WIRELESS COMMUNICATION SYSTEM
LoRa

WL868-RFG

Revision 1.0

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1 Introduction

This document describes the setting (configuration) options of the WL868-RFG communication gateway, which is used for receiving radio messages from devices for remote reading of consumption meters, sensors and converters operating in the LoRaWAN communication system in the 868 MHz band, and for transmitting these messages over a standard IP network (Internet) to a central collection system. The module uses GSM/LTE mobile data services for Internet access.

1.1 LoRaWAN communication system

The LoRaWAN communication network is a radio network enabling the collection of data from a large number of end devices transmitting messages with LoRa type modulation, which enables the transmission of data over a relatively long distance at low transmission power. Networks with such a purpose and possibilities of use are often referred to as the "Internet of Things" ("Internet of Things" - short for "IoT").

LoRaWAN communication network technology is optimized for wireless data collection from battery-powered devices, when the key requirement is to achieve the greatest possible radio range with the lowest possible energy consumption. Communications between end elements and gateways are transmitted over several frequency subchannels using the principle of spread spectrum, with adaptive setting of the transmission rate.

The LoRaWAN network has a "star of stars" topology, where communication gateways collect data from the end devices within their local radio network and transmit it to a central server via a standard IP protocol. Using the LoRaWAN protocol, local networks can be created to cover individual objects or areas, or even global networks that cover large area. The LoRaWAN protocol also supports two-way communication, where the communication gateway transmits data to the end device in the allocated time interval.

1.2 Module usage

The WL868-RFG module is intended to provide data transmission between remote reading radio modules operating in the LoRaWAN system in the 868 MHz band and a central computer application that receives and processes these data. The module receives "User Data" radio messages encoded according to the LoRaWAN standard pursuant to ITU-T Recommendation Y.4480 for the 868 MHz band, checks their correctness, and sends them to the superior Network Server of the LoRaWAN network. The messages are sent via GSM/LTE mobile data service to the Network Server identified by the configured IP address and port number. The messages are encoded into the IP protocol according to the LoRaWAN standard. The module can therefore cooperate with any Network Server that supports the LoRaWAN standard.

The WL868-RFG module supports bidirectional communication according to the LoRaWAN protocol. When sending reverse channel messages, it follows the parameters received from the superior server according to the LoRaWAN standard. The reverse channel is used for activation of the end device and for controlling communication of the end device in the network according to the principles of LoRaWAN network communication, and possibly also for transmission of messages from the application server (changes of end device configuration, remote control commands, etc.). The module receives the reverse channel message from the superior Network Server together with the parameters for its transmission (delay, frequency channel, transmitting power) and, after receiving the next message from the end device, sends the reverse channel message with the required parameters.

1.3 Module features

The module is based on 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 are used for the following 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 - for radio communication with subordinate elements (end devices);
- GSM/GPRS/UMTS/LTE modem - for communication with the Network Server of the LoRaWAN network.

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

The radio transmitter/receiver of the module has an input **coaxial connector** of the SMA (Female) type for connecting an external antenna directly or through a coaxial cable. The GSM modem is equipped in the same way. Both connectors are led out to the upper panel of the module and are marked "ANT RF868" 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 appearance of the WL868-RFG module is shown in Figure 1.

Figure 1: Appearance of the WL868-RFG module

2 Technical parameters overview

Overview of technical parameters of the WL868-RFG module is shown in Table 1.

Table 1: Technical parameters overview of the WL868-RFGmodule

Transmitter and receiver parameters		
Frequency	863 ÷ 870	MHz
Modulation type	CSS (Chirp Spread Spectrum)	
Number of channels in the entire EU868 band	80	
Number of configurable channels	8	(3+5)
Receiver sensitivity	-125	dBm
Reverse channel transmitting power	400	mW
Antenna connector	SMA female	
Communication protocol	LoRaWAN	
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	
Antenna input characteristic impedance	50	Ω
Antenna connector	SMA female	
USB configuration interface		
Transmission speed	115 200	Baud
Operation mode	asynchronous	
Transmission parameters	8 data bits, 1 stop bit, no parity	
Connector	mini USB 2.0	
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 enclosure size	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 (non-condensing)	90	%
Degree of protection	IP20	

3 Configuration of the WL868-RFG module

Configuration parameters of the WL868-RFG module can be displayed and changed from the common computer (PC) by one of these methods:

- with using of common USB cable connected to the module configuration port;
- visually, with using of built-in LCD and control buttons;
- **remotely** via Internet connection.

Technique of interconnection of the module with configuration computer and general rules of configuration are described in detail in paragraph 3.3. The description and meaning of all configuration parameters that can be checked and changed by cable can be found in the section 3.4 „Setting of WL868-RFG parameters via configuration cable".

The description of checking of basic parameters and operational statistics of the module by using of LCD display and control buttons can be found in the section 3.5 „Display of WL868-RFG module parameters on the LCD".

The description of checking and setting of module parameters through the Internet connection can be found in the section 3.6 „Setting of parameters via the Internet data network".

3.1 Connection of the module to the computer

Configuration via USB cable can be performed by using of any PC with MS Windows or Linux operating systems. The module is equipped with the „mini USB" configuration interface and can be connected with the PC by common „USB 2.0 A Male - USB 2.0 mini B Male" interconnection cable. After the module is connected to the computer for the first time, operating system will find and install appropriate generic driver of „USB Serial Device" category automatically. After driver installation is completed, the device will appear in the „Ports (COM and LPT)" section of the „Device Manger" window as „USB Serial Device (COMx)" (see figure 2). Thus the computer is connected with the module and ready for performing any changes in configuration.

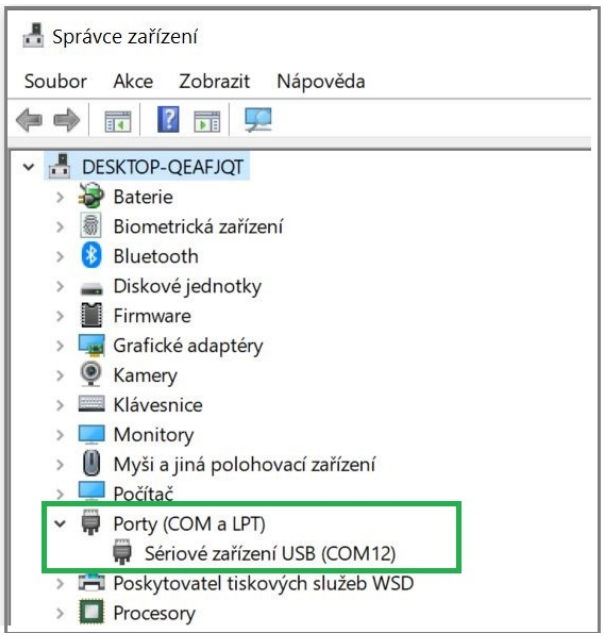

Figure 2: Appearance of the module in Windows „Device Manager"

3.2 Using of „PuTTy" freeware program for configuration

The module configuration can be done with using of any suitable program for the serial line communication. The description bellow is relevant for the open-source software „PuTTY" that is available for free on www.putty.org.

„PuTTY" software runs after clicking on the downloaded file „putty.exe". There will open a window of the terminal communication (see Figure 3). For switching the program into the serial line communication, choose „Serial" option of the connection type in the „Session" tab.

Check (or set up) the communication speed („Speed") to 115200 bits/s and then enter into the „Serial line" tab the number of the serial port that the system automatically assigned to the virtual port at the moment of interconnection

module to the computer. The number of the serial port can be found in OS Windows by using of „Device Manager" (Control Panel/System and Maintenance/Device manager) by clicking on „Ports (COM a LPT)" where the numbers of ports appear (e.g. „COM23" - see figure 2).

