:mm:ss)*
date	*real time (RTC) displaying/setting (RR.MM.DD)*
uptime	*show system uptime from last reset*
sens	*show current values of internal sensors (temperature, voltage..)*
send	*immediate sending of NB-IOT message with current values*
sendp	*immediate sending of series of messages*
smask	*setting of content (selection of transferred information)*
periode	*setting of regular messages broadcasting period*
hist	*historical readings storing period*
ekey	*setting of encryption key "." - encryption disabled)*
info	*setting device name*
reset	*command for module reset*
?	*show list of configuration commands („Help")*

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

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

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

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

```
Timezone : 1
```

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

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

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

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

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

The **"ppm"** command is intended for fine tuning of RTC generator frequency during production and factory setting.

NOTE: *setting of RTC (including time zone setting) is not important for the module common operation. No current module application requires RTC setting.*

By using of **"uptime"** command the time since last module restart (switch on or reset) can be displayed. Using of this command can help with module diagnostics. From current „Uptime" value it is clear, when the module went through the last restart. The variable is of „read only" type. Example:

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

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

```
cfg#sens
 -- Sensors --
CPU  :  25.8 $^\circ$C
VDA  : 3.586 V
cfg#
```

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

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

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

The command **"sendp"** can be used for immediate transmitting of series of standard messages with 1-minute interval. This command can be used for checking of radio signal availability during the system installation. It could enable checking of connection also after closing of mounting rack, or after leaving of watermeter shaft. Number of transmitted messages is set by parameter (number) after command, the first message is transmitted immediately after command. Example of sending of series of 5 messages:

```
cfg#sendp 5
sending 5 msgs
mon#
```

The **"smask"** command can be used for setting of information message content. Message structure is described in "mask" table (see figure 2), where there are different masks in different rows (one mask in one row) and all transferred information of one particular mask are marked by "1" in corresponding column. Binary symbols 0/1 from all three columns (SID, Alarm, RSSI) put together three-bit binary number. Decimal form of this number can be used as "smask" command parameter.

Mask	RSSI	Alarm	SID	Message content
1	0	0	1	SID
2	0	1	0	Alarm
3	0	1	1	SID+Alarm
4	1	0	0	RSSI
5	1	0	1	SID+RSSI
6	1	1	0	Alarm+RSSI
7	1	1	1	all

Figure 2: Table for selection of message content („mask")

Required „mask" of message content can be entered by entering of mask decimal number (= number in "Mask" column) after "smask" command. Example:

```
cfg#smask 3
Send mask changed to 3 :  SID, Alarm
mon#
```

As it is clear from the example, in the messages with mask number "3" there will be transferred only "SID" (meter ID) and "Alarm" (Alarm Flag) values, without RSSI value. This setting will determine message content as it is described in detail in paragraph 3.4 „The NB-K430 module data messages". Values of watermeter counters are always transferred, they cannot be removed from the message.

As NB-IoT services are typically charged per volume of transferred data, it is important to set appropriate message structure, that transfers only data that are really useful. If, as an example, Sensus Alarm Flags cannot be decoded in the superior remote reading system, transferring of this information has no sense.

The **„Periode"** parameter serves for setting of broadcasting period of regular info messages. The value of the parameter is factory preset to **"0" value**, that means **disabled transmitter**. Current value can be checked by **"periode"** command (without parameter). Broadcasting period can be changed by entering of required number of minutes after "periode" command.

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

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

Due to decreasing of broadcasting frequency (saving of battery lifetime) the module enables transfer of higher number of before read values in one message. In this case the message does not contain current values of meters, but it contains an array of previously performed readings, that were stored in module internal memory (hereinafter „historical readings"). Each set of historical readings is accompanied by the time of reading („timestamp") and this

timestamp is also transferred to the central system. To determine the number of transmitted historical data sets, the following restrictions need to be taken into account:

1. Memory volume enables storing **up to 110 historical readings**. The number of historical receive windows, that can be transmitted in one broadcast session, depends on the number of watermeters read and the number of variables read. For example, when reading one variable from the maximum number of 20 water meters, data from 5 receive windows can be read into the history table and sent at once, within one transmission session. Each time a message is sent, the historical readings table is emptied.
2. One data packet (which is the basic billing unit for charging according to the number of transferred data) can hold data from about 20 - 25 variables (depending on the mask settings, as well as how many decimal places the transferred values have). If one variable from the maximum number of 20 water meters is transmitted, the data will reliably fit into one standard packet of the NB-IoT service.

It follows from these dependencies that when reading of larger number of watermeters, setting of reading period and broadcasting period is a **compromise among information delay, energy consumption and service price**. To minimize information delays, it is necessary to broadcast as often as possible. To minimize energy consumption, on the other hand, it is advantageous to broadcast as less as possible. To minimize the price, it is advantageous to fill the transmitted packets as much as possible.

The determination of measurement and broadcasting frequency parameters should always be done on a project basis, taking into account the specific situation and the specific needs and requirements of the project.

Example: *If broadcasting period is set to 240 minutes (4 hours) and the period of storing of historical reading is 60 minutes, the 240/60 = 4 sets of historical data will be stored during the period and it will generate 4*10 = 40 records. This number of records can be relieably transferred in two NB-IoT data packets. records. The setting would be displayed in the module configuration statement as follows:*

```
Send periode : 240
 Hist. periode : 60 min.
   each meter 1-2 records, max. is 110 recs
```

*It is clear from the abstract, that broadcasting period is 240 minutes and historical readings are stored every 60 minutes. If there is 10 read meters, each message will carry 10 * 4 = 40 records.*

The **historical readings storing period** can be preset by using of **"hist"** command followed by parameter. The parameter is required number of minutes. Allowed values of the parameter are 10, 15, 30 and 60 minutes (if other value entered, system will store nearest value). If the parameter is set to "0" (default setting), no historical readings are stored, and only current values are transferred. Example of setting of historical readings storing period to 30 minutes value:

```
cfg#hist 30
History changed from 0 to 30 min.
cfg#
```

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

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

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

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

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

If the encryption key is set to the module's configuration, an information ***„Data will be encrypted by AES"*** displays in the list of configuration parameters (see chapter 3.1.1)

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

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

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

„Info" command can be used for setting of individual description of the module. Maximum length of the string is 29 characters. The description will appear in the „Info text" field in the optical configuration form. The description can contain any information (location or customer code, serial number...). Example of setting of the device individual description:

```
cfg#info NB-X 123456
Change manuf info from :  ''  to :  'NB-X 123456
```

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

```
cfg#reset
 -- Reset code 0x14050302 --
 PIN Reset
 SFT Reset
 SW version 1.01, date Sep  8 2021
Monitor started ..
mon#
```

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

3.1.8 Displaying of other operational entries in the list of parameters

In the lower part of the list of all configuration parameters there are some additional **identification and operational parameters of the module.**, that are of „read only" type. There are following parameters:

```
 Next send : 88 min.
-- 433Mhz modem --
  No. sent : 0 msg(s)
  No. recv : 2 msg(s)
  No. recv error : 0 msg(s)
-- Narrow band modem --
 Next send : 237 min.
  No. sent : 3 msg(s)
  No. recv : 0 msg(s)
Modem state : 4 - ready
Session count : 1
Session timeout : 172664 sec - 1d, 23:57:44
Modem IMEI : 867724031580613
  SIM CCID : 89882390000036330010
  SIM IMSI : 901288001028645
 Last RSSI : -79 dBm
  Conf. version : 19
 SW version 1.01, date Apr  1 2020
```

In the first part there is an information about sent messages. Parameter **"Next send"** means remaining time to the next broadcasting of info message. **"No. sent"**, **"No. recv"**, and **"No. recv error"** indicate numbers of received/transmitted messages from watermeters on the 433 MHz frequency and received/transmitted messages NB-IoT.

