SOFTLINK

WIRELESS COMMUNICATION SYSTEM WM868 WACO

WM868-RFG

Revision 1.0

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1 Introduction

This document describes the configuration options of the WM868-RFG communication gateway, which is used for receiving radio messages from devices for remote reading of consumption meters, sensors and converters operating in the WACO and WACO NB (hereinafter WACO) communication system in the 868 MHz band and for transmitting these messages via standard IP network (Internet) to the central data collection system. The module uses mobile data services GSM/LTE for Internet access.

1.1 WACO communication system

WACO (Wireless Automatic Collector) is radio frequency (RF) communication system intended especially for the remote reading of consumption meters (smart metering area), automatic data collection from sensors (telemetry area), and bi-directional data transfer among control, sensing and actuating elements in automatic control systems (industrial automation area). Installed WACO radio-frequency elements create local radio network covering object of interest (flat, house, building, compound...) or required area (street, city...).

WACO RF network has a „**mesh**" type of topology, where in reach of each radio element there could be placed several other network elements that could operate also as repeaters of received signal. In this kind of network there are typically several possible communication paths between the central point and other single elements of the network. WACO network communication protocol was designed to provide a **maximum data transmission reliability and redundancy** with using of multiple communication paths, but at the same time the network is protected against circularity and multiplication of messages by sophisticated algorithms so that the network keeps also a **high performance** even with high number of radio elements working in one network.

WACO communication protocol was designed in compliance with a telecommunication standard **ISO/OSI model** that ensures a high variability of supported applications. The WACO communication system works **in the 868 MHz band**, in which it uses 7 frequency channels. Three channels with a bandwidth of 100 KHz are intended for high-speed data transfer **in "WACO"** mode (bit rate 38,400 Baud), four channels with a width of 15 KHz are intended for low-speed data transfer **in "WACO NB" mode "** (bit rate 2400 Baud). The WACO high-speed mode is especially suitable for applications of the "virtual bus" type, where high transmission capacity is important, the low-speed WACO NB (NB = Narrow Band) mode is characterized by a significantly (up to 2.5 times) higher range (thanks to a narrow frequency channel) and is suitable especially for collecting data from meters and sensors in larger objects or areas. The older WACO high-speed mode is supported by all wacoSystem WACO radio modules, the later introduced WACO NB low-speed mode is supported by wacoSystem WACO radio modules manufactured from 2022. WACO radio-frequency devices (hereinafter „radio modules") are equipped with **various types of input/output interfaces** that enables integration of various connected device (meters, sensors, actors...) into one network.

WACO communication system includes also special communication devices - **WACO GateWays**, that enable receiving of radio messages from the local WACO RF-network and transfer them to the local or remote computer through the serial line or Internet and (in inverse direction) receiving messages from the serial line/Internet and broadcast them into „its" RF-network.

1.2 Module usage

The WM868-RFG module is designed to mediate data transmission between radio modules of the WACO remote reading system in the 868 MHz band and the central computer application that receives and processes this data. The module receives messages (packets) from the WACO radio network, checks their correctness, wraps them into an IP/UDP frame and sends them to the set IP address and port number of the central system. When encoding messages into IP/UDP frames, the WM868-RFG module uses Softlink's proprietary "NEP" encoding system, so the module can only be used for those central applications that use the "NEP" encoding system. In the opposite direction, the module receives complete radio packets wrapped in IP/UDP datagrams from the superior central system, which are to be sent to the WACO radio network. It unwraps these packets and sends them to the radio network. For Internet access, the module uses mobile data services, for which it has an integrated GSM/LTE modem.

Several communication gateways of the "WACO GSM GateWay" and "WACO Ethernet GateWay" type can be connected to one central system for communication with different radio networks, and vice versa - there can be several communication gateways in one WACO radio network, serving different central systems.

The WM868-RFG module supports both communication modes of the *wacoSystem* WACO: high-speed **WACO** mode and narrowband **WACO NB** mode. The choice of communication mode is determined only by the selection of the frequency channel.

1.3 Module characteristics

The core of the module is a microcomputer with one **Ethernet 10/100 Mb/s** communication port, one **mini USB** configuration port, an integrated 868 MHz radio modem and an integrated GSM/LTE modem. The communication ports serve these purposes:

- Ethernet 10/100 Mb/s port - the module does not use this port;
- mini USB 2.0 port - module configuration port;
- 868 MHz modem - RF communication with subordinate elements (end devices);
- GSM/GPRS/UMTS/LTE modem - GSM communication with the central data collection application.

The module is enclosed in a plastic box adapted for mounting on a DIN rail. The box has a standard "circuit breaker" profile and a width of four standard modules. The module requires external power supply with DC voltage of 12V to 24V, a screw terminal block with voltage polarity marking is used for connecting the power supply voltage.

The module's radio transmitter/receiver has an input **coaxial connector** of SMA (Female) type for connecting an external antenna (directly or via coaxial cable). The GSM modem is equipped in the same way. Both connectors are brought out to the top panel of the module and are marked as "ANT 868 MHz" and "ANT GSM".

The module is equipped with a SIM card holder for use with a "Mini-SIM" (2FF) format SIM card with dimensions of 25 x 15 x 0.76 mm. The SIM holder is located on the front panel of the module, to the left of the LCD display.

An LCD display 40 x 20 mm and control buttons on the right side of the front panel are used to display basic parameters.

The module is not suitable for placement in an outdoor environment without additional protection. The appearance of the WM868-RFG module is shown in Figure 1.
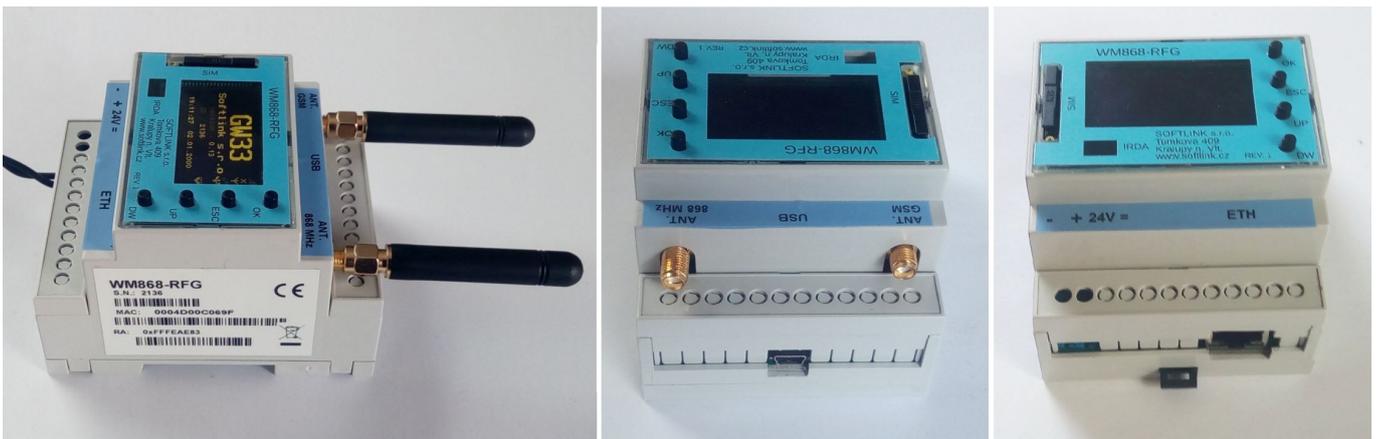
Figure 1: Appearance of the WM868-RFG module

2 Overview of technical parameters

An overview of the technical parameters of the WM868-RFG module is given in Table 1.

Table 1: Overview of technical parameters of the WM868-RFGmodule

Transmitter and receiver parameters		
Frequency	868.0 ÷ 868.6	MHz
Modulation type	FSK	
Number of channels in the band	7	
WACO channel width	100 KHz	(3 channels)
WACO NB channel width	12.5 KHz	(4 channels)
WACO transmission speed	38400	Baud
WACO NB transmission speed	2400	Baud
WACO receiver sensitivity	-107	dBm
WACO NB receiver sensitivity	-115	dBm
Return channel transmitter power	25	mW
Antenna connector	SMA female	
Communication protocol	WACO/WACO NB	
GSM communication interface		
Supported standards	LTE-TDD B38/B40/B41	
	LTE-FDD B1/B3/B5/B7/B8/B20	
	UMTS/HSPA+ B1/B5/B8	
	GSM/GPRS/EDGEB3/B8	
Characteristic impedance of antenna input	50	Ω
Antenna connector	SMA female	
USB configuration interface		
Transmission speed	115 200	Baud
Operation type	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, no parity	
Connector	mini USB 2.0	
Optical configuration interface		
Transmission speed	115 200	Baud
Optical band	870	nm
Optical interface specification	IrPHY 1.4 standard	
Power supply		
External power supply	(12 ÷ 24)	V
Module power consumption	3	W
Mechanical parameters		
Width	70	mm
Height	90	mm
Depth	58	mm
Weight	approx. 200	g
DIN box	4 modules	
SIM-card format	(15x12x0.76)mm)	"Micro-SIM"
Storage and installation conditions		
Installation environment (according to ČSN 33 2000-3)	normal AA6, AB4, A4	
Operating temperature range	(-10 ÷ 50)	°C
Storage temperature range	(0 ÷ 70)	°C
Relative humidity (without condensation)	90	%
Protection degree	IP20	

3 Module Configuration

The parameters of the WM868-RFG module can be checked and set from a computer or tablet in the following ways:

- by direct connection of a computer to the module's **configuration connector** using a standard USB cable
- **visually**, using the built-in display and control buttons;
- **wirelessly**, using an optical converter of the "USB-IRDA" type;
- **remotely**, via the Internet data network.