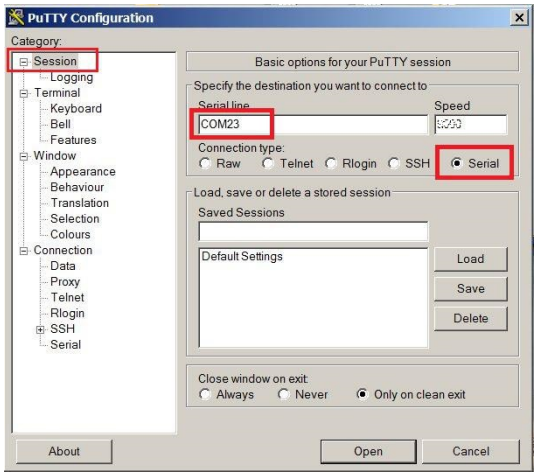

Figure 3: Terminal setting for serial line communication

Click on „Open" button in „PuTTY" program and open the terminal window. After pressing of "ENTER" key there will appear a request for login and (after entering login) password. Factory preset login/pasword couple is „*admin/admin*", it is recommended to change it after installation. After login procedure there will appear a sequence with an information about last reset ended by system command line marked by "LORA-GW-3440#" prompt, which announces that the module is ready to be configured (see figure 4).

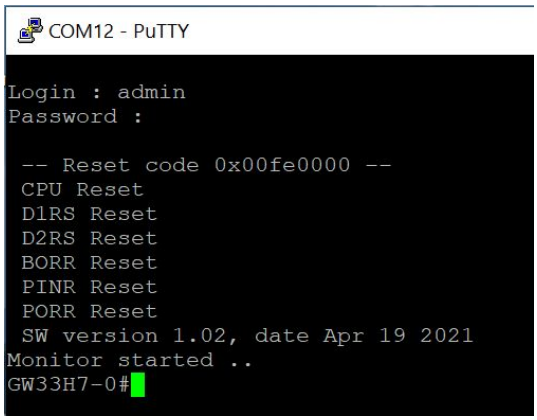

Figure 4: Open terminal window for module configuration via serial line

3.3 General rules for entering of configuration commands

Activate the terminal window for the configuration via the configuration cable according to the instructions above. These general rules are valid for entering commands in the command line:

- the command must be entered only when a prompt for command appears in front of the cursor mark (colored or flashing little square); the prompt is either „LORA-GW-3440#" or „mon" format (see figure 4);
- it is possible to enter only one command each time;
- the command could be entered in an alphanumeric character (or several characters);
- the command is sent to device by clicking on „ENTER" key. After the command being carried out, the prompt will appear again and it is ready for a new command to be entered. In case the command fails to execute, there will appear an error report;
- if it takes longer from the last command, due to a loss of communication on the serial line the module may respond to the command with the error message "command not found" even if the command is correct. In that case, just enter the command again. Before entering each command (especially for longer and more complex commands) it is recommended to "refresh" the serial line by pressing of "ENTER" key.

- check the execution of the command by displaying of the list of configuration parameters which appears by entering "show" or "/" and pressing on „ENTER" key;
- to display a summary of configuration commands and their parameters („HELP"), enter "?" (question mark), or "/?" and press „ENTER" key;
- some subsystems have their own command set. To view a summary (set) of commands for a given subsystem, enter the set name and the "?" (question mark). For example, to display a set of commands for the GSM subsystem, enter the command "gsm?". The individual commands for a given subsystem can be entered by writing of "distinguishing" command for the given subsystem followed by the command itself (after the space). For example, setting the APN for GSM communication is done with the command "gsm apn", where "gsm" is the distinguishing command for the GSM subsystem and "apn" is the command for configuring the APN. The distinguishing commands for each set are listed at the end of the "HELP" configuration command summary;
- when entering characters, distinguish strictly the capital and small letters (according to the documentation or „HELP");
- Do not enter other characters than those listed in „HELP" or in the documentation, otherwise you would be risking the unwanted command enter that might be the same as the ones used for manufacturer settings, diagnostics or service and repair.

3.4 Setting parameters of the WL868-RFG module using the configuration cable

The next part of the manual describes those parameters of the WL868-RFG module whose current value can be determined by directly connecting the module to a PC using the configuration cable and, if necessary, changed from the command line of the PuTTy program as described in section 3.3 of this document.

3.4.1 Listing configuration parameters of the WL868-RFG module

The configuration parameters are listed by entering the **"show"** command on the command line and pressing the "ENTER" key. The following output appears in the terminal window:

```
LORA-GW3440#show

-- CPU info --
CPUID : 411fc271
FPU Type : 00000002
 Flash size 2048 kB
 Flash bank size 1048576 B, 0x00100000
 Flash base addr 0x08000000
 CPU UID 3339510a001c0036

SW version 1.22, date Jul  1 2025

-- HW configuration --
 Active bank : 1
 Name : GW33H
 Type : 2, version 1
 Vendor ID : 0000000000
 Mac addr : 0004d0ffffff
 x32 0.00 ppm
 In slot P card : 'SX1302 Lora', type 150, version 1
 In slot L card : 'SIM7600E GSM32', type 140, version 1
LORA-GW3440#
```

As can be seen from the example, the output contains module identification data, information about its hardware configuration and software version.

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

The summary of configuration commands is displayed by entering the **"?"** command. The following output appears in the terminal window:

```
LORA-GW3440#?
 Help :
 --- System commands ---
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
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
reset             : Reset device
fs                : Test FS
free              : Show free memory
users             : Show users
useradd           : create users passwd
userdel           : delete users
userpass          : change user's password
cfgserver         : Config server IP
cfgport           : Config server port
usecfgserver      : Use config server, 0 - no, 1 - yes
nepserver         : Default NEP server IP
nepport           : Default NEP server port
 --- Utils ---
 tz                : Timezone, default CET-1CEST,M3.5.0,M10.5.0/3
loca              : location (0-63 chars)
ekey              : Set encrypt key, point '.' no encrypt
nepkey            : Set index for nep key, 0 - disabled
neptrapkey        : Set index for nep trap key, 0 - disabled
write             : Write configuration to flash
cread             : Read configuration from flash
clear             : Clear configation and load defaults
ping              : Send ICMP ping to address
sens              : show sensors values
ls                : show all config file names
rm                : delete file
mkdir             : create dir
cat file          : show config file
mount             : mount sd
unmount           : unmount sd
deb               : set debug
?                 : Show this help

sys               : System commands
ip                : IP commands
disp              : Display command
sx                : sx1302 commands
ntp               : NTP command
lora              : Lora gateway command
gsm               : GSM command
hist              : history table command

LORA-GW3440#
```

In the upper part of the output (up to the "?" command), the main commands are listed. These commands set the

functionality of the module as a whole and are always entered directly after the prompt.

In the lower part of the output (after the blank line, starting with "sys"), the names of the individual module subsystems that have their own commands are listed. These commands are displayed by entering the subsystem name followed immediately by the "?" character (without a space). Example of displaying commands for the "ntp" subsystem:

```
LORA-GW3440#ntp?
 Help :
rest             : restart
info             : NTP info
ena              : NTP enable
srv1             : NTP server 1
srv2             : NTP server 2
srv3             : NTP server 3
write            : save configuration
deb              : NTP info
?                : show help
```

The listed commands can be used only for the given subsystem, by entering first the subsystem name after the prompt and then, after a space, the command itself. Example of entering the "info" command for the "ntp" subsystem:

```
LORA-GW3440#ntp info
NTP info :
  172.16.17.1, status : wait, stratum : 0, reach : 0, delay 0, timeout 1671
* 172.16.16.1, status : wait, stratum : 2, reach : 3, delay 143, timeout 1681
```

The meaning of the individual commands, including subsystem commands, is described in the next part of this chapter.