In the **"Modem state"** section there are identification data of internal GSM-submodule (IMEI), unique number of inserted SIM-card (SIM CCID) and unique number of SIM-card user (IMSI). In the **"Last RSSI"** row there is an information about the signal strength of the last message received from the GSM network. In the **"Session**

count row there is a number of sessions since last reset, in the **"Session timeout** row there is a current remainder of session timeout.

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

3.2 Setting of parameters by using of optical converter

The module i equipped with the „IRDA" infrared optical interface, that can be used for configuration through the **„USB-IRDA"** converter (USB-to-optic) or through the **„BT-IRDA"** converter (Bluetooth-to-optic). The module is equipped with the special circular aperture ("peephole") for magnetic fixing of the optical converter, that makes configuration easier.

The settings can be performed through the casing without necessity to open the module's cover. This is the significant advantage especially if the module is used in humid environment and has been sealed by additional silicon filling (additional adaptation for IP-68 proofing).

With using the **"USB-IRDA"** optical converter it is possible to display a list of the current settings of all module parameters. The full table of parameters will open by click on the „Walk" button in „WACO OptoConf" program window. When clicking on the „Read device" button, the module configuration table is displayed, where it is possible to make adjustments to individual parameters. A preview of that table is shown in the figure 3.

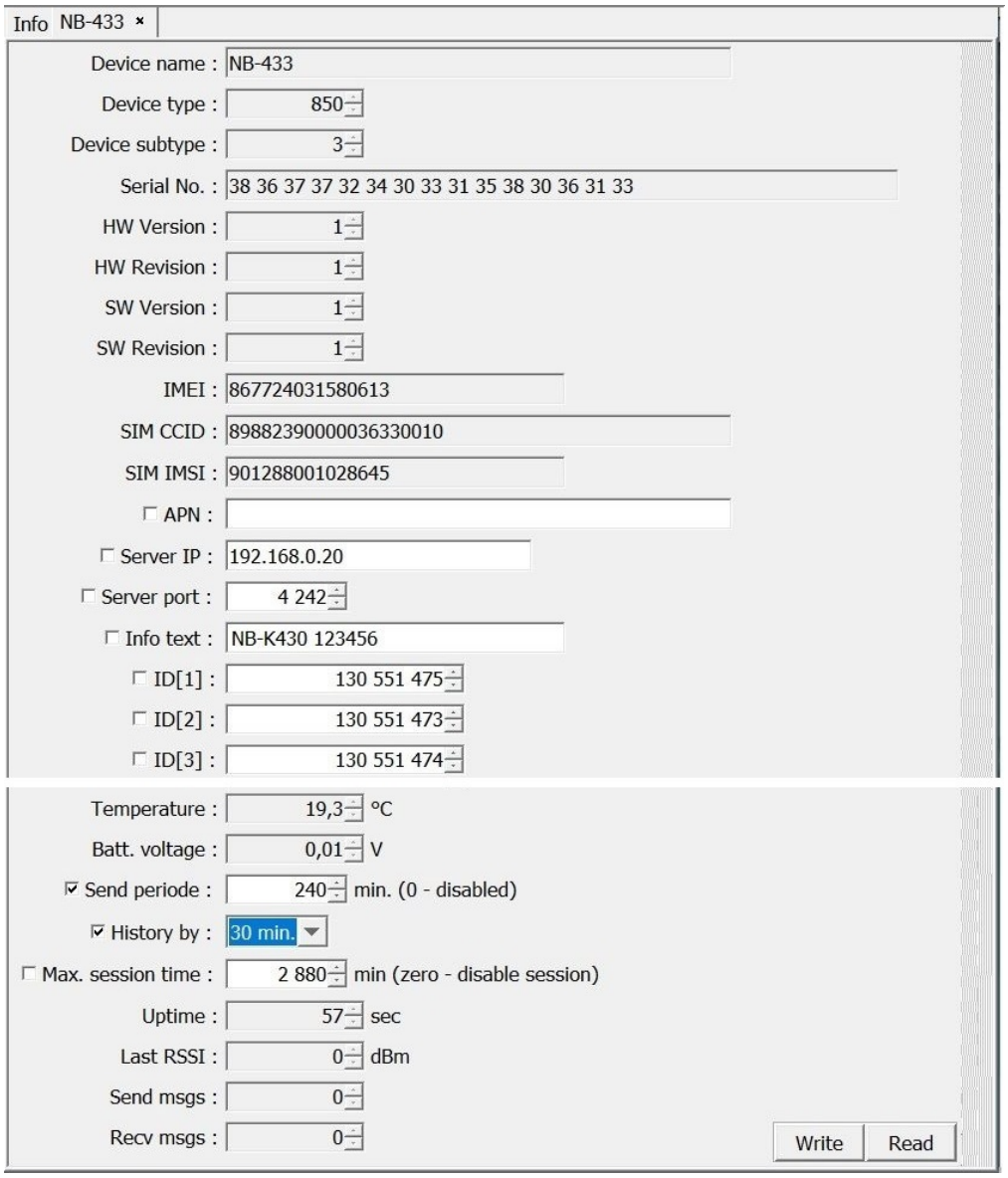


Figure 3: NB-K430 module configuration table

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

In the **middle section of the table** there is a group of commonly used configurable parameters of the NB-K430 module. The parameters (**"APN", "Server IP"** and **"Server port"**) are parameters for setting of **route to target server and application**. The **"Max. Session time"** parameter is used to set the maximum time of connection with the operator's server ("session time") in minutes. A more detailed description of these parameters is given in paragraph 3.1.4 "Commands for setting the communication with the NB-IoT network".

The **„Send periode"** parameter is used for setting of broadcasting period of regular information messages. The **„History by"** parameter is used for setting of historical readings storing period. The parameter is set in minutes, allowed values of the parameter are 0, 10, 15, 30 and 60. The **"Info text"** parameter is intended for setting of device user name/description. More detailed description of these parameters can be found in the paragraph 3.1.7 "Commands of „Utils" group for setting of module basic functions". In the middle part of the table there is also a table of read meters **"Meter ID"** that contains 20 editable fields, where watermeter IDs can be preset.

In the **lower section of the table** there are current values of internal sensors (temperature, voltage...) and other operational "read only" parameters. All these parameters are intended mainly for examination of module function and operation and for module diagnostics.

Most of module parameters can be configured also by using of **„BT-IRDA"** converter and **„SOFTLINK Configurator"** mobile application. This way of configuration can be used for the parameters, that are included in some of configuration forms of the application. Current version of „SOFTLINK Configurator" application supports fulfilment of all settings, that should be performed at the installation site, including basic tests. In the figure 4 there is an identification form of NB-K430 module (bordered by grey colour), administration form (bordered by blue colour) and form for basic module setting (bordered by red colour).