The description of direct connection of the module to a computer is given in paragraph 3.1. General rules for configuring the module are described in paragraph 3.3. The description and meaning of individual module parameters with indication of possibilities and methods of their setting is described in detail in part 3.4 "Setting parameters of the WM868-RFG module using a configuration cable".

The description of checking basic parameters and operational statistics of the module using the display and control buttons is given in part 3.5 "Displaying parameters of the WM868-RFG module on the LCD display".

The description of checking basic parameters and operational statistics of the module using an optical converter is given in part 3.6 "Setting module parameters using an optical converter".

The description of possibilities for checking and setting parameters via the Internet data network is given in part 3.7 "Setting module parameters via the Internet data network".

3.1 Connecting the module to a computer

Configuration using a cable is performed using a computer with MS Windows or Linux operating system, connected by a cable to the module's configuration connector. The module is equipped with a "mini USB" type configuration interface and a standard "USB 2.0 A Male - USB 2.0 mini B Male" connection cable is sufficient to connect it to a computer.

When connecting the module to a computer for the first time, the operating system automatically searches for and installs the correct driver (i.e., a generic driver for devices in the "USB Serial Device" category) and after installing the driver, the operating system displays a notification "Wireless Device is set up and ready" (or similar wording). The device appears in the "Device Manager" window, in the "Ports (COM and LPT)" section as "USB Serial Device (COMx)" (see Figure 2).
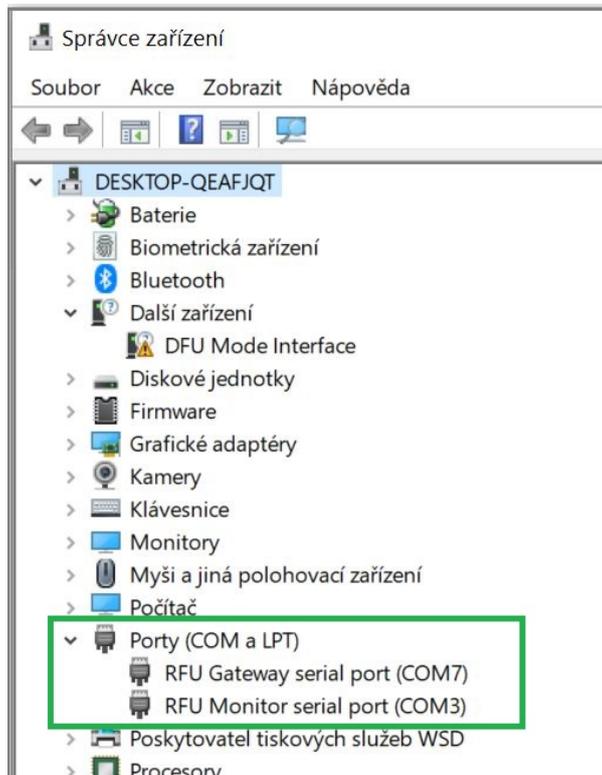

Figure 2: Display of the WM868-RFG gateway in the Windows "Device Manager"

This connects the computer to the module and prepares it for configuration.

If the Windows operating system doesn't find a suitable driver, install the "ugw3.inf" type driver according to the procedure described in the manual "Configuration of wacoSystem product line devices", specifically in paragraph 5.2 of that document. The module has two serial ports created via the USB interface, the driver needs to be installed on each of them.

3.2   Using the "PuTTy" program for module configuration

The module can be configured by using of any suitable program for communication via serial line. The description below is given for the "open-source" program "PuTTY", which can be obtained for free, for example, at www.putty.org.
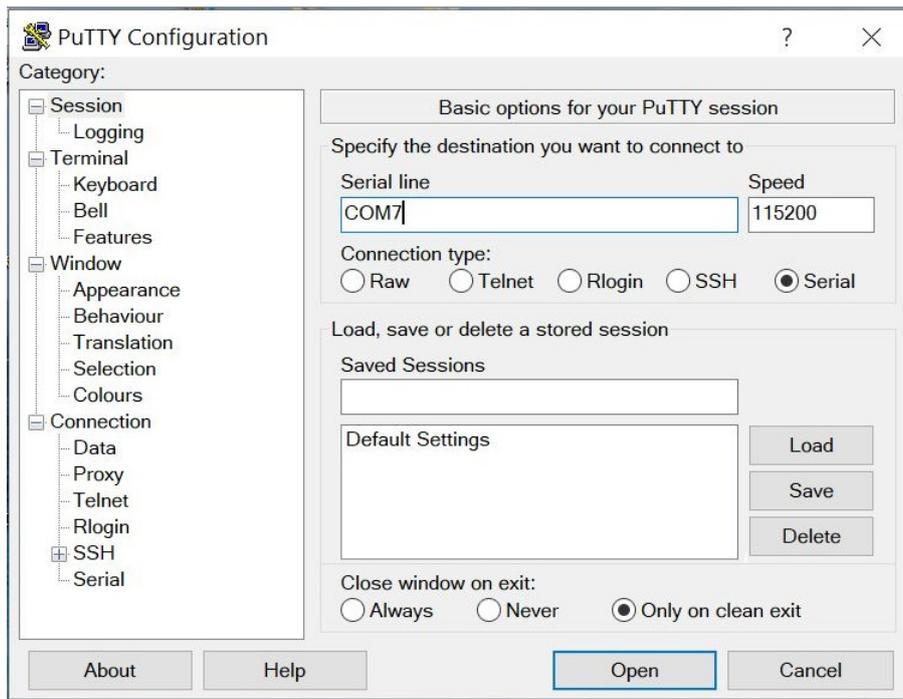
Figure 3: Terminal settings for serial line communication

Start "PuTTY" program by clicking on the downloaded "putty.exe" file. A terminal program window opens (see Figure 3). Switch the program to serial line communication mode by selecting the "Serial" connection type for the "Session" item in the left menu.

Check (or set) the communication speed ("Speed") to 115200 bits/s and write the serial port number in the "Serial line" window as the serial port was automatically labeled by the operating system when the cable was connected. The number of serial port can be found out in Windows OS using "Device Manager" (Control Panel/System/Device Manager) by expanding the "Ports (COM and LPT)" item and looking at the port number (for example, "COM12" - see Figure 2). Configuration is performed on one of the two serial ports of the module (the other is for remote management). If it's not clear from the port display in the "Device Manager" which one it is, find out by trying.

Open the terminal window by clicking the "Open" button in the "PuTTY" program. After pressing the "ENTER" key again, the system command prompt appears in the form "GW33H7-2136#", which signals that the module is ready for configuration (see Figure 4).
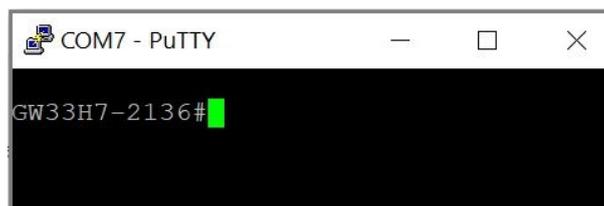
Figure 4: Open terminal window for module configuration via serial line

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3.3 General rules for entering configuration commands

Activate the terminal window for configuration using the configuration cable according to the above procedure. The following general rules apply for entering commands into the command line of the terminal window:

- enter a command only if there is a command prompt ("prompt") in the format "GW33H7-2136#" before the cursor mark (colored or flashing square) (see Figure 4);
- only one command can be entered into the terminal at a time;
- enter the command in the form of an alphanumeric character (or string of multiple characters);
- "send" the command for execution by pressing the "ENTER" button. If the command is executed, the "prompt" appears again and another command can be entered. If the command is not executed, an error message is displayed;
- if a longer time has elapsed since the last command, the module may respond to the command entry with an error message "command not found" even if the command is correct, due to loss of communication on the serial line. In this case just enter the command again. Before entering each command (especially for longer and more complex commands), it is recommended first "refreshing" the serial line with the "ENTER" key.
- check the execution of the command by listing the configuration, that can be displayed by entering of the "show" command (without parameter) followed by "ENTER";
- the summary of configuration commands and their parameters ("HELP") can be displayed by entering of "?"(question mark) command followed by "ENTER";
- some subsystems have their own command set. Display a summary of commands for a given subsystem by entering the name of the set and the "?" (question mark) command. For example, displaying of the set of commands for the GSM subsystem can be done by entering the command "gsm ?". Always enter individual commands from the set for a given subsystem by first writing the "distinguishing" command for the given subsystem and then the command itself after a space. For example, setting of the APN for GSM communication with the command can be performed by "gsm apn" command, where "gsm" is the distinguishing command for the GSM subsystem and "apn" is the command for APN configuration. Distinguishing commands for individual sets are listed at the end of the "HELP" configuration command summary;
- when entering characters, strictly distinguish between uppercase and lowercase letters (follow the documentation or the "help" prompt)
- do not enter characters into the command line that are not mentioned in the help or documentation. There is a risk of unintentionally entering a functional configuration character that is only used for setting, diagnostics and repairs of modules in the manufacturing or repair process.