3.4.3 Commands of the "System commands" group for checking the basic functions of the module

This group of commands is used for checking and diagnosing the basic functions of the module. The following commands are available:

```
 --- System commands ---
ta               : Show tasks
mb               : Show mail boxes
du addr          : Dump memmory
rb addr          : Read byte from addr
rw addr          : Read word from addr
rd addr          : Read dword from addr
sb addr val      : Set byte on addr
sw addr val      : Set word on addr
sd addr val      : Set dword on addr
port             : Show port [a,b,..]
show             : show info
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
reset            : Reset device
fs               : Test FS
free             : Show free memmory
users            : Show users
useradd          : create users passwd
userdel          : delete users
userpass         : change user's password
nepserver        : Default NEP server IP
nepport          : Default NEP server port
```

The commands **"ta", "mb", "du addr", "rw addr", "rb addr", "rd addr", "sw addr val", "sb addr**

val", "sd addr val", "tshort", "tlong", "port", "fs" and **"free"** are used only when troubleshooting faults and repairing the device at the manufacturer's site. **We strongly recommend not using these commands during device operation.**

The **"show"** command displays the current operating configuration (see paragraph 3.4.1):

```
cfg#show
```

The **time** or **date** command can be used to display the current RTC setting. Entering either of these commands without parameters displays the current RTC value of the module. Example:

```
LORA-GW3440#time
Time : RTC 11:11:56, systime 2021-05-05, 11:11:56
LORA-GW3440#date
Date is 2021-05-05
LORA-GW3440#
```

The module can use time synchronization from the GSM network (see the GSM subsystem commands), or by periodically querying preset NTP servers (Network Time Protocol – see the NTP subsystem commands). The **time** and **date** commands (without parameters) can be used to display the current RTC (Real-Time Clock) values. If these sources are not available, these commands can be used to enter the RTC value manually:

```
LORA-GW3440#date 0x210505
Date is 2021-05-05
LORA-GW3440#time 0x111533
Time : RTC 11:15:33, systime 2021-05-05, 11:15:33
LORA-GW3440#
```

As is apparent from the example, the "time" value is entered in the format "0x**hhmmss**", and the "date" value is entered in the format "0x**YYMMDD**". The manually entered value is automatically adjusted according to the time distributed via GSM or NTP when data from these external synchronization sources becomes available.

The **"uptime"** command displays the time since the module was switched on or since its last reset. This command is used only for checking and diagnosing the module; the "Uptime" value indicates when the last module reset occurred. The variable is of the "read only" type. Example:

```
LORA-GW3440#uptime
Uptime 304 sec - 0 day(s), 0:05:04
TSC 304589310 usec.
LORA-GW3440#
```

The **"reset"** command resets the module. After the reset, the saved set of configuration parameters is loaded from the FLASH memory. To keep the currently created configuration, the working configuration set must be saved to the FLASH memory before performing the reset (see paragraph 3.4.7). During the module reset, the connection to the module via the configuration serial line is usually interrupted and must be restored using the "Restart Session" command (in PuTTY, this command is available in the main program menu by right-clicking the top bar). Example of using the module reset command:

```
LORA-GW3440#reset
Reseting ...
 -- Remote Monitor --
Login :
```

The module supports access by multiple users with different login credentials. The **"users"** command displays all users:

```
LORA-GW3440#users
System users :
 'admin'
LORA-GW3440#
```

A new user is added using the **"useradd [login] [password]"** command:

```
LORA-GW3440#useradd servis servis654
User 'servis' created
LORA-GW3440#
```

This change must be saved to the Flash memory so that it is not lost when the module is reset or switched off. The creation of the new user can be checked using the "users" command:

```
LORA-GW3440#write
Write config ... 0
LORA-GW3440#users
System users :
 'admin'
 'servis'
LORA-GW3440#
```

A user is removed using the **"userdel [login]"** command. This change must also be saved. Example:

```
LORA-GW3440#userdel servis
User 'servis' was deleted
LORA-GW3440#
```

If all user accesses are accidentally deleted, the module automatically generates the default account admin/admin during restart.

The password of any user is changed using the **"userpass [login] [oldpassword] [newpassword]"** command:

```
LORA-GW3440#userpass admin admin admin223
Password changed
LORA-GW3440#write
Write config ... 0
LORA-GW3440#
```

The **"nepserver"** and **"nepport"** commands are used to enter the default IP address and port number of the server to which the gateway will forward messages from the radio network. This setting is applied if the gateway has not received a "setup packet", or if the setup packet has expired (see the description of the gateway functionality in chapter **??** "Data messages of the WL868-RFG module").

Example of setting the server IP address and port number for sending messages:

```
LORA-GW3440#nepserver
Config server IP : 0.0.0.0
LORA-GW3440#nepserver 10.0.0.8
Config server IP : 10.0.0.8
LORA-GW3440#
LORA-GW3440#nepport
Config server port : 1141
LORA-GW3440#nepport 1142
Config server port : 1142
LORA-GW3440#
```

3.4.4 Commands of the "ip" subsystem for checking module communication over an IP network

This group of commands is used for setting the module communication subsystem over an IP network. It includes the following commands:

```
LORA-GW3440#ip?
 Help :
info              : show IP info
arp               : show arp table
addr              : show interfaces
route             : show routing table
conn              : show connection table
phy               : show ethernet PHY registers
ethaddr           : set static address mask
ethroute          : set static default router
ethdhcp           : enable / disable DHCP
ethena            : enable / disable ethernet
write             : save configuration
deb               : debug lebel
reg               : show eth registers
?                 : show help
```

The **"ip info"** command is used to display the basic parameters of the IP subsystem. Example output:

```
LORA-GW-3440#ip info
IP info :
 Interfaces : 3
 ARP table size 100, free 100, usage 0
 ARP wait requests 0
LORA-GW-3440#
```

The **"ip arp"** command is used to display the module ARP table. The WL868-RFG module has no other active local port, so its ARP table will typically be empty. The **"ip addr"** command is used to display addresses and statistics of the individual communication ports of the module. Addressing example:

```
LORA-GW3440#ip addr
Interface lo, status Up, half duplex, MTU 1500
 IP Address : 127.0.0.1, mask : 255.0.0.0
 Rx packets 0, bytes 0, errors 0
 Tx packets 0, bytes 0, errors 0

Interface eth0, status Down
 MAC : 00:04:d0:ff:ff:ff
 Rx packets 0, bytes 0, errors 0
 Tx packets 0, bytes 0, errors 0

Interface ppp0, status Up, full duplex, MTU 1500
 IP Address : 10.2.1.177, mask : 255.255.255.255
 Rx packets 123, bytes 8940, errors 0
 Tx packets 126, bytes 9168, errors 0
LORA-GW3440#
```

The lo port (loopback) has the standard loopback address. For the WL868-RFG module, the Ethernet port is not active due to the function of the module; the PPP connection to the superior server is provided through the GSM subsystem. The module IP address is set on the PPP interface.

The **"ip route"** command is used to display the module routing table. Example output of the routing table:

```
LORA-GW3440#ip addr
LORA-GW3440#ip route

Routing table :
 IP : 10.2.1.177/32 (255.255.255.255) dev ppp0
 IP : 127.0.0.1/8 (255.0.0.0) dev lo
 IP : 0.0.0.0/0 (0.0.0.0) gw : 10.2.1.177
LORA-GW3440#
```

The first line defines the route to the superior network through the PPP connection, where the module IP address is associated with the virtual PPP port. The second line defines the route for loopback. The third line defines the default gateway, which is also available through the PPP connection.

The **"ip conn"** command is used to display communication statistics for individual protocols during communication subsystem diagnostics.

The **"ip ethaddr", "ip ethroute", "ip ethdhcp"** and **"ip ethena"** commands are used for setting communication through the Ethernet port. For this type of module, setting these parameters has no practical meaning. The **"ip reg"** command is used for Ethernet interface diagnostics (register listing); for the WL868-RFG module, the use of this command has no practical meaning.

The **"ip write"** command saves any changes in the settings of the "ip" subsystem.

The **"ip deb"** command sets debug outputs of the subsystem to the required level.

3.4.5 Commands of the "gsm" subsystem for checking module communication over the GSM network

This group of commands is used for setting and diagnostics of the "gsm" subsystem for module communication through the data services of the GSM mobile network.