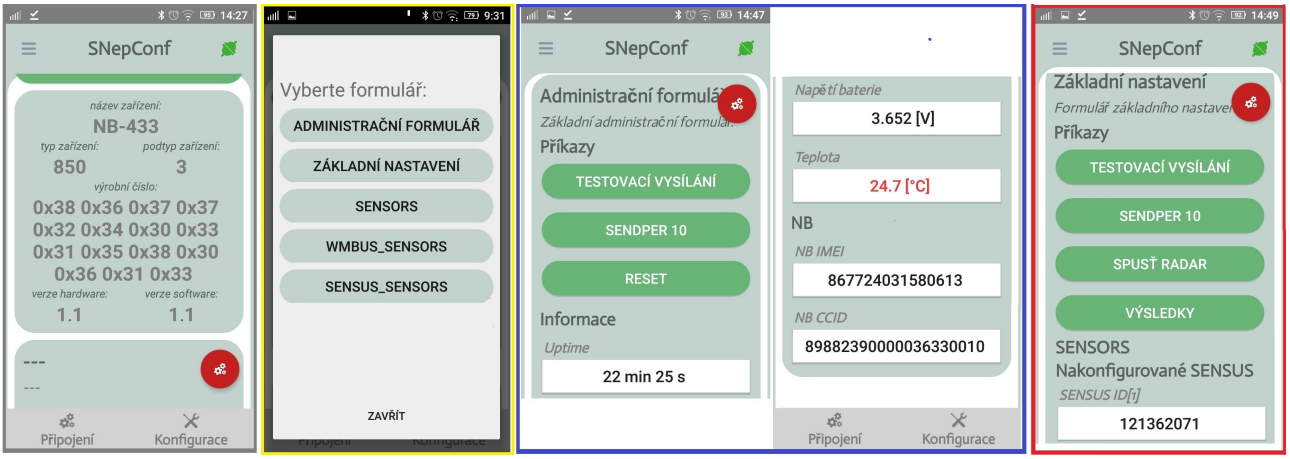


Figure 4: Basic forms of NB-K430 module in „SOFTLINK Configurator" application

Figure 5 shows the procedure for setting the list of read Sensus iPERL watermeters (bordered by purple colour) and previewing the form for similar settings in "WMBUS" mode (bordered by orange colour).

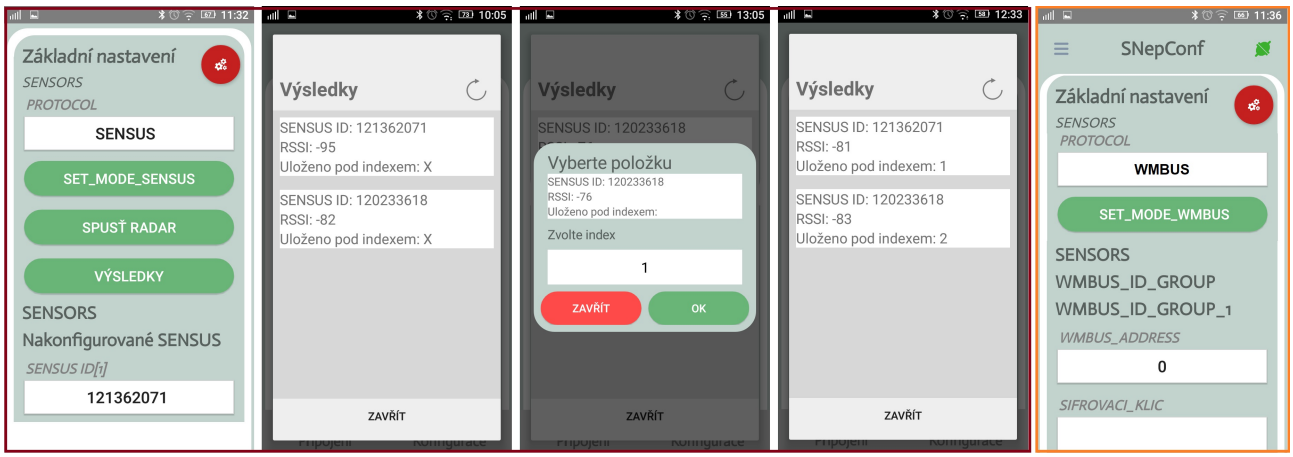


Figure 5: Setting the list of read devices

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

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

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

The device can operate either only in the mode for receiving messages from the Sensus IPERL device ("SENSUS"), or only in the mode for receiving Wireless M-Bus ("WMBUS") messages.
As evident from the pictures, the application enables performing of following settings:

- setting of maximum session time with NB-IoT server
- setting of message content (transferred value selection mask)
- setting of transmitting period of INFO messages
- setting of period of storing of historical readings
- setting of target server IP-address
- setting of IP-address for ICMP "ping" tests
- setting of target server UDP port number
- displaying of source UDP number
- setting of private network Access Point Name (APN)
- starting of one-time testing transmission
- starting of multiple (10 times) transmission series (SENDPER 10)
- switching of RADAR mode for 60 seconds (LAUNCH RADAR)
- displaying of RADAR function results (RESULTS)
- switching of 433 MHz receiving mode
- entering of identifiers and encryption keys of read devices
- sending of RESET command to the module

As the „SOFTLINK Configurator" application is continuously developed and improved, the screen previews of NB-K430 module configuration forms can vary in time.

3.3 Remote setting of module parameters through the NB IoT reverse channel

NB-IoT network uses standard Internet Protocol (IP) that naturally enables data communication in **both directions**. The NB-K430 module can use bi-directional communication for setting of its parameters from so called **"reverse channel"**, that is (for the reason of saving battery) opened only during two second period after transmitting of each message (INFO, TRAP, or RESPONSE). In this period the module's receiver is switched on and the module is able to receive message from remote server.

Messages in reverse direction can be used for setting of module parameters. As these **"setting messages"** are also coded by NEP protocol, they have in fact same structure, as the messages transmitted by module (i.e. set of NEP-coded individual variables inside UDP packet).

The first variable in each setting message is always **Message type**. Setting messages are always of **"SET"** type (OiD 63 = **"1"**). This variable is followed by one or more variables, that are requested to change.

The NB-K430 module performs setting of requested parameters (update requested variables) and sends back a message of the **"RESPONSE"** type (OiD 63 = **"4"**), that contains set of variables after requested update. The message is addressed either to the IP-address of the server from which the SET request came, or to the preset IP address of target server (depending on the setting of "Reply" parameter by "sreply" command).

Remote setting of parameters through the reverse channel can be used for setting of same parameters that can be set by optical interface (because both systems work on the same principle). More details about the reverse-channel communication can be obtained from the producer upon request.

3.3.1 Overview of module configuration parameters

Overview of configuration parameters that can be used for user settings of the NB-K430 module is shown in the Table 2 below. The parameters are presented in the same order as they appear in the List of all configuration parameters (see paragraph 3.1.1).