3.4 Setting parameters of the WM868-RFG module using a configuration cable

The following part of the manual describes those parameters of the WM868-RFG module whose current value can be determined by directly connecting the module to a PC using a configuration cable and possibly changing them from the command line of the PuTTy program as described in section 3.3 of this document.

3.4.1 Listing of configuration parameters of the WM868-RFG module

The module configuration parameters cam be displayed by entering the command **"show"** into the command line and pressing the "ENTER" key. The following listing will appear in the terminal window:

```
Configuration: 2
*** ConfigSystem (520 bytes) ***
Dirty        : No
Location     : Kralupy nad Vltavou, Tomkova 409
Contact      :
Name         :
User         : admin
Auto RESET   : 43211 secs.
*** ConfigNework (24 bytes) ***
Dirty        : No
Use Ethernet : Yes
Use DHCP     : Yes
Use NTP      : Yes
Eth IP       : 0.0.0.0
Eth MASK     : 0.0.0.0
NTP server[0]: 0.0.0.0
NTP server[1]: 0.0.0.0
NTP server[2]: 0.0.0.0
*** ConfigGsm (88 bytes) ***
Dirty        : No
APN          : gprsa.softlink
PIN          :
Use GPS      : No
Sync Time    : No
Use IP       : No
*** ConfigWaco (28 bytes) ***
Dirty        : No
My RFA       : fffeae83
Group        : 13
Hop count    : 0
Free Bufs    : 20
TID Cache    : 50
REP Cache    : 20
*** ConfigRfDrv (2 x 8 bytes) ***
Idx.  Chan  TX Power      T1  CD  WOR  HG
------------------------------------------
0       0    23 dBm       0   1   0   0
1       0    14 dBm       0   1   0   0
*** ConfigUdpNep (76 bytes) ***
Dirty        : No
Hear Beat    : 0
UDP src port : 1141
flags        : 1
N.Type     IP address        Port     Timeout
----------------------------------------------
0 Static   10.0.0.17         1144        0
GW33H7-2136#
```

As is evident from the example, the listing contains the current configuration status of the module. The meaning of individual parameters is explained in the next part of this chapter.

3.4.2 Displaying a summary of configuration commands ("HELP")

The summary of configuration commands can be displayed by using the "?"command. The following listing will appear in the terminal window:

```
GW33H7-2136#?
?            - help
write        - write configuration
show         - show configuration
network      - network configuration
system       - system commands
dump         - [address] dump memory
modify       - modify memory
task         - print tasks
mbox         - print mailboxes
reset        - system reset
nfo         - print system info
bank         - print bank info
mainboard    - print mainboard info
slot         - print slot info
rtc          - set/print rtc
eth          - print ETH info
ip           - IP commands
usb          - USB commands
fs           - FS commands
ppp          - PPP commands
cmux         - CMUX commands
gsm          - GSM commands
waco         - WACO commands
rf           - RF commands
dhcp         - DHCP commands
GW33H7-2136#
```

The commands **?, write, show, reset, info, system, dump, modify, task, mbox, bank, mainboard, slot, fs** and **cmux** are used for system control, basic settings and diagnostics. Their more detailed description is given in section 3.4.3 **"Section of commands for system control and diagnostics"**.

The command groups **network, gsm, waco** and **rf** are used to set up the module's communication system. Their more detailed description is given in section 3.4.4 **"Section of commands for setting communication subsystems"**.

Using the **rtc, eth, ip, usb, ppp** and **dhcp** commands, the current parameters of individual subsystems can be displayed. Their more detailed description is given in section 3.4.5 **"Commands for checking the functionality of communication interfaces"**.

3.4.3 Section of commands for system control and diagnostics

The first part of this section of commands is used to control the basic functions of the module. These are the following commands:

?	*display summary of configuration commands*
show	*display listing of current configuration*
write	*write configuration to memory*
reset	*command for system reset*
info	*display listing of current system data*

Using the **"?"** command a summary of configuration commands ("HELP") can be displayed (see paragraph 3.4.2).

Using the **"show"** command the current operational configuration can be displayed (see paragraph 3.4.1).

The command **"write"** is used to save the configuration to memory. The module contains two sets of configuration: operational configuration and stored configuration. At system startup, the module copies the stored configuration into the operational one, which it then works with. If the user changes configuration parameters, this happens

only in the operational configuration. If the current operational configuration is not saved to FLASH memory, after a reset, the module will "return" to the set of configuration parameters stored in FLASH. When setting a parameter only temporarily (e.g. turn on debug outputs) it is not necessary to save the operational configuration to FLASH memory (after finishing work the debug outputs will be turned off anyway). But if the currently changed operational parameters should be set permanently, save the configuration into FLASH memory after setting the given parameter (or more parameters).

Overwrite the current operational configuration to FLASH memory using the **"write"** command as follows:

```
GW33H7-2136#write
Writing configuration ...
  - System config
  - Network config
  - GSM config
  - WACO config
  - RFDRV config
  - UDPNEP config
Done.
GW33H7-2136#
```

With the command **"reset"** perform a module reset. After performing the reset, the stored set of configuration parameters is loaded from FLASH memory. If it is needed to keep the currently created configuration, before performing the reset it is necessary to save the working set of configuration to FLASH memory. During the module reset, the connection with the module via the configuration serial line is usually interrupted and it is necessary to renew the connection with the "Restart Session" command (in the PuTTY program in the main program menu, accessible by right-clicking on the top bar). Example of using the command for module reset:

```
GW33H7-2136#reset
```

The **"info"** command can be used to display a listing of current data from individual subsystems of the module. This listing is mainly used for diagnostic purposes. Example of diagnostic listing "info":

```
GW33H7-2136#info
MCU          : STM32H743
BOOT from    : 0
FLASH size   : 2048 kB
Sysclk       : 400000000 Hz
HCLK         : 200000000 Hz
PCLK1-4      : 100000000 Hz
Sysclk       : 400000000 Hz
Wait states  : 2,  WR high = 2
Uptime       : 3297 secs.
tsc()        : 3297 secs.
Systime      : 3297 secs.
ResetCase reg: 0x00fe0000
 * POR  Reset
 * PIN  Reset
 * BOR  Reset
 * CPU  Reset
time()       : 3297
time_rtc()   : 1645105852
*** UDPNEP ***
Hear Beat   : 0
UDP src port: 1141
flags       : 1
N.Type     IP address        Port      Timeout
-----------------------------------------------
0 Static   10.0.0.17         1144         0
GW33H7-2136#
```

For module diagnostics, the "uptime" values (time since last reset) and "ResetCase", which indicate the circumstances of the last reset, are particularly interesting.

The second part of the section consists of commands from the **"system"** group. The list of all commands of the group can be displayed by writing the "?" character (without a space) after the group name ("system"). A list of commands belonging to this group appears:

```
GW33H7-2136#system
?           - print help
location    - set location
contact     - set contact
name        - set system name
user        - set user/password
calib       - clock xtal calibration
heap        - heap check
stack       - stack info
swap        - swap boot flag
eet         - Eeprom task debug
adc         - print ADC
systimer    - print SysTimer info
port        - print port A..J
i2c         - I2C test
flash       - test flash
copy        - copy program
invalidate  - invalide both caches
test        - EEPROM sector test
rsect       - read EEPROm sector
GW33H7-2136#
```

The listed commands can only be used for the given group, by first entering the group name after the prompt and then the command itself after a space.

The commands **location, contact** and **name** are used to set auxiliary identification data of the module. These data are optional and serve only as its user-editable description. Example:

```
GW33H7-2136#system location Kladno
Location    : Kladno
GW33H7-2136#system contact SOFTLINK
Contact     : SOFTLINK
GW33H7-2136#system name GW868-Kladno
Name        : GW868-Kladno
GW33H7-2136#
```

The command **user** is used to set authorization for access to the system configuration console. The command introduces "login/password" authorization data, which the system checks when connecting to the configuration console. The current version of the module **does not support** access authorization, so setting this parameter has no meaning.

All other commands in the "system" group are intended only for the manufacturer and are used only for initial module setup in the production process and for diagnostics. **It is strongly recommended not to use these commands during device operation.**

The third part of the section consists of commands **dump, modify, task, mbox, bank, mainboard, slot, fs** and **cmux**, which are intended only for initial module setup during production and for diagnostics by the manufacturer.**It is strongly recommended not to use these commands during device operation.**

3.4.4   Section of commands for setting communication subsystems

This section contains four groups of commands that are used to set individual communication subsystems of the module. These are the following groups of commands:

network	*setting IP network communication*
gsm	*setting GSM communication*
waco	*setting the radio communication system*
rf	*setting the 868 MHz radio subsystem*

To set communication over the IP network, use the **group of commands** *"network"*. The group contains these commands:

```
GW33H7-2136#network
?          - print help
address    - set eth0 interface ip address
netmask    - set eth0 interface net mask
dhcp       - enable/disable DHCP
ntp        - enable/disable NTP
ntps       - set NTPserver address
GW33H7-2136#
```

The commands **"address"** and **"netmask"** are used to set the IP address for communication via the Ethernet port, with both values entered in the usual format (for example 10.0.0.6, 255.255.255.1). For this type of module, setting these parameters is not significant.