It includes the following commands:

```
LORA-GW3440#gsm?
 Help :
apn              : APN
auth             : lcp auth type 0 - none, 1 - PAP, 2 - CHAP, 3 PAP/CHAP
user             : lcp user PAP/CHAP
pass             : lcp pass PAP/CHAP
pingip           : IP for icmp connection test
pingper          : Periode in sec. for icmp connection test
pingreq          : Req. count for icmp connection test
pingtim          : Timeout for icmp connection test
pin              : SIM pin
useip            : IP on/off
usegps           : GPS on/off
usetime          : Sync time on/off
info             : show GSM info
gps              : show GPS info
cmux             : show CMUX info
lcp              : show LCP info
deb              : GSM debug
write            : save current configuration
cread            : read configuration
at               : modem command
sms              : phone msg
restart          : Restart GSM modem
?                : show help
LORA-GW3440#
```

The **"gsm apn"** command sets the APN (Access Point Name) gateway name between the GSM network and the connected IP network. Example of setting the APN name "gr.softlink":

```
LORA-GW3440#gsm apn gr.softlink
APN : 'gr.softlink'
LORA-GW3440#
```

The **"gsm auth", "gsm user"** and **"gsm pass"** commands are used to set the access data for the GSM operator's IP network. The **"gsm auth"** command sets the required authorization method; the **"gsm user"** and **"gsm pass"** commands set the login and password. Example settings:

```
LORA-GW-3440#gsm auth 3
Auth type : 3
LORA-GW-3440#gsm user honza
lcpuser : 'honza'
LORA-GW-3440#gsm pass 125frsed238
lcppass : '125frsed238'
LORA-GW-3440#
```

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

```
LORA-GW3440#gsm pin 2583
SIM pin : '2583'
LORA-GW3440#
```

The **"gsm pingip", "gsm pingper", "gsm pingreq"** and **"gsm pingtim"** commands set the parameters for connection checking by the ICMP ping test:

- the "gsm pingip" command sets the IP address of the computer to which the ping will be sent
- the "gsm pingper" command sets the testing period in minutes
- the "gsm pingreq" command sets the number of tests performed in one series
- the "gsm pingtim" command sets the maximum ping response time

Example of setting ICMP ping test parameters:

```
LORA-GW3440#gsm pingip
Ping IP : 172.16.16.2
LORA-GW3440#gsm pingper
Ping periode : 60 sec.
LORA-GW3440#gsm pingreq
Ping req. count : 3
LORA-GW3440#gsm pingtim
Ping timeout : 10 sec.
```

With this setting, the module will send a series of three check ping requests to the computer "172.16.16.2" every 60 minutes. If none of the requests receives a response within 10 seconds, the module restarts the GSM connection.

GSM connection testing is a preventive measure against a situation where the PPP connection is terminated by the GSM network server, for example as a result of restarting the GSM network server. This situation causes loss of connection between the module and the superior data collection system; the module is not aware of the loss of the PPP connection and the connection cannot be restored by activity of the superior system.

The setting can be checked by using the "ping" command (see the description of this command in section 3.4.7 "Commands of the Ütilsgroup for communication checking and setting").

The **"gsm useip", "gsm usegps"** and **"gsm usetime"** commands with parameter "0/1" enable or disable individual services of the "gsm" subsystem:

- the "gsm useip" command activates the PPP connection to the IP network through GSM data services
- the "gsm usegps" command activates the GPS receiver that is part of the GSM subsystem
- the "gsm usetime" command activates time synchronization from the GSM network

Entering the command without a parameter displays the current setting. Example of checking activation of the listed services and then enabling time synchronization from the GSM network:

```
LORA-GW3440#gsm useip
Use GSM IP : 1
LORA-GW3440#gsm usegps
Use GPS : 1
LORA-GW3440#gsm usetime
Sync GPS/GSM time : 0
LORA-GW3440#gsm usetime 1
Sync GPS/GSM time : 1
```

The **"gsm info"** command displays basic information about the "gsm" subsystem settings, including data transmission statistics through the GSM interface. Example:

```
LORA-GW3440#gsm info
 GSM info :
  IMEI : 867584035706790
  CCID : 8942031020012105157
  IMSI : 230030092110515

  RSSI  : -51 dBm
  Data mode : LTE
  ppp connections : 1
  IP : 10.2.1.177
 Recv bytes : 16864
 Recv  pkts : 232
 Send bytes : 17092
 Send  pkts : 235
 Ping test : 172.16.17.1
  periode : 60 min.
  next : 9:16 sec.
  sent : 5
  recv : 5
  timeouts : 0
  restarts : 0
LORA-GW3440#
```

The **"gsm gps", "gsm cmux"** and **"gsm lcp"** commands display status information and statistics of the GPS module and statistics of the internal CMUX and LCP interfaces. The **"gsm restart"** command restarts the subsystem, and the **"gsm deb"** command sets debug outputs of the subsystem to the required level. These commands are used only for module diagnostics.

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

```
LORA-GW3440#gsm sms 603659910 test
Sending to '603659910' message 'test'
LORA-GW3440#
```

3.4.6 Commands of the "lora" subsystem for setting radio communication

This group of commands is used for setting and diagnostics of the "lora" subsystem for data transmission between the 868 MHz LoRaWAN radio network and the superior LoRaWAN network server. It includes the following commands:

```
LORA-GW-3440#lora?
 Help :
info              : show radio info
server            : lora gw IP
port              : lora gw port
deb               : debug lebel
write             : save current configuration
cread             : read configuration
?                 : show help
LORA-GW-3440#
```

The **"lora info"** command displays basic information about the settings of the "lora" radio subsystem, including statistics of data transmission through the radio interface and data transmission to the superior server. Example:

```
LORA-GW-3440#lora info
Lora info :
Radio info [0]:
 EUI[0] : 0x0016C001F11617D0
 Temp : 27.0 °C
 Last RSSI  : -107 dbm
 Recv  pkts : 17
 Send  pkts : 0
 Recv error : 0
 Radio err  : 0
Lora stats :
 Recv  pkts : 17
 Send  pkts : 0 from 0
 Send  push : 110
Resend push : 85
 Recv  ack  : 0
Push timeout: 17
 Send  pull : 258
 Recv  ack  : 0
 Stat periode : 300 sec.
 Pull periode : 10 sec.
Lora server IP : 172.16.17.25
Lora server port : 1700
LORA-GW-3440#
```

The first line of the output shows the unique LoRa device identifier **EUI**, which is used to identify the device in the network. The identifiers are assigned by the manufacturer of the radio chips and cannot be changed.

The next part of the output contains **operating statistics** of received, sent, repeated and error packets at the level of radio communication in the 868 MHz network and at the level of communication with the network server. These values are used for system diagnostics.

The **Stat periode** value shows the setting of the period for transmitting information about the current status of the module. The **Pull periode** value shows the setting of the period for transmitting a short "Pull Packet" (without JSON), which serves as a "Heartbeat" – information that the gateway is ready to receive data. Both periods are fixed by the manufacturer and cannot be changed.

The lower part of the output shows the currently set **address data** of the network server (IP address, port number). These values can be changed by using the **"lora server"** and **"lora port"** commands as follows:

```
LORA-GW-3440#lora server 172.16.17.25
Lora server IP : 172.16.17.25
LORA-GW-3440#lora port 1700
Lora server port : 1700
LORA-GW-3440#
```

The **"lora deb"** command sets debug outputs of the "lora" subsystem to the required level.

The **"lora write"** command saves any changes in the "lora" subsystem settings to memory.

