GLOBAL
ELECTRONIC
SOLUTIONS

Narrowband RF Communication Module
GES-RF869

User Manual

Model name: GES-RF869
Company name: Global Electronic Solutions d.o.o. Novi Sad

Table of Contents

1 Device overview

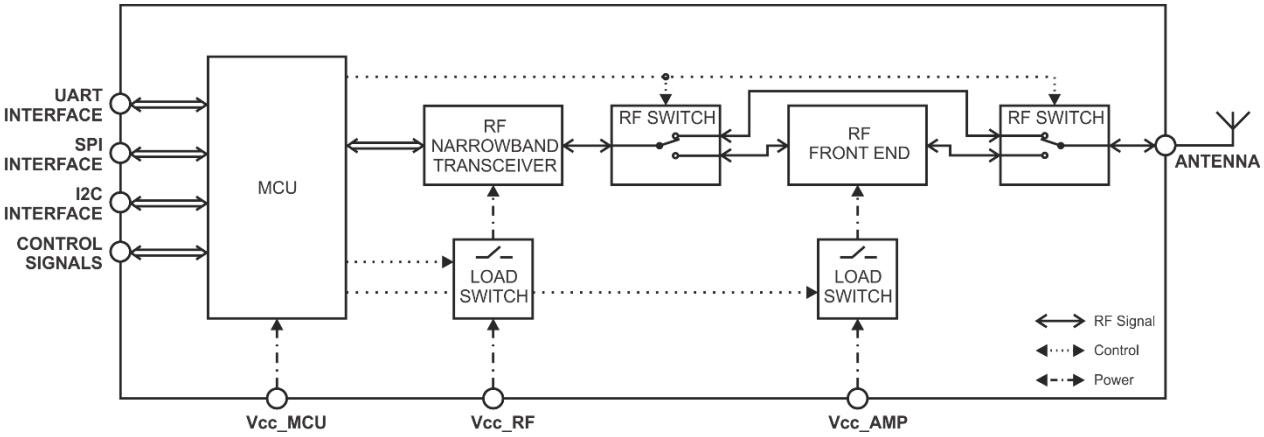
1.1 Description

GES-RF869 is a radio module which is in compliance with ETSI EN 300 220-1. This module provides possibility of exchanging small packets of data, up to 100 Bytes, with low speeds, in a relatively simple way. It works on operational frequency band 869,400MHz-869,650MHz which enables it to have radiated power of up to 27dBm (500mW). It provides duty cycle control and obeys 10% duty cycle restrictions for 869,400MHz-869,650MHz frequency band. It offers multiply radio communication channels inside operational frequency band and possibility of transmit power configuration.

1.2 Basic Features

- Transmit power: configurable from 10mW(10dBm) to 500mW(27dBm)
- Radio communication baud rate: 1200bps, 19200bps
- Max receiving sensitivity: -129dBm(1200bps), -116dBm(19200bps)
- Number of radio communication channels: 11
- Communication interface: SPI and UART
- Power saving sleep mode
- Data exchange in packets
- Minimum send/receive data in packet: 1 Byte
- Maximum send/receive data in packet: 100 Bytes
- Option of packet address filtering

1.3 Functional Block Diagram



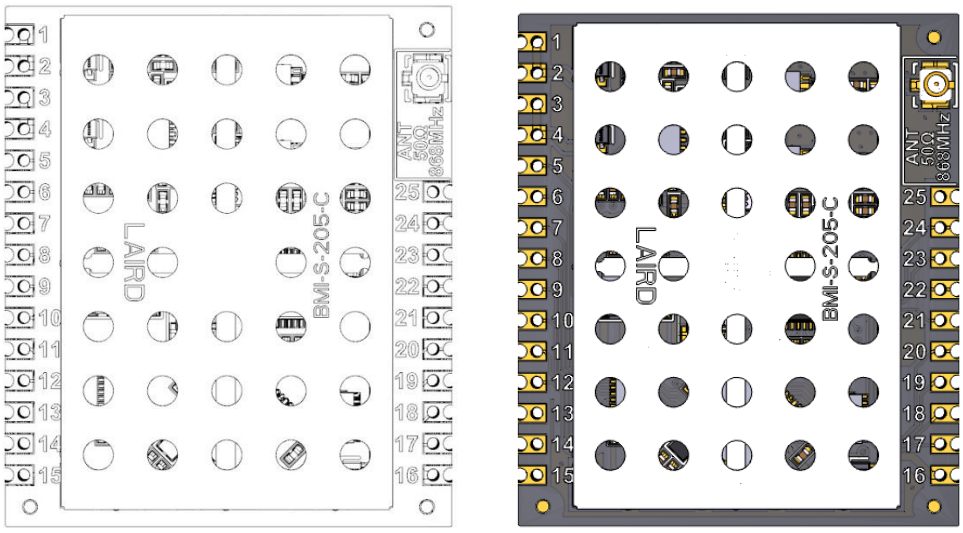
Module consists of three main components:

- MCU which provides module functionality and implements communication interfaces
- RF Narrowband Transceiver which controls radio communication and directly sends/receives data for low power data exchange (power levels 1-5)
- RF Front End which is used to amplify transmitted/received radio signal for high power data exchange (power levels 6-10)

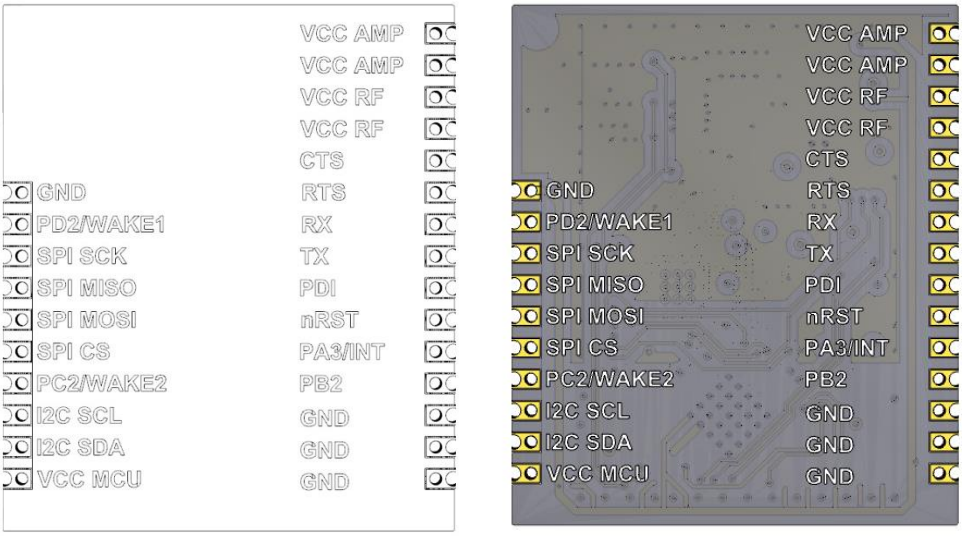
2 Hardware Characteristics

2.1 Module appearance

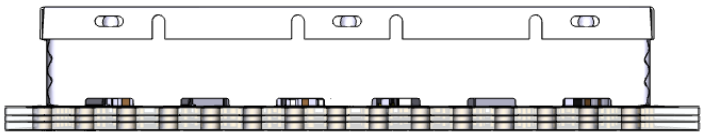
2.2 Top view



2.3 Bottom view



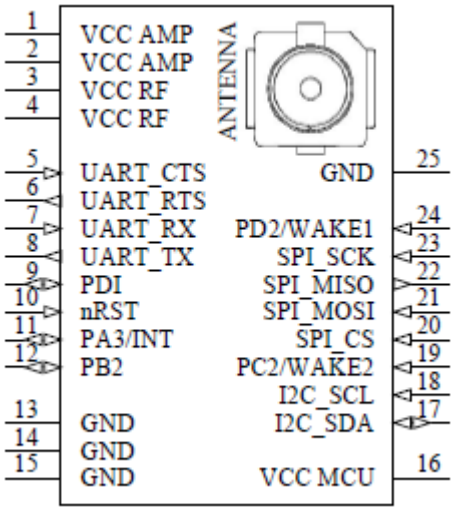
2.4 Side view



2.5 Pin description

Pin	Pin name	Pin type	Description
1, 2	VCC AMP	Power	RF amplifier power supply. See Electrical characteristics for details.
3, 4	VCC RF	Power	RF transceiver power supply. See Electrical characteristics for details.
5	CTS	Input	UART clear to send, active low. Indicates whether the module can send serial data to user (Active, on low state) or not (inactive, on high state).
6	RTS	Output	UART request to send, active low. Indicates whether the user can transmit serial data (active, on low state) or not (inactive, on high state).
7	RX	Input	UART serial data reception.
8	TX	Output	UART serial data transmission
9	PDI	I/O	Program and debug interface data
10	nRST	Input	Program and debug interface clock
11	PA3/INT	Output	Digital output – module ready for SPI interface
12	PB2	I/O	NOT USED IN THIS VERSION
13, 14, 15, 25	GND	Power	Ground. Although those pins are internally connected, it is strongly recommended to connect all those pins to ground.
16	VCC MCU	Power	MCU power supply. See Electrical characteristics for details.
17	I2C SDA	I/O	I2C serial data line – NOT USED IN THIS VERSION
18	I2C SCL	I/O	I2C serial clock line – NOT USED IN THIS VERSION