The commands **"dhcp", ntp** and **"ntps"** are used to enable DHCP functions (assigning IP addresses from an external server) and NTP (loading system time from an external server). For this type of module, setting these parameters is not significant.

To set communication via GSM, use the **group of commands** *"gsm"*. This group contains the following commands:

```
GW33H7-2136#gsm
?          - print help
info       - print info
config     - print config
apn        - set APN
pin        - set PIN
gps        - enable GPS localization
synctime   - synchronize time
useip      - use IP
restart    - restart GSM module
sms        - send SMS, number text  format of number
debug      - set DEBUG level
mgmt       - print GsmMgmt info
cmux       - print Cmux info
clear      - clear statistics
GW33H7-2136#
```

The **"gsm info"** command can be used for displaying basic information about the "gsm" subsystem settings, including statistics of data transfer via the GSM interface.

The **"config"** command can be used for displaying the configuration status of the GSM subsystem:

```
GW33H7-2136#gsm config
*** ConfigGsm (88 bytes) ***
Dirty      : No
APN        : grp.softlink
PIN        :
Use GPS    : No
Sync Time  : No
Use IP     : No
```

From the configuration listing, it is clear that the subsystem configuration is saved (Dirty=0), the APN name is set to "grp.softlink.cz" and PIN checking is disabled. GPS functions and time synchronization are disabled.

The **"gsm apn"** command can be used for setting the APN (Access Point Name) gateway name between the GSM network and the connecting IP network. Example of setting the APN name "gr.softlink":

```
GW33H7-2136#gsm apn gr.softlink
APN : 'gr.softlink'
GW33H7-2136#
```

The **"gsm pin"** command can be used for setting the PIN for the SIM card used by the given module for GSM communication. Example of setting the PIN to "2583":

```
GW33H7-2136#gsm pin 2583
SIM pin : '2583'
GW33H7-2136#
```

Using the commands **"gsm useip"**, **"gsm gps"** and **"gsm synctime"** with parameter "0/1" the individual services of the "gsm" subsystem can be turned on or off:

- the "gsm useip" command activates the PPP connection to the IP network via GSM data services
- the "gsm gps" command activates the GPS receiver, which is part of the GSM subsystem
- the "gsm synctime" command activates time synchronization from the GSM network

Using the command without a parameter, the current settings can be displayed. Example of checking the activation of these services and subsequent activation of time synchronization from the GSM network:

```
GW33H7-2136#gsm useip
Use IP : Yes
GW33H7-2136#gsm gps
Use GPS : No
GW33H7-2136#gsm synctime
Sync Time : No
GW33H7-2136#gsm synctime 1
Sync Time : Yes
```

The **"gsm mgmt"** and **"gsm cmux"** commands can be used for displaying status information and statistics of the GPS module and statistics of internal GSM interfaces. The command **"gsm restart"** is used to restart the subsystem, with the command **"gsm debug"** the debug outputs of the subsystem to the required level can be set. The **"gsm clear"** command can be used for reset the statistics of the GSM subsystem. All these commands are used only for module diagnostics.

The **"gsm sms"** command can be used for sending a control SMS, which can be used, for example, to verify whether the used SIM card is activated in the mobile operator's network. Example:

```
GW33H7-2136#gsm sms 603659910 test
Sending to '603659910' message 'test'
GW33H7-2136#
```

To setup the radio communication system, use the **group of commands** *"waco"*. This group contains the following commands:

```
GW33H7-2136#waco
?          - print help
rfa        - set RF address
group      - set group address
hop        - set hop count
info       - print info
debug      - set debug level
test       - set test timeout (0-STOP)
radar      - print RADAR
GW33H7-2136#
```

The **"waco rfa"** command can be used for entering the radio address (RF address) of the module. This address is unique in the WACO network, it is set during production, and should not be changed under normal circumstances. However, in certain circumstances changing the radio address may be advantageous (e.g. if it is needed to replace a faulty communication gateway without the need to change the configuration of other elements in the WACO radio network). In this case, the "waco rfa" command can be used to set the desired address.

Example of checking the current radio address of the module and making a change:

```
GW33H7-2136#waco rfa
My RFA: fffeae84
GW33H7-2136#
GW33H7-2136#waco rfa fffeae83
My RFA: fffeae83
GW33H7-2136#
```

IMPORTANT NOTE! Changing the radio address should only be done in exceptional cases, and always after consultation with the manufacturer!

The command **"waco group"** is used to set the group address of the module. In the WACO system, group addresses can be used to create an almost unlimited number (65536) of groups ("virtual buses"). When addressing messages, in addition to the specific radio address of the module, group addressing can also be used, where the message is always delivered to all modules in the given group (i.e. all modules that have the given group address). For standard functionality of the module, setting the group address is not important, because this type of module uses a general "broadcast" type address for sending INFO messages. However, some applications may use group addressing.

Set the **group address of the module** using the command **"waco group]"**, where the number 0 to 65535 is the group address of the module. Example of a command to set the group address of the module to 13 and the corresponding configuration line:

```
GW33H7-2136#waco group 13
Group: 13
GW33H7-2136#
```

The **"waco hop"** command can be used for setting the maximum number of retransmissions (repetitions) of a radio message sent by the given module as a prevention from cyclic circulation of messages within the network. Example: if the parameter is set to "3", the sent message is automatically deleted after three transmissions. It is recommended setting the parameter to value n, or n+1, where "n" is the lowest number of retransmissions that is necessary for message delivery to recipient. A too low "SLRF Hop Count" parameter causes discarting message before it reaches the recipient, too high parameter value causes unnecessary load on the radio network by pointless repetition of messages and their duplication.

Set the **maximum number of retransmissions** by using the command **"waco hop [number]"**, where the number 0 to 15 means the maximum number of retransmissions of messages sent by the given module. Example of a command to set the number of hops to 4 hops:

```
GW33H7-2136#waco hop 4
Hop count: 4
GW33H7-2136#
```

With the command **"waco info"** the configuration of the radio communication system can be displayed. Example:

```
GW33H7-2136#waco info
*** WACO task ***
RFA      : fffeae83
Group    : 13
Hop cnt  : 4
Repeater : 0
Promisc  : 0
Free buf : 20
TID cache: 50
REP cache: 20
Debug    : 0
Test tout: 0
*** TID cache ***
RFA       TID Port  Timeout
-------------------------------
GW33H7-2136#
```

As is clear from the listing, in addition to the current configuration parameter settings, the subsystem memory status is also displayed in the listing. The listing is mainly used for diagnostic purposes.

The **"waco debug"** command can be used for setting the desired level of debug outputs that help in diagnosing the module. Example:

```
GW33H7-2136#waco debug 1
Debug      : 1
GW33H7-2136#
```

The command **"waco test"** can be used to set the **period of sending a test message**. The period is given in "intervals", where one interval is 1/20 second (so a value of "100 intervals" corresponds to a transmission period of 5 seconds). Example of a command to set the test message transmission period to 10 seconds (200 intervals):

```
GW33H7-2136#waco test 200
Test tout   : 200
GW33H7-2136#
```

Entering the command simultaneously turns on the test transmission. **Test transmission is turned off** by entering the command **with a zero parameter**, or by performing a module reset.

The **"waco radar"** command can be used for displaying the **"RADAR Table"**, which shows all radio modules whose messages the WM868-RFG module received during the past 60 minutes. The number of records in the table is limited to 500. Example:

```
GW33H7-2136#waco radar
   1:      WACO, fffed713          -94-   12
   2:      WACO, ffffa9ae          -100   201
   3:      WACO, fffeb6a1          -76-   225
   4:      WACO, ffff4bf8          -90-   264
```

As is clear from the table, the gateway received messages from four wacoSystem WACO series modules over the past hour. The table shows for each record the radio address of the module, the signal strength values (RSSI) with which the message was received, and the time that has elapsed since the message was received. The radar table listing is very useful especially when installing the module because it shows whether the gateway will mediate communication for all devices for which it is intended.

To set the parameters of the 868 MHz radio subsystem, use the **group of commands "rf"**. This group contains the following commands:

```
GW33H7-2136#rf
?           - print help
info        - print info
channel     - set channel
txpower     - set TX power (dBm)
config      - get configuration
stats       - get statistics
cw          - generate CW
xtal        - calculate XTAL frequency
clear       - clear statistics
debug       - set debug level
GW33H7-2136#
```

WARNING! The internal construction of the device allows the installation of two WACO 868 MHz radio subsystems. Therefore, it is necessary for each command from the "rf" group to **use the index "0"**, which in the WM868-RFG type module designates its only 868 MHz radio subsystem.

The command **"rf info"** displays the configuration of the 868 MHz radio subsystem.