Table 2: Overview of NB-K430 module configuration parameters

Item	Name	Type	Description	Default.
1	Timezone	number	Time zone (time from UTC)	1
2	Server IP	code	target server IP-address	
3	Ping IP	code	IP address for ICMP tests	
4	Server port	number	target application port number	4242
5	Reply	yes/no	setting of reply to setting messages from the network	no
6	My src port	number	port number of source application	read only
7	APN	text	private network Access Point Name	
8	Max session time	number	Session timeout	2 days
9	Send period	0 - 65535	Broadcasting period in minutes	240
10	Hist. period	number	historical readings storing period	0
11	Send mask	number	number of message content mask	3
12	Encryption	code	Encryption key	indiv.
Status of 433 MHz modem				
13	No. sent	curr. status	No of sent messages from reset	read only
14	No. recv	curr. status	No of received messages from reset	read only
15	No. recv	curr. status	No of received error messages from reset	read only
16	Recv. window	number	length of receiving window	40
Status of NB-IoT modem				
17	Next send	curr. status	Time to next message in minutes	read only
18	No. sent	curr. status	No of sent messages from reset	read only
19	No. recv	curr. status	No of received messages from reset	read only
20	Modem state	curr. status	internal GSM module status	read only
21	Session count	curr. status	number of sessions from rese	read only
22	Session timeout	curr. status	time to closing of current session	read only
23	Modem IMEI	curr. status	internal GSM module unique ID	read only
24	SIM CCID	curr. status	unique number of inserted SIM-card	read only
25	SIM IMSI	curr. status	unique number of SIM-card user	read only
26	Last RSSI	curr. status	signal level of last received message	read only
Software status				
27	Conf. version	curr. status	No of stored images since last FLASH erasure	read only
28	SW version	curr. status	version number and date of issue	read only
List of settings of read devices				
29	ID	character	device identifier (serial number)	

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

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

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

Yellow colouring of the „Item" number highlights the parameters, that can be configured by using of **USB-IRDA optical converter** as described in details in chapter 3.2 „Setting of parameters by using of optical converter". These parameters can be set also remotely (from remote server) with using of NB-IoT back channel.

3.4 The NB-K430 module data messages

3.4.1 Structure and types of data messages

The NB-K430 module is intended for wireless reading of "smart" category watermeters and sending of read data to the superior system via NB-IoT services of GSM operator.

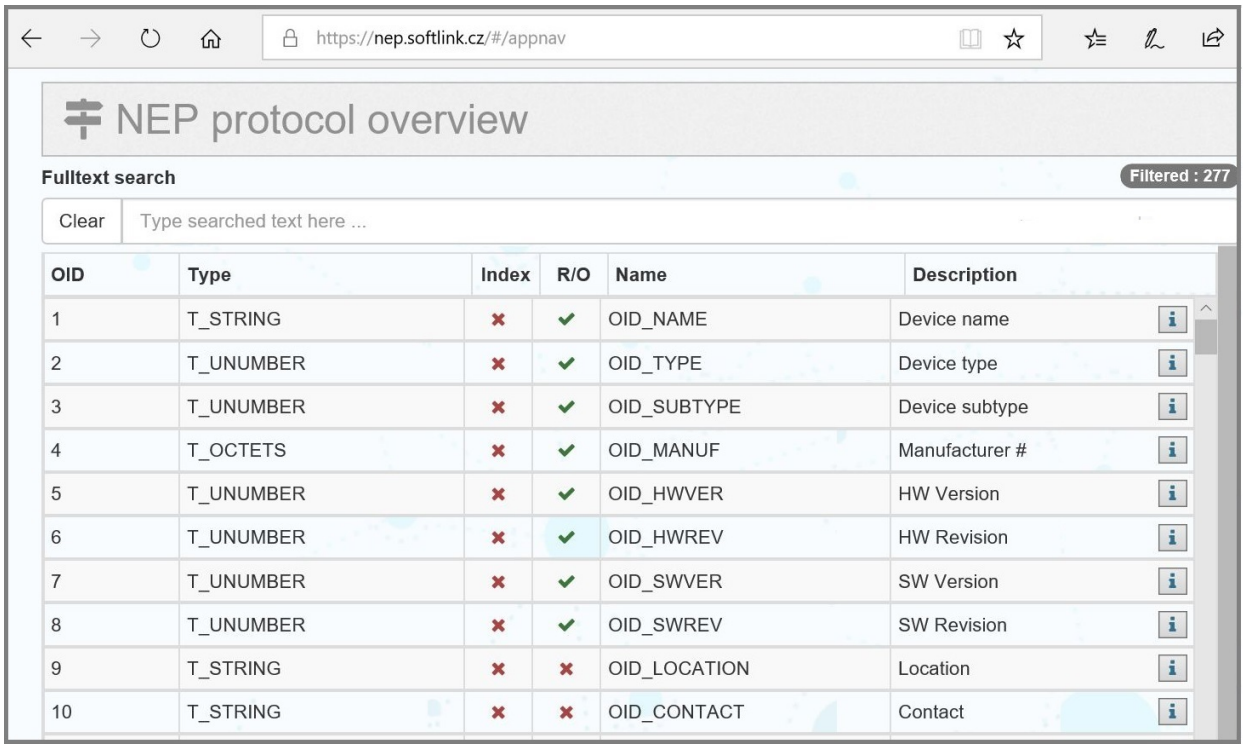
NB-IoT service utilizes for transfer of messages packets (datagrams) of UDP protocol (UDP = User Datagram Protocol), that is a transport layer of the Internet Protocol (IP).

Header of UDP datagram of the NB-K430 module consists of three fields:

- source port (16 bits) - constantly preset to "2000"
- destination port (16 bits) - set by "Server port" parameter
- length (number of Bytes) of UDP packet (16 bits)

UDP header is followed by data content with all transferred variables.

Individual variables are coded into the data content of the message by using of "NEP" proprietary coding system invented by SOFTLINK. In this system each type of variable has its own designation called "OID" (Object ID), which determines meaning, character and data type of the variable. These variables, that could be used multiple times (as multiple inputs, temperatures, voltages...) must be used jointly with order number of the variable called „Index". „NEP coding table" is centrally maintained by SOFTLINK and it is available on the public WEB address NEP Page. Preview of „NEP coding table" for coding of variables in the WACO system is shown in the figure 6.



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

Figure 6: Preview of „NEP coding table" for coding of variables in WACO system

Each variable is transferred together with its decoding information „Type" and „Length" that enables decoding of the information (i.e. determine variable's OID, index and value) on the receiving side even without knowledge of variable meaning. More detailed description of the NEP protocol can be downloaded in PDF format at the NEP Page.

The NB-K430 module message data content contains fixed part with identification and operational data and variable part with measured values. The module generates two basic types of messages:

- periodically transmitted **"INFO"** messages with current values of meters/sensors (readings)
- spontaneous alarm messages of **"TRAP"** type, generated immediately at alarm status (event)

The module generates these messages either in open, or in encrypted mode. Besides these basic types the module can generate also acknowledgment messages of „RESPONSE" type, as a response for setting messages from remote server (see paragraph 3.3).

3.4.2 Description of INFO message

Principal content of INFO message are statuses (readings) of watermeters, monitored by the module. Together with these readings there are also some identification and operational information of the module itself. The INFO messages are broadcasted in regular intervals preset by "periode" parameter (see paragraph 3.1.7).

Fixed part of the message is comprised of the first nine variables, that are contained in each message. In the table below there are marked in the OID field by yellow colour.

Variable part of the message contains set of measured values that depends on setting of the **message mask** by "smask" command. If only **current values** are transferred, the message contains only one set of measured values, without timestamps. If **historical readings** are transferred (see setting of "hist" parameter in paragraph 3.1.7), the message contains several sets of measured values with appropriate **"timestamp"** before each set. One set of measured values contains one or more variables for each watermeter read by the module.

By setting of "mask" parameter following variables can be selected for transfer:

OID 205/x - watermeter number (ID) with index "x"
OID 98/x - watermeter „alarm flag" with index "x"
OID 201/x - watermeter message RSSI with index "x"

The message always contains watermeter counter value (OID 100/x), this variable cannot be switched off.

The variables are linked to individual watermeters by using of index "x". Indexes are assigned to the watermeters in the Table of read watermeters (see paragraph 3.1.6) edited by "sid [index] [value]" command.