19	PC2/WAKE2	Input	Digital input – NOT USED IN THIS VERSION
20	SPI CS	Input	SPI chip select, active low. The module operates as SPI slave.
21	SPI MOSI	Input	SPI data input
22	SPI MISO	Output	SPI data output
23	SPI SCK	Input	SPI clock
24	PD2/WAKE1	Input	Digital input, falling edge awakes module from sleep mode

2.6 Pin layout

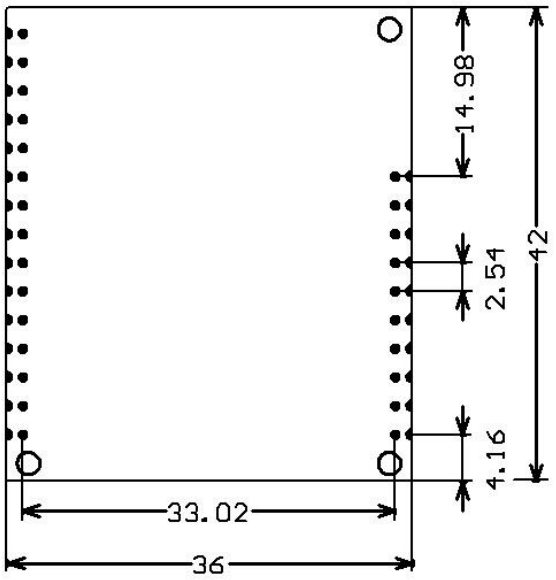


2.7 Electrical characteristics

Absolute Maximum Ratings				
Supply Voltage V_{CC}	-0.3	to	+3.9	VDC
Any Input or Output Pin	-0.3	to	V_{CC} + 0.3	VDC
Operating temperature	-20	To	+85	˚C
Storage temperature	-20	To	+85	˚C

2.8 Mechanical Specifications

Shape and size	Rectangular, 36mm x 42mm
Height	7.5mm (surface mounted)
Weight	
PCB thickness	1mm
Cover	38.1mm x 25.4mm x 6mm
Components	All SMD components, on one side of PCB
Mounting	SMD or TH



Module dimensions (in mm)

2.9 Design notes

2.10 Power supply requirements

The module does not have an internal voltage regulator, therefore a low noise and well regulated supply voltage is required for proper module operation. Make sure that supply voltage is within tolerance given in Electrical characteristics.
The module has three power supply rails, VCC MCU (pin 16), VCC RF (pins 3 and 4) and VCC AMP (pins 1 and 2). Those supply rails are not internally connected, so they can be supplied from different voltage regulators. However, those supplies must have the same voltage. Refer to Electrical characteristics for current requirements of those supply rails.
Each of these rails must be properly decoupled. Placing at least a 100nF ceramic capacitor as close as possible to the module is mandatory. Placing additional 10µF capacitors in parallel with each 100nF capacitor is recommended. All capacitors should be of X5R or X7R type dielectric.