The **"rf channel"** command can be used for setting the frequency channel to which the module is tuned. WACO system radio modules can operate on seven frequency channels that do not interfere with each other. The frequency channels are divided as follows:

- channels with a bandwidth of 100 kHz designated as **0, 1 and 2** are intended for **WACO** type communication with a transmission speed of **38.4 kb/s**
- channels with a bandwidth of 12.5 kHz designated as **3, 4, 5 and 6** are intended for **WACO NB** type communication with a transmission speed of **2.4 kb/s**

The WM868-RFG module thus supports both "fast" **WACO** type communication, suitable especially for implementing virtual buses, and "slow" **WACO NB** type communication, suitable for collecting data from meters and sensors in larger objects, where the advantage is approximately **2.5 times greater radio range** compared to WACO communication. The individual frequency channels are arranged as follows:

Channel	Carrier	Range From	Range To	Bandwidth
0	868.10000	868.05000	868.15000	100.00
1	868.30000	868.25000	868.35000	100.00
3	868.36250	868.35625	868.36875	12.50
4	868.38750	868.38125	868.39375	12.50
5	868.41250	868.40625	868.41875	12.50
6	868.43750	868.43125	868.44375	12.50
2	868.50000	868.45000	868.55000	100.00

Set the frequency channel using the command **rf channel 0 [number]"**, where the number 0 to 6 means the number of the frequency channel to which the module is tuned. The channel change is effective only after a module reset. Example of setting the frequency channel to channel number 3:

```
GW33H7-2136#rf channel 0 3
RF channel [0] = 3
GW33H7-2136#
```

The **"rf txpower"** command can be used for setting the transmission power of the module to the required level expressed in dBm. The maximum level of the transmission signal for the 868 MHz band is 25 mW, which corresponds to the maximum settable transmission power of 14 dBm. Example of setting the transmission power to 10 dBm (10 mW):

```
GW33H7-2136#rf txpower 0 10
RF TxPower [0] = 10
GW33H7-2136#
```

With the **"rf config"** command the current settings of the 868 MHz radio modem can be displayed. Example:

```
GW33H7-2136#rf config 0
   Channel : 3
  TX power : 10
   RX tout : 0
    LBT/CD : 1
       WOR : 0
 High gain : 0
GW33H7-2136#
```

From the listing it is clear that the module has set frequency channel "3", transmission power 10 dBm. The other parameters have the following meaning:

　　RX tout - timeout for turning on the receiver after sending a message (always off for this device)
　　LBT/CD - Listen Before Talk and Carrier Detect function (always on for this device)
　　WOR - Wake On Radio (always off for this device)
　　High Gain - turning on the "High Gain" function (always off for this device)

The **"rf stats"** command can be used for displaying statistics of data packet transmission via the 868 MHz radio subsystem. This listing is used for module diagnostics. Example:

```
GW33H7-2136#rf stats 0
CRC errors     : 362
IN packets     : 1264
OUT packets    : 8
Dropped packets: 0
GW33H7-2136#
```

Reset the statistics by using the **"rf clear"** command.

The commands **"rf cw", "rf xtal"** and **"rf debug** can be used only for initial module setup and for diagnostics in the manufacturer's workshop. The "cw" command starts generating the carrier frequency when tuning the crystal, the "xtal" command is used to correct the crystal frequency. The "debug" command can be used to set the desired level of debug outputs.

3.4.5 Section of commands for checking the functionality of communication interfaces

Using the commands described below, the listings of parameters for individual communication layers can be displayes. These are the following commands:

eth	*listings of parameters and statistics of the Ethernet interface*
ip	*listings of IP protocol communication settings*
usb	*listings of parameters and statistics of the USB interface*
ppp	*listings of PPP communication layer settings*
dhcp	*listing of DHCP dynamic addressing system settings*

The command **"eth info"** is used for Ethernet interface diagnostics (register listing). For the WM868-RFG module, using this command has no significance.

The command **"ip info"** is used to list settings and diagnose communication on the IP protocol. Example:

```
GW33H7-2136#ip info
Name             Mtu      Speed  IP              IP mask           HW address
--------------------------------------------------------------------------
lo0              65535        0  127.0.0.1       255.0.0.0
eth0             1500 100000000                                    00:04:d0:0c:06:9f
ppp0             1500   3200000  10.1.0.26       255.255.255.255

ARP table:
St Interface Tout Type   IP address
---------------------------------------------------------------
Routing table:
----------------------
Network          Netmask          gateway         Interface      Protocol  Type
-------------------------------------------------------------------------------
10.1.0.26        255.255.255.255  10.1.0.26       ppp0                      LOCAL DIRECT
127.0.0.0        255.0.0.0        127.0.0.1       lo0                       LOCAL DIRECT
0.0.0.0          0.0.0.0          0.0.0.0         ppp0                      LOCAL INDIRECT
UDP table:
-------------------------------
   68
 1141
  123
  161
   69
Device           Mbox-UPPER-device  Mbox-LOWER-device
---------------------------------------------------------------
lo0              00000000 00000000   00000000 00000000
eth0             00000000 00000000   240035c0 24000a0c
ppp0             00000000 00000000   24004490 2400c320
GW33H7-2136#
```

In the upper part of the listing there is a list of **current communication port settings**. The **lo0 (loopback)** port has a standard loopback address. For the WM868-RFG module, the **eth0 (ethernet)** port is not active due to the module's function, the **ppp0 (PPP protocol)** connection with the superior server is realized through the GSM subsystem. The IP address of the module is set for the PPP interface.

The next part of the listing is the module's **ARP table**. The WM868-RFG module has no other active local port, so its ARP table will typically be empty.

The next part of the listing there is the module's **routing table** (Routing Table). The first line of the routing table defines the path to the superior network via PPP connection, where the IP address of the module is connected to the virtual PPP port. The second line defines the path for loopback. The third line defines the default gateway,

---

which is also accessible via PPP connection.

In the lower part of the listing there is a list of set **UDP ports** (UDP table). Port **1141** is intended for main application data transfer (NEP protocol), other port numbers are intended for standard IP management services (DHCP, NTP, SNMP and TFTP).

The last part contains a listing of registers for individual ports.

The command **"usb info"** can be used for USB interface diagnostics (register listing). For the functionality of the WM868-RFG module, using this command has no significance.

The command **"ppp info"** can be used to list settings and diagnose communication on the PPP protocol. The currently assigned IP address of the module is listed in the PPP port parameters line. Example:

```
GW33H7-2136#ppp info
Name    LCP Tout Cnt IPCP Tout Cnt PFC ACFC  Flags IP address
----------------------------------------------------------------
ppp0     9   0    5   9    0    5   1    1    D     10.1.0.26
Device           Mbox-UPPER-device   Mbox-LOWER-device
---------------------------------------------------------------
ppp0             24003f58 240047b8    24003930 2400c440
GW33H7-2136#
```

The command **"dhcp info"** can be used to list settings and diagnose the DHCP system for dynamic IP address assignment. This listing is intended only for module diagnostics. Example:

```
GW33H7-2136#dhcp info
** DHCP client automaton **
State       : SELECTING (1)
secs        : 3600
lease       : 0
t1          : 0
t2          : 0
tout        : 3
xid         : 0x11ff1705
My addr     : 0.0.0.0
Mask        : 0.0.0.0
Server      : 0.0.0.0
Dflt Route  : 0.0.0.0
HWA         : [1], 00:04:d0:0c:06:9f
GW33H7-2136#
```

3.5 Displaying parameters of the WM868-RFG module on the LCD display

The WM868-RFG module is equipped with a multi-line **LCD display** and **control buttons** on the front panel, which are used to display selected identification, configuration and operational data of the module.

After turning on the module, basic information about the module is displayed on the LCD display (see Figure 5 on the left).

The text data includes, in addition to the manufacturer's name, the type and version of the device, the ID (serial number) of the device and the system time. On the right side of the display there is a set of symbols that indicate the status of the module's basic communication channels:

- at the top is the standard "signal strength" image symbolizing **GSM communication** with a graphical representation of GSM signal strength. Below the symbol there are up/down arrows that flash with each message received (down) and sent (up);
- in the middle is an antenna pictogram, symbolizing **communication via the 169 MHz radio network**. Below the symbol there are also up/down arrows that flash with each WACO message received and sent;
- at the bottom is a pictogram of USB and Ethernet data interfaces. Below the pictogram symbolizing **communication via the Ethernet port** is an "X" symbol, which the system uses to indicate that this port is not active.

When pressing the "OK" button the screen displays a main menu with possibility to browse more detailed data (see Figure 5 in the middle).

Figure 5: Display of the main screen, menu and system information

Right of the display there are four control buttons that are used to select individual menu items. They have the following functions:

- the **"OK"** button displays the selected (marked) item from the menu;
- the **"ESC"** button returns from a specific display back to the menu;
- the **"UP"** and **"DOWN"** buttons are used to move in the menu or scroll through displayed records.