If there are historical data transferred, OID 205/x variable carrying watermeter ID is transferred only once, at the beginning of variable part of the message. Here there is a set of OID 205/x variables that forms a list of watermeters read by the module with their indexes. Sets of historical readings do not contain OID 205/x variables then.

Example of INFO message with **current values** of two watermeters and sending of all variables („full mask"):

OID	Index	OID Name	Description	Example
63		Message type	Message of DATA/INFO type	6
2		Device Type	Type name by manufacturer	850
3		Device Subtype	Device modification	3
4		Manufacturer No.	Device identification (IMEI)	
12		Uptime	Time from last reset (sec)	186552
61		Sequence No	unique message number	
105	1	Temperature	Processor temperature in 0.1 °C	223
106	1	Voltage	Battery voltage in mV	3765
462	1	RSSI	Last RSSI value	-61
100	1	Input value 1	Current status of watermeter 1	1996
205	1	Address 1	ID (serial number) of watermeter 1	130551473
98	1	Value type1	Alarm flag of watermeter 1	0
201	1	RF RSSI 1	Last message RSSI of watermeter 1	-67
100	2	Input value 2	Current status of watermeter 2	12887
205	2	Address 2	ID (serial number) of watermeter 2	130551476
98	2	Value type 2	Alarm flag of watermeter 2	0
201	2	RF RSSI 2	Last message RSSI of watermeter 2	-69

Example of INFO message with **current values** of 2 watermeters and sending of minimum data ("minimum mask"):

OID	Index	OID Name	Description	Example
63		Message type	Message of DATA/INFO type	6
2		Device Type	Type name by manufacturer	850
3		Device Subtype	Device modification	3
4		Manufacturer No.	Device identification (IMEI)	
12		Uptime	Time from last reset (sec)	186552
61		Sequence No	unique message number	
105	1	Temperature	Processor temperature in 0.1 °C	223
106	1	Voltage	Battery voltage in mV	3765
462	1	RSSI	Last RSSI value	-61
100	1	Input value 1	Current status of watermeter 1	1996
100	2	Input value 2	Current status of watermeter 2	12887

Example of INFO message with **historical data** of two watermeters and sending of meter ID and RSSI (mask "3"):

OID	Index	OID Name	Description	Example
63		Message type	Message of DATA/INFO type	6
2		Device Type	Type name by manufacturer	850
3		Device Subtype	Device modification	3
4		Manufacturer No.	Device identification (IMEI)	
12		Uptime	Time from last reset (sec)	186552
61		Sequence No	unique message number	
105	1	Temperature	Processor temperature in 0.1 °C	223
106	1	Voltage	Battery voltage in mV	3765
462	1	RSSI	Last RSSI value	-61
List of read watermeters				
205	1	Address 1	ID (serial number) of watermeter 1	130551473
205	2	Address 2	ID (serial number) of watermeter 2	130551475
*TimeStamp and data of the **first** historical reading*				
17		Timestamp	Time of reading (Epoch Unix Time Stamp)	1549031954
100	1	Input value 1	Current status of watermeter 1	1996
201	1	RF RSSI 1	Last message RSSI of watermeter 1	-67
100	2	Input value 2	Current status of watermeter 2	12887
201	2	RF RSSI 2	Last message RSSI of watermeter 2	-69
*TimeStamp and data of the **second** historical reading*				
17		Timestamp	Time of reading (Epoch Unix Time Stamp)	1549035554
100	1	Input value 1	Current status of watermeter 1	1999
201	1	RF RSSI 1	Last message RSSI of watermeter 1	-65
100	2	Input value 2	Current status of watermeter 2	12893
201	2	RF RSSI 2	Last message RSSI of watermeter 2	-70

Example of INFO message with **historical data** of three watermeters and sending of minimum information (mask "0"):

OID	Index	OID Name	Description	Example
63		Message type	Message of DATA/INFO type	6
2		Device Type	Type name by manufacturer	850
3		Device Subtype	Device modification	3
4		Manufacturer No.	Device identification (IMEI)	
12		Uptime	Time from last reset (sec)	186552
61		Sequence No	unique message number	
105	1	Temperature	Processor temperature in 0.1 °C	223
106	1	Voltage	Battery voltage in mV	3765
462	1	RSSI	Last RSSI value	-61
*TimeStamp and data of the **first** historical reading*				
17		Timestamp	Time of reading (Epoch Unix Time Stamp)	1549031954
100	1	Input value 1	Current status of watermeter 1	1996
100	2	Input value 2	Current status of watermeter 2	12887
100	3	Input value 3	Current status of watermeter 3	9587
*TimeStamp and data of the **second** historical reading*				
17		Timestamp	Time of reading (Epoch Unix Time Stamp)	1549035554
100	1	Input value 1	Current status of watermeter 1	1999
100	2	Input value 2	Current status of watermeter 2	12893
100	3	Input value 3	Current status of watermeter 3	9596

3.4.3 Description of TRAP message

Messages of TRAP type are used for immediate transmitting of information about event detected by the NB-K430 module. The information contains type of detected event (e.g. "Processor temperature exceeded limit") that can be followed by one or several variables with parameters of the event (e.g. "Temperature" and "Temperature limit"). This way the message recipient get information about limit exceeding, accompanied by current temperature value and value of the limit.

Type of detected event is encoded into the **"Alarm code"** variable (OID 60 - TRAP CODE), where value of variable determines event type. Current version of the NB-K430 module supports following types of events:

- OID 60 - hodnota "0" - event of "RESET" type
- OID 60 - hodnota "15" - input in "LEAK" status - alarm
- OID 60 - hodnota "16" - input in "NO LEAK" status - normal (**)
- OID 60 - hodnota "17" - input in "BURST" status - alarm
- OID 60 - hodnota "18" - input in "NO BURST" status - normal
- OID 60 - hodnota "19" - input in "LOW BATTERY" status - alarm
- OID 60 - hodnota "20" - input in "BATTERY OK" status - normal
- OID 60 - hodnota "25" - input in "REVERSE FLOW" status - alarm
- OID 60 - hodnota "26" - input in "FLOW OK" status - normal

The "RESET" event is always generated by the module after it has been reset (immediately after start-up). Other types of events are generated by the module based on changes in numerical statuses of individual watermeters (see setting the "alrb" parameter in paragraph 3.1.6 "Commands for setting the reading of the status of water meters". If the module works **in the "iPERL"** mode, the linking of individual alarm types to status changes is pre-defined in the module software, according to the iPERL documentation.

Fixed part of the message is comprised of the first six variables, that are the same as in INFO message. The only difference is that "Message type" (OID 63) is set to **"5"** value, what is a flag of **TRAP** type of message.

After this part of the message there is always **„Alarm code"** variable (OID 60 - TRAP CODE), carrying information about the event type. "RESET" type of event is assigned by **value "0")**.