The **"lora cread"** command loads the stored parameters of the "lora" subsystem from memory. Example:

```
LORA-GW-3440#lora cread
Reading Lora configuration .. ok, 5 bytes
LORA-GW-3440#
```

3.4.7 Commands of the "Utils" group for communication checking and setting

This group of commands is used for checking and setting basic operating system functions and basic communication functions of the module. It includes the following commands:

```
  --- Utils ---
  %tz
loca             : location (0-63 chars)
ekey             : Set encrypt key, point '.' no encrypt
nepkey           : Set index for nep key, 0 - disabled
neptrapkey       : Set index for nep trap key, 0 - disabled
write            : Write configuration to flash
cread            : Read configuration from flash
clear            : Clear configation and load defaults
ping             : Send ICMP ping to address
sens             : show sensors values
deb              : set debug
ls               : show all config file names
rm               : delete file
mkdir            : create dir
cat file         : show config file
mount            : mount sd
unmount          : unmount sd
deb              : set debug
?                : Show this help
```

The **"loca"** command can be used to set an individual module designation, for example according to its location. Up to 63 alphanumeric characters can be entered. Example of setting an individual module designation:

```
LORA-GW-3440#loca unhost
Change location from : '' to : 'unhost'
LORA-GW-3440#
```

The **"Encryption key"** variable is used to set encryption keys for message encryption using the AES-128 key. Up to four encryption keys can be added to the table. These can be assigned to individual communication channels using other commands ("nepkey", "neptrapkey"). An encryption key with a length of 16 bytes is entered using the **"ekey"** command followed by a space, the index (1 to 4), and, after another space, a 16-byte string that can be entered in decimal or hexadecimal form (see examples).

Example of entering an encryption key in hexadecimal form:

```
LORA-GW-3440#ekey 3 0x2a 0x35 0x9f 0xbc 0xff 0x8a 0xf1 0xca 0x88 0x15 0x62 0x93 0xeb 0x0f 0x91 0x88
New key[3] :2a359fbcff8af1ca88156293eb0f9188
LORA-GW-3440#
```

Example of entering an encryption key in decimal form:

```
LORA-GW-3440#ekey 4 42 53 159 188 255 138 241 202 136 21 98 147 235 15 145 136
New key[4] :2a359fbcff8af1ca88156293eb0f9188
LORA-GW-3440#
```

The list of entered encryption keys can be displayed by using the "ekey" command without a parameter:

```
LORA-GW-3440#ekey
Key[1] : a61e8d65d04df7270b7722c2ea89f72a
Key[2] : a61e8d65d04df7270b7722c2ea89f72a
Key[3] : 2a359fbcff8af1ca88156293eb0f9188
Key[4] : 2a359fbcff8af1ca88156293eb0f9188
LORA-GW-3440#
```

Encryption is disabled by entering the "." (dot) parameter after the "ekey" command:

```
LORA-GW-3440#ekey 4 .
Key[4] disabled
LORA-GW-3440#
```

The **"nepkey"** command assigns one of the entered keys to the communication channel between the gateway and the central data collection system, which is encoded using the "NEP" protocol. Messages encoded in the NEP protocol are used for remote supervision of the device. By entering an encryption key, communication between the gateway and the data collection application will be encrypted in both directions. Example of assigning the key with index "3" to the channel with NEP encryption:

```
LORA-GW-3440#nepkey 3
NEP key index : 3
LORA-GW-3440#
```

Similarly, the **"neptrapkey"** command can be used to set the encryption key for encryption of spontaneous alarm messages ("traps"). In the current version, the module does not send any spontaneous alarms, so using this command has no practical meaning.

The **"write", "cread"** and **"clear"** commands are used to control saving the configuration to memory. The module contains two configuration sets: the operating configuration and the stored configuration. At system start, the module copies the stored configuration to the operating configuration, with which it then continues to work. If the user changes configuration parameters, the changes are made only in the operating configuration.

If the current operating configuration is not saved to FLASH memory, after a reset the module returns to the set of configuration parameters stored in FLASH. If a parameter is set only temporarily (for example, debug outputs are enabled), the operating configuration does not need to be saved to FLASH memory (debug outputs will be switched off after the work is finished anyway). However, if the currently changed operating parameters are to remain set permanently, after setting the given parameter or parameters the configuration must be saved to FLASH memory.

The current operating configuration is written to FLASH memory by the **"write"** command:

```
LORA-GW-3440#write
%Write config ... 0
LORA-GW-3440#
```

The configuration is loaded from FLASH memory by the **"cread"** command:

```
LORA-GW-3440#cread
Read config ... 39
LORA-GW-3440#
```

The configuration is deleted from Flash memory by the **"clear"** command:

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

This command deletes the configuration parameters from FLASH memory and they must be set again. If the module is reset after FLASH memory has been cleared, the default set of parameters defined in the device program is written to FLASH memory after reset.

We recommend using this command only to users with good knowledge of the system, or after consultation with the manufacturer.

The availability of the IP connection between the WL868-RFG module and any computer on the Internet can be checked using the ICMP "ping" function by entering the **"ping [address]"** command. When this command is entered, the system sends a control ping to the specified IP address and displays the result. Example:

```
LORA-GW-3440#ping 172.16.15.1
PING ip 172.16.15.1 ..
 resp. time 131 ms
 resp. time 33 ms
 resp. time 60 ms
LORA-GW-3440#
```

The **"sens"** command displays the values of the integrated module sensors (power supply, processor temperature). This command is used only for module checking and diagnostics.

```
LORA-GW-3440#sens
 -- Sensors --
CPU  :  34.6 $^\circ$C
VDA  : 3.342 V
LORA-GW-3440#
```

The **"deb"** command enables setting debug outputs for the "monitor" subsystem to the required level (1 to 3). This command is used only for module checking and diagnostics. The "deb" command without a parameter displays the debug output level settings for all subsystems. Example of enabling "monitor" debug outputs to level "1" and then checking the debug output settings:

```
LORA-GW-3440#deb 1
Change mondebug level from 0 to 1
LORA-GW-3440#deb
Debug level :
 monitor - 1
 eth - 0
 display - 0
 gsm - 0
 wmbus - 0
LORA-GW-3440#
```

The **"ls"**, **"rm"**, **"mkdir"**, **"cat"**, **"mount"** and **"unmount"** commands allow manual interventions in the module file system. These commands are not required for normal module operation. They can be used in case of module modernization (adding HW/SW components) or restoring module functionality, for example after unintentional deletion of the directory with stored configurations by an unqualified intervention of the operator. The individual commands have the following purpose:

ls [/dir]	*listing files in the specified directory*
rm [/dir/file]	*deleting a directory or file*
mkdir	*creating a new directory*
cat [/dir/file]	*viewing the specified configuration file*
mount	*mounting an external disk*
unmount	*disconnecting an external disk*

Example of listing directory contents and viewing a configuration file (which must always be in the "/etc" directory):

```
LORA-GW-3440#ls
Readdir '/'
  256 2020-01-01, 0:00:00 /.
  256 2020-01-01, 0:00:00 /..
  256 2020-01-01, 0:00:00 /etc
LORA-GW-3440#ls /etc
Readdir '/etc'
  256 2020-01-01, 0:00:00 /etc/.
  256 2020-01-01, 0:00:00 /etc/..
  124 2020-01-01, 0:02:38 /etc/gw.cfg
  165 2021-05-06, 11:47:59 /etc/network.cfg
  157 2021-05-05, 12:11:39 /etc/gsm.cfg
  254 2021-05-06, 11:47:59 /etc/system.cfg
LORA-GW-3440#
```

```
LORA-GW-3440#cat /etc/gsm.cfg
Show file '/etc/gsm.cfg' :
[gsm]
apn = gprsa.softlink
pin = 1234
useip = true
usegps = true
synctime = false
pingip = 172.16.17.1
pingperiode = 60
pingreqcount = 2
pingreqtimeout = 10
LORA-GW-3440#
```

The file system control commands are intended mainly for the manufacturer and we **strongly recommend not using them** without detailed knowledge of the module function. For normal operation, only the use of the "cat" command for checking the current module configuration may be useful.

3.4.8 Commands of the "sys", "disp" and "sx" subsystems for initial setting and diagnostics of the module

The commands of these three subsystems are used for the initial setting of the module during production and commissioning of the motherboard ("sys"), display ("disp") and radio chip ("sx").

We strongly recommend not using these commands during device operation.