In the current version of the module, basic information about the module can be viewed through five menu items:

- System HW configuration, sensor status and uptime ("System info")
- Ethernet interface settings and statistics
- GSM interface settings and statistics
- Display of current records in the "Radar" table
- WACO 868 MHz radio interface statistics

A preview of the display of individual menu items is shown in Figure 6. *The last two menu items are not functional in the current version of the module.*
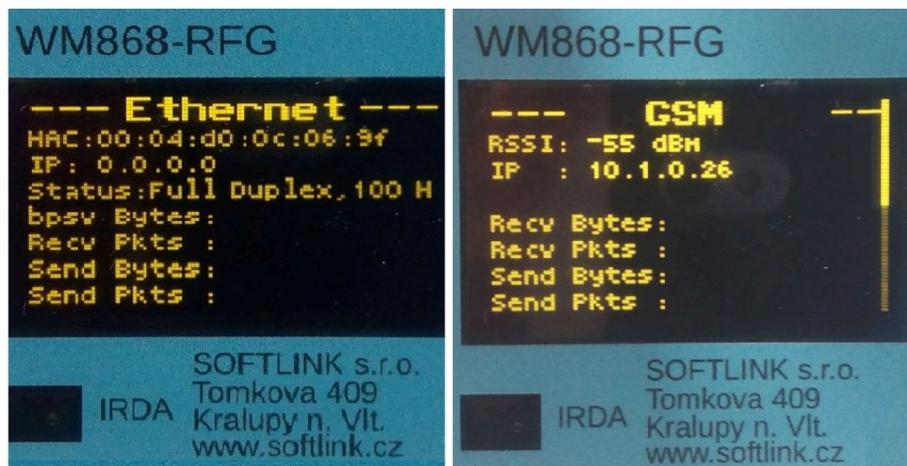

Figure 6: Preview of Ethernet and GSM menu item displays

3.6 Checking module parameters using an optical converter

The module is equipped with an infrared optical interface "IRDA", which is used for configuration using a **"USB-IRDA"** converter. Using an optical converter and suitable software supporting parameter reading using the NEP protocol (for example, "WACO OptoConf"), it is possible to read those parameters for which the NEP protocol has been implemented. Because the set of these parameters changes (expands) over time, this document only shows the principle of their display, not their complete description.

The description of connecting the optical converter to a computer ("USB-IRDA") and general rules for configuring the module using an **optical converter** are described in Chapter 3 of the manual **"Configuration of devices in the wacoSystem product line"**, which is available for download on the module manufacturer's website.

The list of parameters that can currently be read from the module can be displayed using the "Walk device" button in the "WACO OptoConf" program window. A preview of the list is shown in Figure 7.

In the current version of the WM868-RFG module, no parameters can be changed via the optical interface, only their values can be checked. The description of parameters is given in the "NEP" Encoding Table, which is maintained centrally by SOFTLINK and is available at the public WEB address NEP Page. A more detailed description of the encoding principle of the "NEP" protocol is given in section 4 "Structure of sent messages".
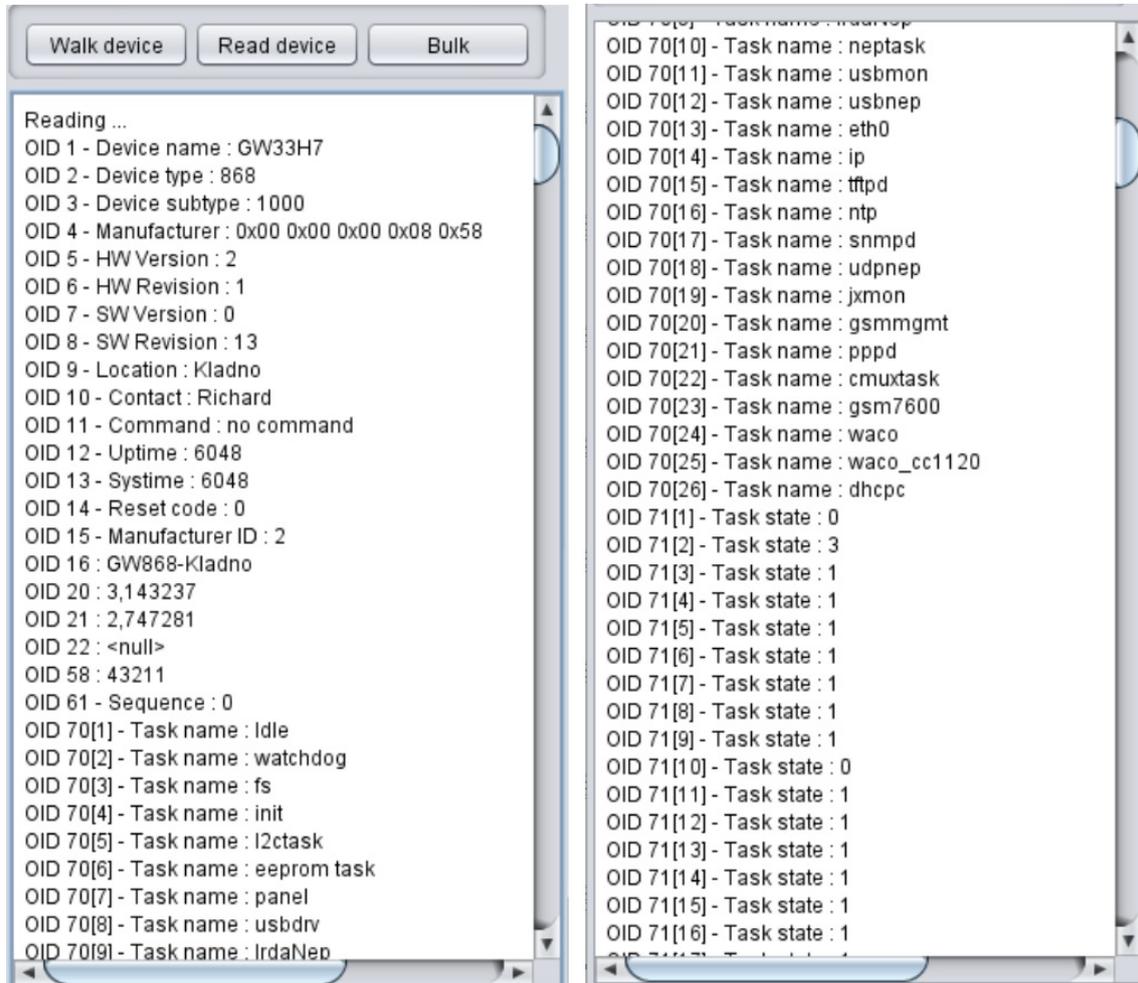

Figure 7: Table of WM868-RFG module parameters available via optical interface

3.7   Setting module parameters via the Internet

Since the WM868-RFG module is, by the principle of its gateway function, always connected to the Internet, some standard tools commonly used in IP networks can also be used for its remote management:

- "ICMP" for checking module availability
- "TFTP" for downloading and uploading module configuration files

To a limited extent, the module also supports parameter checking using the NEP protocol over IP/UDP protocol (see section 3.6 "Checking module parameters using an optical converter").

Checking the availability of the module using the "ICMP ping" application can be done from the command line of any computer by entering the "ping" command and the IP address of the module. An example of performing an availability check using the "ping" command from the Windows command line:

```
C:\Users\99hon>ping 172.1.16.24
Pinging 172.1.16.24 with 32 bytes of data:
Reply from 172.1.16.24: bytes=32 time=1ms TTL=64
Reply from 172.1.16.24: bytes=32 time=1ms TTL=64
Reply from 172.1.16.24: bytes=32 time=3ms TTL=64
Reply from 172.1.16.24: bytes=32 time=1ms TTL=64

Ping statistics for 172.1.16.24:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 1ms, Maximum = 3ms, Average = 1ms
C:\Users\99hon>
```

All important configuration parameters of the module are stored in configuration files. An effective way of remote configuration is to make the required changes **by changing the appropriate configuration file using the TFTP protocol**. Make the change by downloading the required file, modifying it, and uploading the modified file back to the module. This method of configuration allows storing backups of configuration files, prepare and test changes locally in advance, and then perform the actual file replacement very quickly. The module allows storage of two copies of the system software (Bank 0 and Bank 1), where one copy can be "on-the-fly" overwritten with a new version of software followed by a system transition to the new version with minimal disruption to module operation.

4   Structure of sent messages

The WM868-RFG communication gateway receives radio messages from WM868 series modules, which are in the format of the WACO communication protocol, and forwards them via the Internet to a remote data collection application (AMR) server in IP/UDP data packets.

In the opposite direction, the gateway receives IP/UDP data packets with messages for individual modules via the Internet and immediately sends them to the WACO radio network.

The gateway receives radio messages in WACO format, checks their correctness and sends them wrapped in a UDP packet to the address of the target application. Decoding of messages is performed only by the target application. Similarly, in the opposite direction, the gateway receives "ready-made" messages in WACO format from AMR and sends them to recipients via the radio interface. The content and description of radio messages from individual types of end radio devices is given in the documentation for these devices.

4.1   UDP packet structure

The structure of the message sent over the Internet is shown in Figure 8. It is a standard IP/UDP packet containing an IP header, UDP header and the actual transmitted data. The UDP header is described at the bottom of the figure. The packet is addressed to the target application (see description of setting the IP address of the target application below).
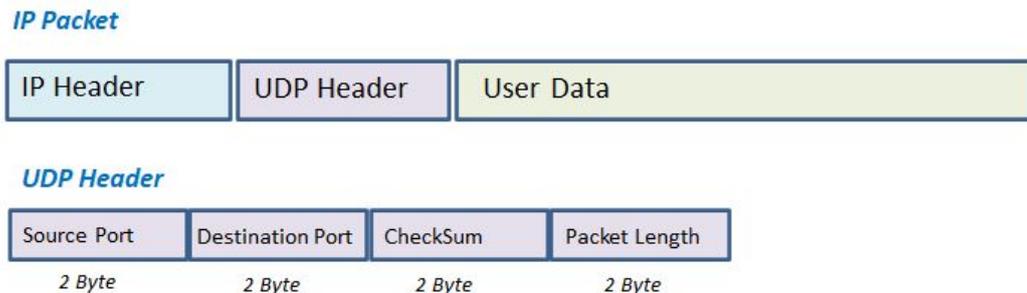

Figure 8: UDP packet structure

4.1.1   Setting the IP address of the target application

The target application is the application to which the gateway should send data. Setting the IP address of the target application is dynamic, using the mechanism of "zero" packets. The target application sends a UDP packet with zero data content length to each gateway at regular intervals (for example, every 30 seconds). After receiving such a packet, the gateway stores the IP address of the message sender as the IP address of the target application, to which it then sends all messages. This IP address is valid for three minutes, until then it must be renewed with another zero packet. The module can also have a static IP address of the target server set, which is not overwritten by the zero packet mechanism.