„Alarm code" variable can be followed by one or several variables specifying event parameters. „RESET" type of event is followed by variable of **„Reset code"** type (OID 14 - RESET CODE), carrying information about the reset cause. In the NEP coding table there are following types of reset:

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

Example of "TRAP" type message with information about the reset of "Warm start" type (caused by regular command):

OID	Index	OID Name	Description	Example
63		Message type	TRAP type message	5
2		Device Type	Type name by manufacturer	850
3		Device Subtype	Device modification	3
4		Manufacturer No.	Device identification (IMEI)	
12		Uptime	Time from last reset (sec)	0
61		Sequence No	unique message number	
60		Trap code	RESET alarm code	0
14		Reset code	Reset code WARM START	1

3.4.4 Encryption of messages

Encryption of messages by AES key can be activated by setting of encryption key with using of **"ekey"** command (see paragraph 3.1.7 „Commands of „Utils" group for setting of module basic functions"). Encrypted message is in its first variable („Message type") designated as „Encrypted message" (OID 63 value is **127** - ENCRYPTED MESSAGE). The first six variables of the message are always sent unencrypted, because they carry data that are necessary for decryption. All other variables are encrypted by **block cipher CFB** and they are transferred in the message as encrypted value of one variable, designated as **„Encrypted part of the message"** (OID 19 ENCRYPTED BLOCK).

Structure of encrypted message has following structure:

OID	Index	OID Name	Description	Example
63		Message type	ENCRYPTED MESSAGE type	127
2		Device Type	Type name by manufacturer	850
3		Device Subtype	Device modification	3
4		Manufacturer No.	Device identification (IMEI)	
12		Uptime	Time from last reset (sec)	186552
61		Sequence No	unique message number	
19		Encrypted block	Encrypted part of the message	rest of variables

In the encrypted part of message there are all other variables encrypted by block cipher. The first variable in the encrypted block is always "Message type" (OID 63 MESSAGE TYPE), that carries an information, whether the type of message is INFO (value 6), or TRAP (value 5). Other variables follow in same order (and structure), as in unencrypted message (starting with seventh variable to the end of message).

4 Operational conditions

This section of the document describes basic recommendations for transportation, storing, installation and operation of NB-K430 radio modules.

4.1 General Operation Risks

The radio modules are electronic devices power-supplied by internal batteries. The modules read counters or registers of the connected consumption meters.

During their operation be aware mainly of the following risks:

4.1.1 Risk of mechanical and/or electric damage

The devices are enclosed in plastic boxes, so that the electrical components are protected from the direct damage by human touch, tools, or static electricity. In normal operation no special precautions are needed, besides avoiding of the mechanical damage from strong pressure or shocks.

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

Installation of the module can be performed only by a person with necessary qualification in electrical engineering and at the same time trained for this device installation. It is recommended to lead antenna and signal cables as far from 230/50 Hz power cables as possible.

4.1.2 Risk of premature battery discharge

The devices are equipped with the long duration batteries. Battery life can be influenced by these factors:

- storage and operation temperature – in high temperatures the spontaneous discharging current increases, in low temperature the battery capacity reduces;
- frequency of radio-transmitting.

Modules are delivered with preset period of regular transmitting of info-messages as stated in the configuration table in section of this document and the battery life cycle is quoted for this period. If the transmitting period is significantly reduced, battery life will be proportionally shortened.

4.1.3 Risk of damage by excessive humidity

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

Modules are enclosed in IP65 grade plastic boxes (proof against short-time squirted water) or with additional sealing by high-adhesion silicon filling, that can ensure proof against inundation by water (IP68 grade). Modules, that are delivered with IP68 sealing from factory are clearly assigned by IP68 degree of protection on the manufacturer's production label (e.g.: "NB-K430/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 ordered in basic variant with IP65 degree of protection are delivered with battery switched off. The modules ordered with IP68 degree of protection are delivered in fully operating status with battery switched on. For saving battery energy reasons the long transmitting period (e.g. 1 day) is pre-set in the factory, or transmitting is blocked by setting of "periode" parameter to "0" value.

4.3 Modules storage

The modules should be stored in dry rooms or halls, in the temperature interval (0 ÷ 30) °C. To prevent the unwanted discharging of internal battery it is recommended to keep the long transmitting period configured until the module's installation.

As NB-IoT services are charged by GSM operator, it is recommended to insert SIM and activate the service just before module installation.

4.4 Safety precautions

Warning! Mechanical and electrical installation of the NB-K430 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 NB-K430 module installation

NB-K430 radio modules are enclosed in plastic casings with an IP65 degree of protection equipped with mounts for mounting on the wall, pipe or any other construction element. Battery switch, configuration connector as well as antenna connector are placed on the module's printed circuit board, so that it is necessary to open the casing to access these elements. The module is equipped with a "Micro-SIM" (3FF) format card holder placed inside the module on the PCB. Alternatively, it can be ordered with embedded SIM (chip-SIM) of chosen GSM operator.

Modules with additional silicon filling (IP68 degree of protection) are delivered with embedded SIM-card (chip-SIM), mounted antenna, and with battery switch in "ON" position. Configuration of the module should be performed by USB-IRDA/BT-IRDA optical converter as described in section 3.2 „Setting of parameters by using of optical converter". **It is recommended do not open the casing during operation until it is really necessary, and if so, do it very carefully.**

In the figure 7 there is displayed the NB-K430 module dismantled into individual components

Figure 7: Set of NB-K430 module components with stick antenna

In the figure 8 there is displayed the detail of NB-K430 module printed circuit board with configuration connector with the location of the configuration connector (bordered in red), the SIM card holder (marked in purple), the NB-IoT uplink antenna connector (marked in blue), the 868 MHz receiver antenna connector (marked in light blue) and the battery switch (marked in yellow) on the opposite side of the board. The serial number on the module label must always correspond to the serial number on the auxiliary label affixed to the printed circuit board (data marked in orange). The appearance of the printed circuit board may vary slightly depending on the modification of the module.