3.4.9 Commands of the "ntp" subsystem for time synchronization setting

This group of commands is used for setting the system time synchronization subsystem (RTC) from network servers of the NTP (Network Time Protocol) system. It includes the following commands:

```
LORA-GW-3440#ntp?
 Help :
rest             : restart
info             : NTP info
ena              : NTP enable
srv1             : NTP server 1
srv2             : NTP server 2
srv3             : NTP server 3
write            : save configuration
deb              : NTP info
?                : show help
LORA-GW-3440#ntp info
```

Time synchronization from NTP servers can be enabled or disabled by using the **"ntp ena [0/1]"** command.

Up to three NTP servers can be set for synchronization by using the **"ntp srv1", "ntp srv2"** and **"ntp srv3"** commands, where the command parameter is the server IP address.

The current subsystem settings can be displayed by using the **ntp info** command.

Example of using commands for setting RTC synchronization:

```
LORA-GW-3440#ntp ena 1
Ntp is enable
LORA-GW-3440#ntp srv1 172.16.17.1
Server[1] : 172.16.17.1
LORA-GW-3440#ntp info
NTP info :
+ 172.16.17.1, status : wait, stratum : 2, reach : 48, delay 39, timeout 1758
* 172.16.16.1, status : wait, stratum : 2, reach : 51, delay 54, timeout 1768
LORA-GW-3440#
```

The output shows that synchronization was enabled by the "ntp ena" command, the NTP server was set by the "ntp srv1" command, and the setting was checked by the "ntp info" command.

The **"ntp write"** command saves the setting.

The **"ntp restart"** command restarts the subsystem, and the **"ntp deb"** command sets debug outputs of the subsystem to the required level.

3.4.10 Commands of the "hist" subsystem for viewing records in the "History" table

The **"History" subsystem** is used to support gateway operation. It contains a table with records of the last received messages from all end radio devices whose message was received by the gateway during the last 150 minutes. Each end device always has only one record in the table, regardless of how many messages from that device the gateway captured during the last 150 minutes. The maximum capacity of the table is 960 records; if the gateway receives more messages within the given interval, the oldest messages are always deleted. The "History" record table is used for monitoring gateway operation. According to the table records, it is possible to determine which end devices are within the radio range of the gateway and with what signal strength the gateway receives their signal. The content of the "History" table can be viewed through the module web interface (see 3.6 "Setting module parameters via the Internet").

The "hist" command group is used to check the "History" subsystem. It includes the following commands:

```
LORA-GW-3440#hist?
 Help :
info             : show table info
hash             : show hash detail
rec              : show table records
?                : hashtable help
LORA-GW-3440#
```

The **"hist info"** command displays the number of records in the table, and the **"hist hash"** command displays a listing from the hash table used for storing records. This information is intended only for subsystem diagnostics.

The **"hist rec"** command displays the content of the "History" table, where records of the last messages from individual devices are stored. Example:

```
LORA-GW-3440#hist rec
Hash record list :
LORA : 0x0015e5f3, RSSI -123, time : 2026-12-03, 23:05:05
LORA : 0x0200007f, RSSI -120, time : 2026-12-03, 23:04:28
LORA : 0x0015e14b, RSSI -121, time : 2026-12-03, 23:03:49
LORA : 0x02000082, RSSI -121, time : 2026-12-03, 22:58:18
LORA : 0x0200007e, RSSI -116, time : 2026-12-03, 22:54:48
LORA : 0x04000004, RSSI -122, time : 2026-12-03, 22:51:45
Hash records : 6
LORA-GW-3440#
```

The output shows that the gateway received messages from six end devices during the last 150 minutes. Each record contains the device identification in the LoRa network (LoRa Network Address), the RSSI value (Received Signal Strength Indicator), expressing the signal strength of the last received message, and the time of reception of the last message from the given device.

The command can be used, for example, during gateway installation when it is necessary to make sure that its location ensures reliable reception of signals from all devices it is expected to serve. Compared with using the diagnostic options of the network server (which also has the same information available), the advantage is the possibility to obtain the required information even when the connection to external servers through the uplink is not yet available.

3.5 Displaying parameters of the WL868-RFG module on the LCD display

The WL868-RFG module is equipped on the front panel with a multi-line **LCD display** and **control buttons**, which are used to display selected identification, configuration and operating data of the module.

After the module is switched on, the LCD display shows basic data about the module (see Figure 5 on the left).

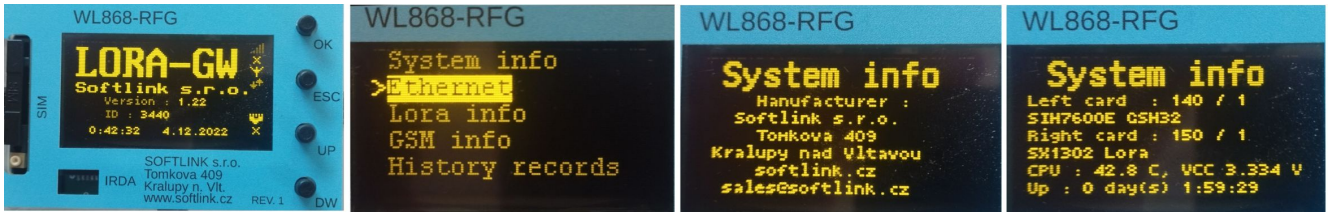

Figure 5: Main screen, menu and system information display

The main screen (first from the left) contains the manufacturer name, device type and version, device ID (serial number) and system time. On the right side of the display there is a set of symbols indicating the status of the basic communication channels of the module:

- at the top there is a standard "signal strength" icon symbolizing **communication via GSM**, with a graphical representation of GSM signal strength. Below the symbol there are up and down arrows, which flash each time a message is received (down) and sent (up);
- in the middle there is an antenna pictogram symbolizing **communication through the 868 MHz radio network**. Below the symbol there are also up and down arrows, which flash each time a LoRa message is received and sent;
- at the bottom there is a data network pictogram symbolizing **communication through the Ethernet port**. Below the pictogram there is an "X" symbol, by which the system indicates that this port is not active.

Pressing the "OK" button opens the display of additional data in the form of the main menu (see Figure 5 – second from the left).

The four control buttons to the right of the display are used to select individual menu items and have the following functions:

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

In the current module version, basic module data 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
- 868 MHz radio interface statistics ("Lora info")
- listing of current records of the "History" table

A preview of the display of individual menu items is shown in Figure 6.

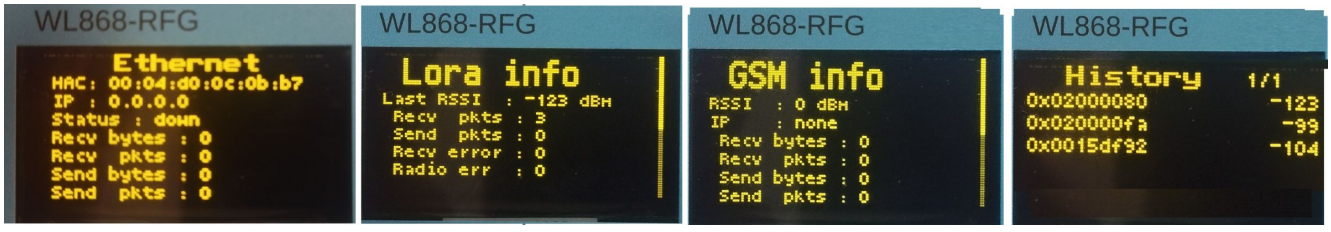

Figure 6: Preview of Ethernet, LoRa, GSM and History menu item displays

3.6 Setting module parameters via the Internet

Because the WL868-RFG module, by the principle of its gateway function, is always connected to the Internet, standard tools commonly used in IP networks can also be used for its remote management:

- "ICMP" for checking module availability
- "Telnet" for remote access to the module configuration console
- "TFTP" for downloading and uploading module configuration files
- "HTTP" for displaying some data through the module WEB interface