This system allows for easy redirection of communication to another server, easy change of IP address, or temporary redirection of communication from the gateway to an analyzer (or other diagnostic tool) for diagnostic purposes.

The communication gateway can send data to 5 different servers simultaneously. Communication with servers can be encrypted.

4.2   UDP message data content

The data content of the message is encoded using SOFTLINK's proprietary "NEP" encoding system, where each type of variable has its own "OID" (Object ID) designation, determining the meaning, character and data type of the given variable. For variables that can be used multiple times (several inputs, temperatures, voltages...), the serial number of the variable ("Index") is also a mandatory data. The "NEP" encoding table is maintained centrally by SOFTLINK and is available at the public WEB address NEP Page.

A preview of the "NEP" table for encoding variables in the wacoSystem product line is shown in Figure 9

Figure 9: NEP variables table

For each variable, its decoding information ("Type" and "Length") is also transmitted so that each variable can be decoded on the receiving side (i.e. determine the OID, index and value of the variable) even without knowledge of its meaning. The general format of the message data content is shown in Figure 10.
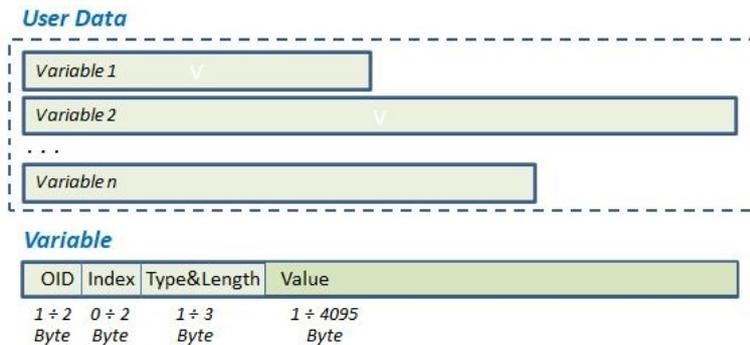

Figure 10: General structure of NEP variable

It is clear from the figure that the UDP packet payload consists of one or more NEP variables stacked together. The general structure of the NEP variable is shown at the bottom of Figure 10. Three NEP protocol variables are used to transmit the WACO radio message:

- The first variable is **"Message Type"** (OID 63). This is a mandatory NEP protocol variable that indicates what type of message it is. The value of the variable carrying the WACO system message is always "6", which means "DATA". This variable always occupies the same length in the UDP payload and is always the same.
- The second variable is **"RSSI"** (OID 120/1). This is a number expressing the strength of the radio signal (Received Signal Strength Indication) with which the transmitted radio packet was received by the gateway. The gateway "attaches" the measured signal strength to the packet itself so that this information can be used by the target application for operational purposes.
- The third variable is the actual **WACO radio packet** (OID 119/1). Its length depends on the amount and type of NEP variables being transmitted.

The structure of the specific format of the message data content containing a WACO system data packet is shown in Figure 11
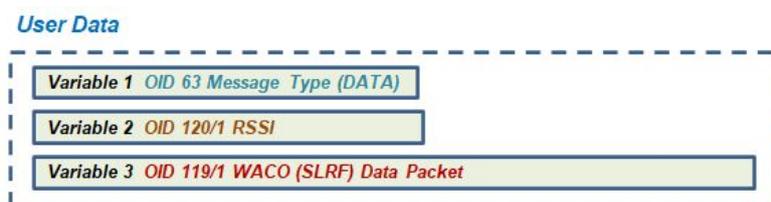

Figure 11: Structure of a message from the WM868-RFG gateway containing a WACO packet

5 Operating Conditions

This section of the document provides basic recommendations for transport, storage, installation, and operation of WM868-RFG type radio modules.

5.1 General Operational Risks

WM868-RFG radio modules are electronic devices powered by an external power supply that receive radio messages from surrounding radio modules and forward these messages to a superior server via the Internet. They are connected to the local Internet network through GSM data services. During operation of the device, the following risks are particularly present:

5.1.1 Risk of mechanical damage

The devices are covered in plastic boxes, so electronic components are not accessible for a direct mechanical damage. When installing it is necessary to ensure a sufficient space for connecting cables (including the configuration cable) and also that the cables are as short as possible (especially power and antenna cables). It is necessary to ensure the proper fastening of the module to DIN-rail with a plastic lock. In normal operation no special precautions are needed, besides avoiding of the mechanical damage from strong pressure or shocks.

Special attention is required for power, communication/signaling and antenna cables. In operation it is necessary to ensure that the cables are not stressed by mechanical tension or bending. In the 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 could 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.

The module is specified for installation in normal internal premises with the temperature range of $(-10 \div +50)°C$, with humidity up to 90% without condensation. Direct installation of the equipment in outdoor areas is not possible.

5.1.2 Risk of electrical damage

Electrical 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. The device is powered by DC power with safe voltage up to 24 V and current consumption up to 200 mA.

The power supply must meet the requirements for the safety protective transformer ČSN-EN61558-2-6. The module has an integrated protection against reversing the polarity of the supply voltage. Reversing the polarity is indicated so that after switching on the supply voltage to the module a green LED „PWR" on the front panel does not shine. Unwanted reversing the polarity of the supply voltage does not lead to damage or destruction of the device. In addition, the module is on the supply inlet equipped with a irreversible fuse (polyswitch) with the actuating current of 300 mA and over-voltage protection with 30 V switching level.

The module is not equipped by any disconnecting component – switch. It is suitable to place in installation a disconnecting component, for example a circuit breaker, which can be inserted into 24V/DC lateral of the supply or into the 230V/AC side of the supply. The primary side of the power source must be protected by automatically irreversible fuse.

For connecting external antennas, it is necessary to use appropriate coaxial cables, which should be routed as far as possible from 230V/50Hz power lines.

5.2 The condition of modules on delivery

Modules are delivered in standard cardboard boxes. At standard term of delivery the module does not include the antenna, the power supply and cables, if required these components must be ordered separately.

5.3 Modules storage

Modules should be stored in dry rooms with a temperature range $(0 \div 30)$ °C.

5.4 Safety precautions

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

5.5 Environmental protection and recycling

The equipment does not contain exchangeable components, which require compliance with specific rules in terms of environmental protection for their replacing, storage and disposal. 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.

5.6 Module Installation

WM868-RFG radio modules are enclosed in plastic boxes with IP 20 protection, equipped with plastic locks for DIN rail mounting. The box does not need to be opened during installation, dismantling or normal operation. A view of the WM868-RFG module from the front panel side, from the side and from the bottom is shown in Figure 12.
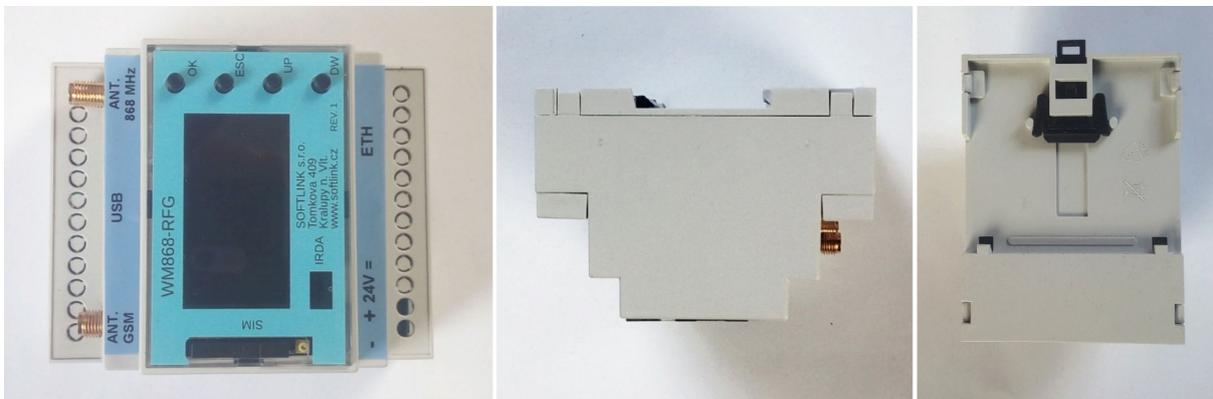

Figure 12: View of the WM868-RFG module and detail of the mounting system

The module in the picture does not have antennas or power cable connected.