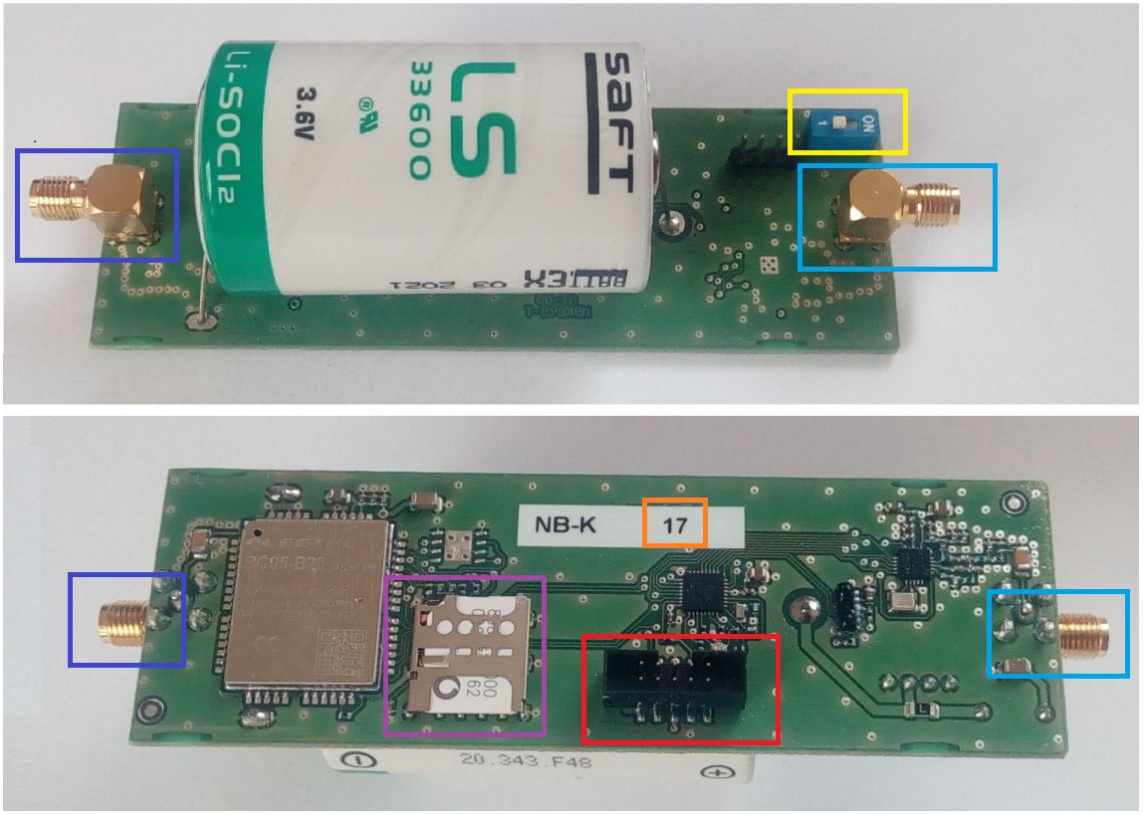


Figure 8: Detail of NB-K430 module PCB

The case of NB-K430 module consists of two parts:

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

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

- attach the module to a suitable firm object (wall, pipe) by four screws or by a clamping tape. There are mounts by the casing bottom side intended for the attachment. The recommended position of the mounted module is vertical, with the with the lid underneath;
- perform an elementary module check by using of USB-IRDA/BT-IRDA optical converter. Check in "RADAR" mode whether all watermeters, that should be read by the module, are in the reach of its 433 MHz receiver;
- check the tightening of the antenna/cable gland nuts of both antennas;
- if the internal rules or the mounting process needs the antifraud seal to be installed (as the protection from the unwanted influencing), stick the antifraud seal across the joint between the two parts of the box.

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

- completely loosen the sealing nuts of the cable glands at both ends of the module;
- unscrew the two screws on the sides of the box to release the module cap;
- carefully slide out the cap of the module, while the antenna of the 433 MHz receiver (if it is already mounted) slides inside the cover. Help yourself by pushing the antenna slightly into the module;
- after removing the cover, carefully slide the printed circuit board (PCB) out of the module housing. Either extend the board completely (if it is necessary to screw on the NB-IoT antenna), or only partially so that the configuration connector gets out of the housing (see figure 8). If the antenna of the NB-IoT transmitter is already mounted, help yourself by slight pushing the antenna into the module;
- if the antennas were not mounted on the printed circuit board, screw them to the antenna connectors at both ends of the module. An 433 MHz receiver antenna is located at the end of the PCB with the battery switch, and an NB-IoT antenna is located at the opposite end of the PCB;
- connect the power supply to the module by switching the blue micro-switch ("jumper") located on the printed circuit board to the "ON" position;
- perform an elementary module diagnostics and alternatively go through the module configuration (setting of parameters) with using of configuration cable as described in chapter 3 „Module configuration". In case the module has been fully pre-configured in the preparatory phase of installation, at least check in "RADAR" mode whether all watermeters, that should be read by the module, are in the reach of its 433 MHz receiver;
- insert the printed circuit board into the module housing. Insert the board so that the blue battery micro-switch is on the open side of the case (i.e. on the side where the lid is screwed on). The sealing nut of the cable gland must be fully loosened so that the antenna (or antenna cable) can easily slide out of the housing through the bushing. Push the board with the pressure of your finger on the edge of the PCB completely to the stop (do not push on the antenna connector or on the micro-switch). In the correct position, the printed circuit board should protrude only approx. 1 mm beyond the edge of the box housing.
- check the integrity of the rubber seal on the edge of the housing and make sure that the cable gland sealing nut on the lid is completely loose;
- carefully slide the lid onto the housing. The antenna of the 433 MHz receiver is gradually pushed out through the cable gland. Attach the lid to the case by screwing in and tightening both screws;
- tighten the sealing nuts on both cable glands to seal both glands;
- if the internal rules or the mounting process needs the antifraud seal to be installed (as the protection from the unwanted influencing), stick the antifraud seal across the joint between the two parts of the box.

(*) ATTENTION! *If the module is sealed by additional silicon filling with IP68 degree of protection do not open its casing during the installation! Module configuration could be performed by USB-IRDA/BT-IRDA optical converter .*

If the module is rated in IP65 or IP68 degree of protection, this declaration is valid only under condition of the proper mounting and sealing. When assembling the modules with IP68 degree of protection that will be placed in the

humid environment, it is necessary to follow these rules:

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

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

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

4.7 Module and meter replacement

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

- check the antifraud seal before dismantling – the antifraud seal damage must be solved according to the internal rules of the customer/project;
- loosen the fixing screws (or clamping tape) that hold the module on the wall, pipe or other pad and dismantle the module;
- completely loosen the sealing nut of the cable gland at the cap;
- unscrew two screws on the sides of the module casing, loosen the cap of the module and slide out the cap from the casing. Help yourself by slight pushing the 433 MHz antenna into the module;
- by switching of micro-switch („jumper") placed on the PCB into the „OFF" position disconnect the module from the battery power supply;
- if an external NB-IoT antenna used, loosen the sealing nut of the cable gland at the casing and carefully slide out PCB from the casing to have an access to the antenna connector;
- disconnect the cable of the external antenna from antenna connector;
- put both parts of the module back together by screwing the cap together with base (*). Mark the module visibly as „defective", alternatively you can fill in the form (mounting report) about the module replacement;
- install a new module in the same way as described in paragraph 4.6 above. Pay attention to the correct setting of basic parameters, namely broadcasting period and communication with watermeters;
- write down the serial number and seal number of the new module, alternatively also actual statuses of counters of connected meters;
- if possible, arrange making of all appropriate changes in the database of the remote reading system immediately.

***(*) CAUTION!** Pay attention to the completing of the correct casing with the appropriate PCB. The correct module completion can be checked out according to the auxiliary label with the serial number glued on the PCB.*

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

- do not open the module, if not really necessary! Rewrite ID (serial number) of original meter to the ID of new meter with using of USB-IRDA/BT-IRDA converter;
- check in "RADAR" mode, whether the new meter is in radio reach of the module and whether the read value corresponds to watermeter mechanical counter;
- if wireless configuration is not possible, check the antifraud seal and open the module by following the procedure set out in the paragraphi 4.6;
- connect to the module with a configuration cable and use the "sid [index] [value]" command to set the serial number of the new water meter by overwriting the original value (see paragraph 3.1.5 "Commands for setting the meter reading");
- when replacing a watermeter transmitting in WMBUS mode for the device that is a different type than the original watermeter, use "wkey" command to set its decryption key and set DIF/VIF parameter and alarm interpretation by using of "dib1", "dib2", "diba" and "alrb" commands;
- by using of "recvwin" and "radar" commands (see paragraph 3.1.5 check, whether the new meter is in radio reach of the module and whether the read value corresponds to watermeter mechanical counter;

- fill in the required documentation for the meter replacement (mounting sheet), precisely write down the value of the mechanical counter of the new meter;
- cover the module and seal it according to the instructions in paragraph 4.6. Alternatively wait for the first reading and cover the module afterwards.
- if possible, arrange making of all appropriate changes in the database of the remote reading system immediately.

Changing the watermeter settings in the NB-K430 module can also be performed **from a remote computer** over the network (see paragraph **??** "Setting the module parameters from a remote computer using a reverse channel"). In this case, the remote computer can request the content of the RADAR table from the module NB-K430, on the basis of which the module sends the table content in form of a special message. The remote application can change the settings of the meter reading list with the "Set Meter ID" command, sent via reverse channel.