Checking module availability using the "ICMP ping" application is performed from the command line of any computer by entering the "ping" command and the IP address of the module. Example of checking availability by 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>
```

Configuration of module parameters can be performed through remote access using the "Telnet" application. An example of remote connection to the module via the Telnet application from the PuTTY program is shown in Figure 7:

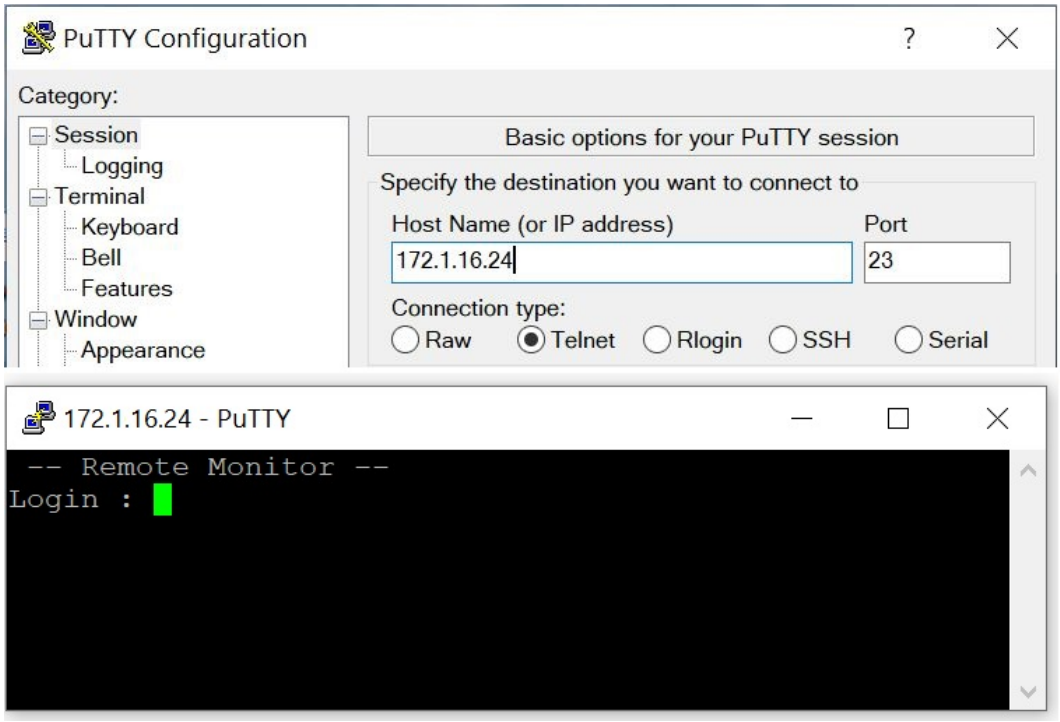

Figure 7: Connection to the WL868-RFG module using the Telnet protocol

The upper part of the figure shows the PuTTY program settings for communication using the Telnet protocol; the lower part shows a preview of the remote access configuration window.

The procedure for configuring the module through the Telnet remote access application is the same as when connecting the computer locally to the module through a USB cable.

All important configuration parameters of the module are stored in configuration files. An efficient method of remote configuration is to make the required changes **by modifying the relevant configuration file using the TFTP protocol**. The change is performed by downloading the required file, editing it and uploading the modified

file back to the module. This configuration method makes it possible to keep backups of configuration files, prepare and test changes locally in advance, and then replace the file itself very quickly, with minimal disruption to module operation.

The configuration files can be listed using the "ls" command and viewed using the "cat" command. An example of listing the configuration files and viewing the content of the "gw.cfg" configuration file is given in section 3.4.7 "Commands of the Ütilsgroup for communication checking and setting".

The module is also equipped with a WEB server, which enables **displaying some parameters using the HTTP protocol**. Currently, it is possible to display through a WEB browser the **content of the "History" table** with a list of all devices whose messages the module has received during the last 150 minutes (see Figure 8).

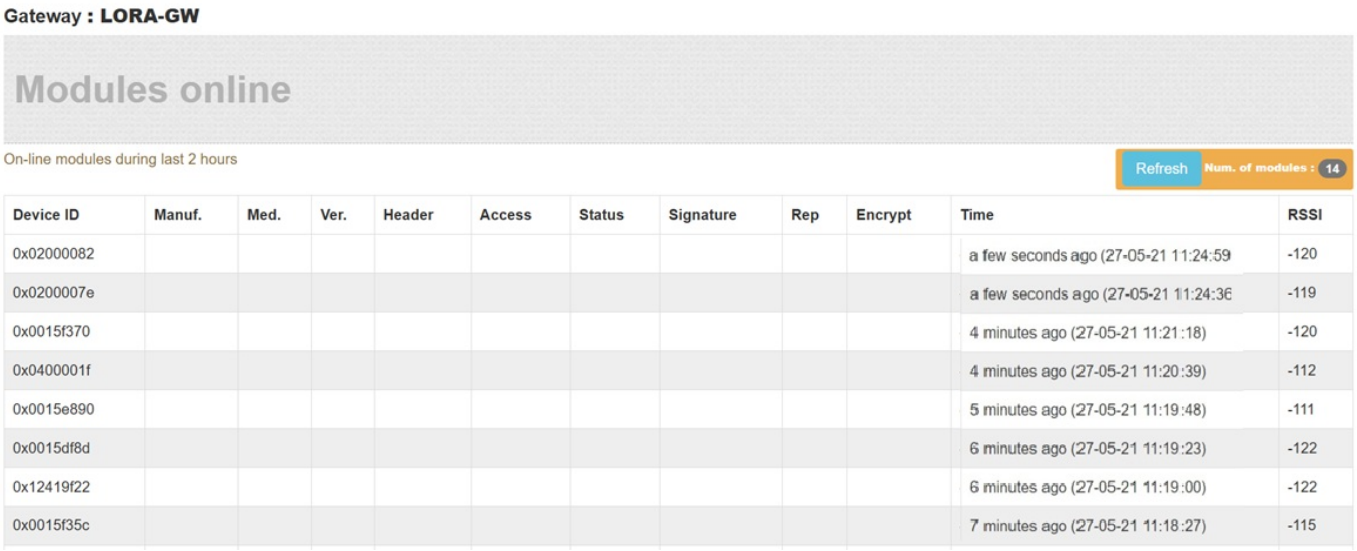

Figure 8: Displaying the "History" table of the WL868-RFG module via HTTP

The "History" table displays the following data:

- "Device ID" - device identification (LoRa Network Address)
- "Manufacturer" - manufacturer code according to the M-Bus standard
- "Medium" - medium code according to the M-Bus standard
- "Version" - generation/version number according to the M-Bus standard
- "Access" - message sequence number according to the M-Bus standard
- "Status" - device error status according to the M-Bus standard
- "Signature" - encryption type and parameter according to the M-Bus standard
- "Rep" - message repetition flag ("true" - the message was repeated)
- "Encrypt" - message encryption flag ("true" - the message was encrypted)
- "Time" - message reception time
- "RSSI" - signal strength with which the message was received

The identification data according to the M-Bus standard and the "Rep" message repetition flag are intended for gateways operating in the Wireless M-Bus system. For the WL868-RFG module, these columns in the table have no meaning and are always empty. The table can be used to verify reception capability for a specified set of devices, for example after a change in gateway installation (replacement, relocation, new antenna, etc.), or to verify whether the gateway receives data from a newly installed device.

4 Operational conditions

This section of the document describes basic recommendations for transportation, storing, installation and operation of WL868-RFG radio modules.

4.1 General operational risks

Radio modules WL868-RFG are electronic devices powered from the external power source that receive radio messages from surrounding terminals and forward these messages to the superior server over the Internet. They are connected to the Internet via GSM data services (GPRS, UMTS, LTE). During the operation of the modules there are following potential risks:

4.1.1 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 ÷ +50)°C, with humidity up to 90% without condensation. Direct installation of the equipment in outdoor areas is not possible.

4.1.2 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.

To connect external antennas, it is necessary to use standardized good quality coaxial cables and lead them as far from the 230V/50Hz power lines as possible.

4.2 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.

4.3 Modules storage

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

4.4 Safety precautions

Warning! Mechanical and electrical installation of the WL868-RFG module can be provided only by a person with necessary qualification in electrical engineering.

4.5 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.

4.6 WL868-RFG module installation

WL868-RFG radio modules are enclosed in plastic casings with an IP20 degree of protection equipped by plastic locks for mounting on the DIN-rail. Casings should not be open under mounting, dismantling and normal operation. A view of the WL868-RFG module mounted on the DIN-rail in the distribution cabinet is shown in Figure 9.

Figure 9: View of installed WL868-RFG module

The module in the picture has an external 868 MHz antenna (the antenna cable is at the top right of the module), a stick GSM antenna (at the top left of the module). The power cable is connected at the bottom on the left side of the module, and an Ethernet cable is connected at the bottom right.

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 4.1.1 „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 4.1.2 „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 4.9 „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.

4.7 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 4.6. 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.

4.8 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.

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 Internet connection via GSM-modem and testing of the receiver functionality in the „Radar" mode.

A quick check of the functionality of the Internet connection can be performed immediately after switching on the module using the data on the LCD display. Check the connection to the GSM network in the „GSM Info" display, check the functionality of the 169 MHz receiver can be done by displaying the terminals within the reception area with using of the „History" table.

The „History" table is filled in gradually as the individual terminal devices „ring" one after the other. When installing a local LoRaWAN collecting network, it is advantageous to put the gateway into operation first, and just

then the individual terminal devices. This way it is possible to check continuously the success of the installation of individual terminals from the laptop with the „Modules online" („Radar") table opened in the WEB browser (see the description in paragraph 3.6 „Setting the module parameters via the Internet data network". This way the quality of the connection between the transmitting devices and the communication gateway can be also checked.

A detailed check of the settings of all parameters can be performed using a laptop and a program for communication over the serial line (for example „PuTTY") as described in paragraph 3.4 „Configuration of the WL868-RFG module by using the configuration cable ".

4.10 Operation of the WL868-RFG module

Receiving radio messages from surrounding radio modules and forwarding of the messages to the superior system via Internet the WL868-RFG module performs fully automatically.

The greatest risks of the signal losses from surrounding radio modules are commonly caused by human activities within the installation. It is mainly about the following risks:

- turning off the module power (e.g. circuit breaker failure or unintentional shutdown);
- malfunction of the Internet connection caused by a local failure of the GSM network, or failure of the PPP connection caused by incorrect functioning of the authorization servers or other devices of the GSM operator;
- temporary or permanent shading of the antenna (e.g. due to building operations);
- mechanical damage of the module, the antenna cable or the antenna when handling things at the installation site.

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

In case of loss of income data from large number (or all) reading modules, it is recommended to contact the installation site caretaker and ask for the potential cause of the anomaly or perform the physical check on the installation site.

5 Troubleshooting

If during installation or operation anomaly or malfunctions are detected, the probable cause of the failure can be found in the following manner:

1. No data come from the gateway; no data are available from the devices which communicate via the gateway (hereinafter as „reading modules"). In this case try to find the cause of the failure as follows:
   - Find out whether there is an IP-connection between the gateway and the superior system by using of the standard "ping" test commonly used in the IP-network:
     - if the gateway is connected directly to the public network (it has a public IP-address), it should respond to "ping" test from any computer with an access to the public Internet;
     - if the gateway is connected to a private network (it has a private IP-address) and there is an access to the edge router of the private network available, try to use "ping" test from the edge router;
     - if the gateway is connected through a VPN/APN, "ping" test can be performed from the computer which has access to the VPN/APN.
     - Availability of the gateway and its functionality can be verified by using the WEB-application „Modules Online" („Radar") as described in paragraph 3.6.
   - If the gateway is accessible and functional, try to find out the reason why the gateway does not receive the signals from reading modules under the proceeding described in the paragraph 2;
   - If the gateway is not accessible examine its power supplying, especially:
     - whether there has been a power failure in the object,
     - whether the power supply is on,
     - whether the gateway is really under power supplying (the „Power" LED should be shining).
   - If the power supplying of the gateway is not working, repair wiring, power supply or A/C power input.
   - If the power supplying is correct and the gateway is not accessible, search for any circumstances which may affect the IP-connectivity, especially if the local Internet access in the installation site is currently available, if there are any changes in routing or in IP-addressing, or whether the **PIN-control of the SIM is turned off**.
   - If the IP-connectivity is most likely available and the power supply is correct (LED „Power" on the module shines), perform a quick check of connection to the local network according to the paragraph 4.9. In case that the gateway has no IP-address assigned, check functionality of the local IP network and reset the module by disconnecting and connecting of the power supply (the source off/on). If this intervention does not restore communication, replace the gateway according to the paragraph 4.7. If after replacing the new module works correctly, label the dismantled module as "defective". If there is no apparent physical damage on the module and it is still under warranty, follow the warranty claim procedure;
   - If the neither restart nor replacing of the module do not lead to restoration of the connection between the gate and the superior system, solve the problem of IP-connectivity with experts in routing within IP-network.
2. The module evidently communicates, answers to "ping", the result of the quick test of the gateway availability is „OK", but data does not come from all (or most) reading modules which communicate via the gateway. In this case try to find the cause of trouble following way:
   - Check receiving functionality of the module in „Modules online" („Radar") mode as described in the paragraph 4.9. If there is no device in the „Radar" table even after a long time, the module probably does not receive any messages;
   - Ensure that there are no changes in the object, which could have the fatal effect on receiving quality;
   - Check the module visually for any damage of the antenna, antenna cable or connector. If there are any doubts about functionality of any of these components, replace it;
   - Check the module settings according to the paragraph 3.4.6 (Commands of "gw" subsystem for setting of RF network communication), particularly settings of the communication mode and frequency channel parameters;
   - If the module is configured correctly perform measuring of the signal strength from reading modules by using of the analyzer (or other receiving device);

- If the signal from reading modules in the place of the WL868-RFG module installation is sufficiently strong and the module is set correctly, replace the module according to paragraph 4.7. If after the replacing a new module works correctly, label the dismantled module as "defective". If there is no apparent physical damage on the module and it is still under warranty, follow the warranty claim procedure;
- If even after replacing the new module does not work correctly, the possible cause of trouble could be the local radio interference or wrong settings that has not been discovered by examination. Check functionality of the exchanged module in different location (in area where other gateway is evidently working) and if the module works properly in another location, search for a source of interference or request a company with an expertise in the radio signal transmission to determine the cause of trouble.
- If the module does not work even at another location, go through its configuration again or try to set-up the spare module to the same configuration. If even spare module with the same configuration does not work, the trouble is probably in configuration details related to given purpose. Ask for support the manufacturer or other knowledgeable person.

3. The module evidently communicates, responds to "ping" tests, result of „Modules online" („Radar") test is positive, but the data from some reading modules are not received. In this case the problem may be caused by weakening of the signal in the area of the gateway antenna position, failure of the gateway receiver or radio interference at the installation site. Execute the similar examination as described in the point 2:
   - check the antenna, the antenna cable and the connector,
   - inspection of the gateway installation site,
   - inspection of reading modules installation sites.

   If all the results are correct and signals from reading modules measured by signal analyzer or referential receiver are sufficiently strong, replace gateway and proceed further as described in the point 2.

6 Additional information

This manual is focused on the description, parameters and configuration options of the WL868-RFG communication gateway, used to provide communication in the LoRaWAN network according to ITU-T Recommendation Y.4480 for the 868 MHz band. This device is part of the **wacoSystem** product family by SOFTLINK. More information about the WL868 (LoRa), WM868 (WACO, LoRa, Wireless M-Bus), WB169 (Wireless M-Bus), WS868 (Sigfox) or NB (NB-IoT) module series can be found on the manufacturer's website:

www.softlink.cz

If you are interested in any information related to the use of WL868, WM868, WB169, WS868, NB series radio modules or other SOFTLINK devices for the IoT area, please contact the manufacturer:

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