Installation of the module should be performed by the following procedure:

- 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;
- when selecting an installation site pay attention to secure sufficient space for connection of antenna, power and signaling cables to the module (see paragraph 5.1.1 „Risk of mechanical damage"). It is necessary to keep the sufficient space for the connecting of configuration cable as well;
- when selecting a site for the module installation it is necessary to choose a place with availability of power supply. The power supply should be placed close to the module so that the feed of 24 voltage is as short as possible. Further it is necessary to consider the method of the module switching off and location of an appropriate disconnecting element (see paragraph 5.1.2 „Risk of electrical damage").
- mount the module to the selected place on the DIN-rail. Pull down black plastic lock in the bottom side of the module (outward of the module), attach the module to the DIN-rail so that the rail fits into the slot on the rear side of the module and push the black plastic lock up (inward the module);
- connect the antenna and signal cables to the module;
- make sure that the power supply is turned off and connect the power cable to the module. Verify that the polarity of power supply corresponds with the marking on the module terminals;
- check whether everything is properly connected and fasted and turn on the power supply. Green LED „Power" will shine on the module and the operation system will start up;
- perform the basic diagnostic of the module in compliance with the procedure mentioned in the paragraph 5.9 „Functional check of the module" and possibly (if the module was not pre-configured during the preparatory stage of installation) its configuration with using of the configuration cable according to the procedure described in the paragraph 3 „Configuration of the module individual parameters";

- record information about the module installation (serial number, position, picture of installation...) to the operational documentation under internal rules.

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. The conditions is possible either estimate empirically on the base of previous experience, or accomplish a measurement of the signal strength by the signal analyzer.

5.7 Module replacement

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

- switch off the power supply and disconnect the power cable wires from the module;
- disconnect the signal cable and the antenna cable;
- release the module from DIN-rail by pulling down of the black plastic lock on the bottom side of the module down (outward of the module) and remove the module from the rail;
- attach the new module at the place of the original module and proceed further according to the procedure mentioned in the paragraph 5.6. Especially pay attention to the correct connection of the power cable;
- after switching power on perform the diagnostics and set-up parameters;
- label the original module as „defective" and fill in the appropriate documentation prescribed by internal rules for this case.

5.8 The module dismantling

When dismantling module turn the power supply off and disconnect the power supply cables from the module. Disconnect the signal cable and the antenna cable from the module. Release the module from DIN-rail by pulling down of the black plastic lock on the bottom side of the module (outward of the module). If there is no further use for the antenna, remove the antenna cable and the antenna. If there is no further use for the power supply, remove the power supply and the power cable. If the power supply is used for other purposes, secure power cables against short circuit (by insulation of live ends of wires or by removal of useless power branches) and connect the power supply again. After dismantling label the module properly as „dismounted" and fill in the appropriate documentation prescribed by internal rules for this case.

5.9 Module Functionality Check

After putting the module into operation (or after each repair and module replacement), it is recommended checking the functionality of the Internet connection via the GSM modem and checking the functionality of reception in "Radar" mode.

A quick check of the Internet connection functionality can be performed immediately after turning on the module using the data on the LCD display. Check the connection to the GSM network in the "GSM Info" display.

The functionality of the 868 MHz band receiving system can be checked using the "Radar" table using the "waco radar" command (see detailed description in paragraph 3.4.4 "Section of commands for setting communication subsystems". The table is filled gradually as individual devices respond. When installing a local WACO/WACO NB collection network, it is advantageous to put the WM868-RFG communication gateway into operation first, and only then the individual transmitting devices.

A detailed check of all parameter settings can be performed using a portable computer and a program for serial line communication (for example, "PuTTY") as described in paragraph 3.4 "Configuration of the WM868-RFG module using a configuration cable".

5.10 Operation of the WM868-RFG Module

The WM868-RFG module automatically receives radio messages from surrounding radio reading modules and forwards these messages to a superior server via the Internet. Although the WACO / WACO NB transmission system uses sophisticated protection against mutual interference during transmission (signal collision, which occurs when two modules transmit at the same time), occasional message dropouts from some modules may occur when operating a large number of modules in one radio network.

The greatest risks of permanent loss of signal from surrounding radio modules are associated with the activity of the facility user. These include mainly the following risks:

- turning off the module's power supply, for example, circuit breaker failure, or its unintentional shutdown;
- non-functionality of the Internet connection caused by a local GSM network outage, or a PPP connection outage in connection with incorrect functionality of authorization servers, or other GSM operator equipment;
- risk of temporary or permanent antenna shading (for example, due to building modifications);
- risk of damage to the module, antenna cable or antenna when handling objects at the installation site.

To eliminate these risks, it is recommended paying great attention to selecting the module installation location and selecting the type and location of both antennas so that a suitable compromise is found between the quality of 868 MHz signal reception, GSM signal quality and the degree of risk of mechanical damage to the module, antenna cable, or antenna. The installation itself needs to be done carefully, using quality cables and mounting elements.

In case of a mass outage of data reception from a larger number (or all) of radio reading modules, it is recommended contacting the user of the installation facility and determining the cause of the anomaly, or performing a physical check at the installation site.

6 Troubleshooting

If an anomaly or malfunction is detected during installation or operation of the module, the probable cause of the failure can be determined by the following procedure:

1. No data is coming from the given communication gateway, information about the status of devices whose communication is mediated by the gateway (hereinafter "reading modules") is not available. In this case, proceed to determine the probable cause of the failure as follows:

   - check if there is an IP connection between the gateway and the superior system by performing a standard remote device availability test in the IP network using the "ping" function as follows:
     - if the gateway is in a publicly accessible network (has a public IP address), perform the "ping" test from any computer;
     - if the gateway is in a non-public network and there is an access to the border router of the non-public network available, perform the "ping" test from the border router;
     - if the gateway is in a VPN/APN, perform the "ping" test from a computer that has access to the given VPN/APN.
   - If the gateway is accessible, look for the reason why the gateway is not receiving signals from surrounding modules according to the procedure described in point 2;
   - If the gateway is not accessible, check if its power supply is functional. It is recommended to check especially:
     - if there has been a power outage in the building,
     - if the power supply is not turned off,
     - if the gateway is actually powered, i.e. if the "Power" LED is lit.
   - If the gateway's power supply is not functional, solve the repair of the power supply or the power supply line.
   - If the power supply is working and the gateway is not accessible, check circumstances that may affect the functionality of IP connectivity, especially the current availability of the Internet in the given location (whether it is a local Internet outage), possible changes in routing or IP addressing, or whether the **PIN check is disabled** for the given SIM.
   - If IP connectivity is most likely functional and the power supply is fine (the "Power" LED is lit on the module), perform a quick check of the functionality of the connection to the local Internet as described in section 5.9. If the gateway does not have an assigned IP address, check the functionality of the local IP network and reset the module by disconnecting and reconnecting the power supply (turning off/on the power source). If communication is not restored after this intervention, replace the gateway according to section 5.7. If after replacement the new module works normally, mark the dismounted module as faulty. If there is no visible external damage and it is under warranty, proceed according to the warranty policy;
   - If restart or gateway replacement does not lead to the restoration of functionality of the connection between the gateway and the superior server, solve the IP connectivity problem with IP routing experts.

2. The module is clearly communicating, responds to "ping", the result of the quick gateway availability test is "OK", but data is not coming from all (or a large part) of the devices whose communication is mediated by the gateway. In this case, proceed to determine the probable cause of the failure as follows:

- perform a reception functionality check in "Radar" mode according to section 5.9. If there are no devices in the "Radar" table even after a longer time, the module probably does not receive any messages;

- make sure that no changes have occurred in the building that could have a fatal impact on reception quality;

- visually inspect the module to see if there has been any damage to the antenna, antenna cable, or connector. In case of any doubts about the functionality of any of these components, replace it;

- check the module settings according to section 3.4.4 (Section of commands for setting communication subsystems), especially the setting of group address, frequency channel and transmission power;

- If the module is set correctly, measure if the signal from reading modules at the module's reception location is sufficiently strong (by using an RF-analyzer or other receiving device);

- If the signal from the reading modules at the reception location of the WM868-RFG module is sufficiently strong and the module is set correctly, replace the module according to section 5.7. If after replacement the new module works normally, mark the dismounted module as faulty. If there is no visible external damage and it is under warranty, proceed according to the warranty policy;

- If even the replaced module does not work after replacement, the cause of the problem may be local radio interference, or module configuration. Test the functionality of the replaced module in another location (in a space where another gateway clearly works) and if the module works in another location, look for the source of the interfering signal. In case of lack of experiences in this area contact some specialized company dealing with radio signal transmission with a request to determine the cause of the problem.

- If attempts to put the module into operation were not successful even with replaced module, there is probably a problem with the way it was configured for the purpose. In this case, it is recommended contacting the manufacturer or another knowledgeable person for help or support.

3. The module is clearly communicating, responds to "ping", the result of the gateway availability test in "Radar" mode is positive, but data is not coming from some devices whose communication is mediated by the gateway. In this case, the cause of the problem may be signal attenuation in the gateway's reception area, gateway receiver failure, or radio interference at the installation site. In this case perform similar checks as in point 2:

- check of antenna, antenna cable and connector,

- inspection of the gateway installation site,

- inspection of the installation sites of reading modules.

If everything is in order and the signal from the reading modules measured using an analyzer or other receiver is sufficiently strong at the module's reception location, replace the gateway and proceed as in point 2.

7 Additional information

This manual is focused on description, parameters and configuration options of radio modules WM868-RFG of the WACO RF system, operating in the 868 MHz band, that are a part of the Softlink's **wacoSystem** product family. More information about all WM868 (WACO), WB169 (Wireless M-BUS), WS868 (Sigfox), or NB (NB-IoT) series of the modules can be found on the manufacturer website:

www.wacosystem.com
www.softlink.cz

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