4.8 Module dismantling

When dismantling, disassemble the module from the wall, pad, or pipe. Open the module, switch off battery and possibly disconnect antenna cable. Put the module parts back together by mounting of the cap on the module base. After the dismantling mark the module as „dismantled" and fill in the relevant documentation, prescribed for this situation by the internal rules. If possible, arrange deactivation of the module in the database of remote reading system immediately.

4.9 Functional check of the module

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

- check setting of basic module parameters, especially broadcasting parameters (encryption, broadcasting period, routing information) as described in paragraph 3.1.4;
- perform survey of radio signal reception form watermeters in "RADAR" mode by using of "recvwin" and "radar" commands through configuration cable, or equivalent functions of optical converter;
- examine coverage of installation site with NB-IoT radio-signal by sending of several messages with using of "send" command as described in paragraph **??** „System commands group for control of module basic functions" and their receiving in the remote reading system. Some indication about the NB-IoT signal availability can be obtained by checking of RSSI value in the list of configuration parameters, or "Last RSSI" value in the optical configuration table;
- perform complex (end-to-end) check of implementation of the module into the remote reading system by inspection of data rendered by module in reading system database. If the module broadcasting period is quite long, use test broadcasting function described in previous item.

4.10 Operation of the NB-K430 module

The NB-K430 module performs readings of watermeters and broadcasting of radio messages fully automatically. The greatest risks of permanent breakdown of module broadcasting are commonly caused by human activities within the installation site, especially mechanical damage of the module, excessive humidity or water inundation, or shading the RF signal by metallic object due to building operations.

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

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

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

5 Troubleshooting

5.1 Possible causes of module failures

If during operation of NB-K430 module some anomaly, malfunctions or other troubles are recognized, the possible causes of the failures can be classified by following categories:

5.1.1 Power supplying failures

The module is supplied by electrical power from the long-life internal battery. Approximate battery life is specified in paragraph 1.3 „Hardware features". 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 voltage is correct, with no signs of discharging and the device still does not communicate through its configuration port and does not respond to any commands and this status will not change even after module's restart (by switching off and switching on its battery), the system failure probably occur. Perform the replacement of the module according to the instructions in paragraph 4.7 and check functionality of the new module. If the new device works properly, label the original module as „defective" and fill in the appropriate documentation prescribed by internal rules for this case.

5.1.3 Failures of communication with NB-IoT network

Transmitting functionality is signaled by flashing of yellow LED on the module printed circuit board.

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 with frequent breakdowns in the receiving data from the module.

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

- weak radio-signal of NB-IoT network in installation site. RF signal availability can be influenced by weather conditions (rain, fog..), or by some changes around module installation site as well as around NB-IoT provider base station.
- permanent or occasional shading of radio signal caused by construction works or any construction changes within the premises, or by operation around the installation site (moving of machines, cars, etc.);
- permanent, periodical or occasional interference (jamming) of radio signal from external source (another radio system in the same frequency band, or industrial disturbance);
- low level of transmitting signal caused by transmitter failure;
- low level of receiving signal caused by receiver failure;
- low level of transmitting and receiving signal caused by damage of antenna or antenna cable (if external antenna used).

If above described indications of unreliable radio-communication become evident, proceed with troubleshooting of the malfunctioning in following steps:

- visually check surrounding of the installation site to find out if there are any changes that can influence radio signal (e.g. new objects, things, machines...). If there are such negative circumstances, solve the trouble by reorganization of the object or by relocation of the module or its antenna (if external antenna used);
- 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 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 of the new module as described in paragraph 4.9 after that;
- if the module is not properly working even after its replacement for proven device and equipment, the trouble can be caused by weak signal of NB-IoT network or interference (jamming) from external source in the installation site. In this case consult actual status of coverage and its future development with your NB-IoT network provider.

5.1.4 Failures of communication with watermeters

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

- if there are no messages from some watermeter, check its ID (serial number) in the table of read watermeters (see paragraph 3.1.6 „Commands for communication with watermeters");
- check receiving of watermeter messages in "RADAR" mode with the length of receiving window at least 45 seconds. Alternatively check presence of watermeter messages in the full statement of received messages by using of "mr" command (see paragraph 3.1.6 „Commands for communication with watermeters");
- visually check condition of the watermeter (mechanical damage, flooding by water, low battery). Follow troubleshooting instructions in watermeter documentation, in any doubt replace the watermeter;
- visually check surrounding of the watermeter installation site to find out if there are any changes that can influence radio signal (e.g. new objects, things, machines...). If there are such negative circumstances, solve the trouble by reorganization of the object or by relocation of the NB-K430 module or its antenna (if external antenna used) to the place with better signal from the watermeter;
- if there are any doubts about functioning of NB-K430 module 433 MHz receiver, try receiving of signal by using of spare device. If the module is not working properly, replace it according to the paragraph 4.7.

5.2 Troubleshooting procedure

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

1. No data are available from any watermeter read by the NB-K430 module. In this case it is recommended to check functionality of the module subsystems in following order:
   - check correctness of setting of the module in the central system database;
   - check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures";
   - check functionality of the system as described in the paragraph 5.1.2 „System failures";
   - check functionality of transmitting and receiving of NB-IoT signal as described in the paragraph 5.1.3 „Failures of communication with NB-IoT network";
   - check functionality of receiving messages from watermeters as described in paragraph 5.1.4 „Failures of communication with watermeters".
2. Readings from some of watermeters read by the module are not available. In this case it is recommended to check functionality of the module subsystems in following order:
   - check functionality of watermeter itself;
   - check correctness of central application configuration related to the watermeter, especially compliance with setting of its ID and index in the table of read watermeters in the NB-K430 module configuration;
   - check functionality of receiving of messages from watermeters as described in paragraph 5.1.4 „Failures of communication with watermeters".
3. Data values from some of watermeters read by the module are incorrect. In this case it is recommended to check functionality of the watermeter.
4. Data from the module come irregularly, with periodical breakdowns. In this case it is recommended to check functionality of the module subsystems in following order:

- check functionality of transmitting and receiving of NB-IoT signal as described in the paragraph 5.1.3 „Failures of communication with NB-IoT network";
- check functionality of power supplying as described in the paragraph 5.1.1 „Power supplying failures".

NOTE: NB-K430 module is a reliable device with relatively simple and resilient construction, so that any possible failure of the device is very likely caused by external circumstances, especially mechanical damage, excessive humidity, discharging of internal battery, or local radio-interferences in the installation site. After each replacement of the module caused by its failure it is recommended to check the root cause of the failure and take necessary measures to eliminate any persisting troubles.

6 Additional information

This manual is focused on description, parameters and configuration options of NB-K430 RF-modules, designed for operation in NB-IoT network, that are a part of the Softlink's **wacoSystem** product family. More information about all modules of "NB" series (NB-IoT), as well as about WS868 (Sigfox), WM868 (WACO), or WB169 (Wireless M-BUS) series of 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 NB, WS868, WM868, WB169 series or other manufacturer's equipment for telemetry and remote reading of consumption meters, feel free to contact manufacturer:

SOFTLINK s.r.o., Tomkova 409, 278 01 Kralupy nad Vltavou, Czech Republic
Phone.: +420 315 707 111, e-mail: sales@softlink.cz, WEB: www.softlink.cz.