2.11 Pin connection recommendations

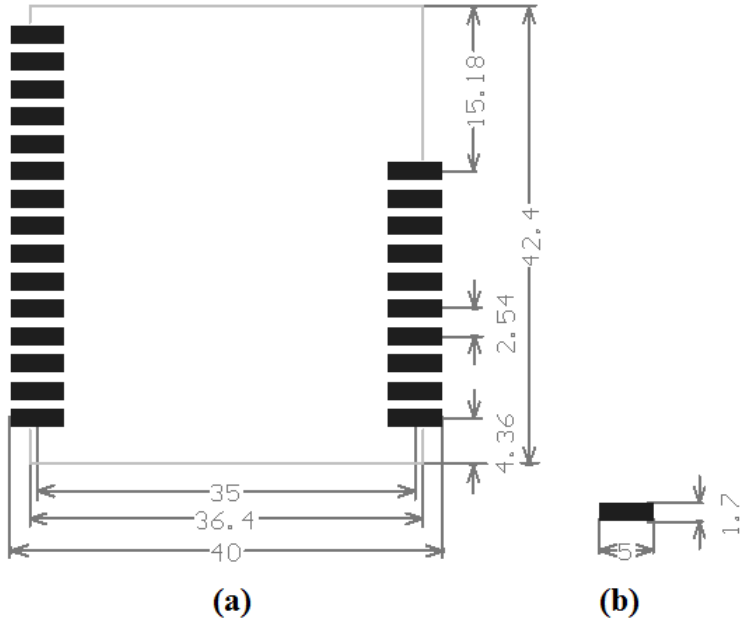
A total of 25 pins exists on the module. Those pins are divided into two rows of 10 and 15 pins. The only required pin connections are power supply pins (VCC MCU, VCC RF, VCC AMP and GND) and either SPI or UART communication lines. Firmware updates can be done via UART interface.
Leave all unused pins unconnected. Do not connect any pin to voltage above the module supply voltage or below ground.

2.12 Layout considerations

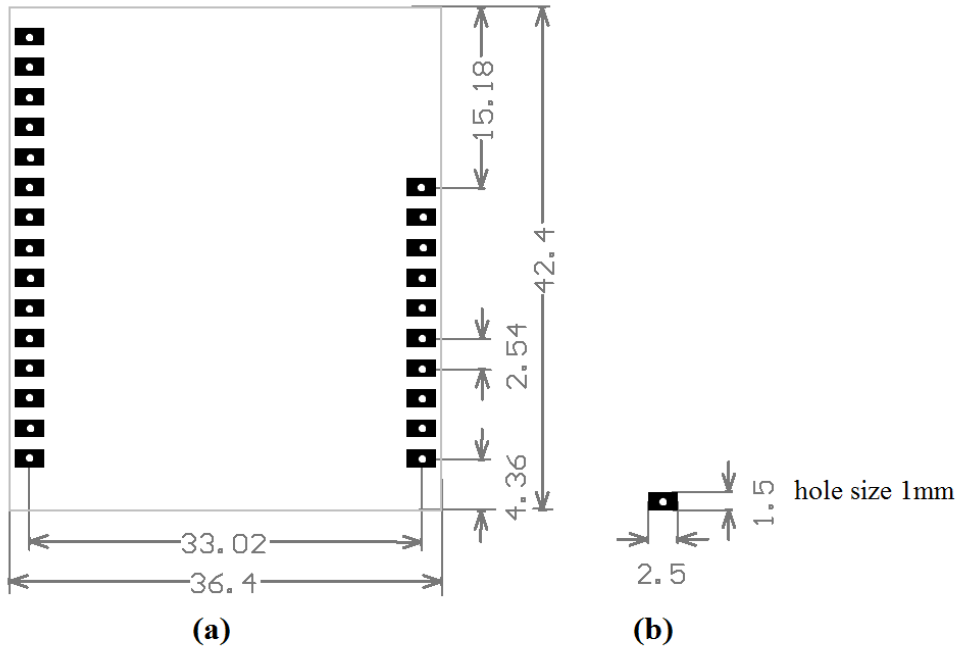
It is strongly recommended to follow good layout practices to ensure proper operation of the module. Power supply lines, particularly those for VCC AMP, should be kept as short and wide as practical. Use of ground plane is recommended. Signal lines should be routed away from noise sources.
Care must be taken not to route any lines or planes under the module in case of surface mounting (SMD). The underside of the module has traces and vias that could short to traces on user's PCB.
In case of through hole mounting (TH), the module can be soldered directly to PCB using standard 2.54mm pitch board-to-board header connector. Receptacle board-to-board connectors can be soldered to user's board and used as a socket for the module, provided that header connectors are soldered to the module. Since the module's PCB is not in direct contact with user's PCB in case of through hole mounting, it is allowed to route traces beneath the module. However, avoid routing any noisy traces there.

2.13 Soldering recommendations

This module is housed in a hybrid SMD/TH package and is suitable for both hand and automated assembly techniques.



Recommended SMD footprint (a) and pad dimensions (b)



Recommended TH footprint (a) and pad dimensions (b)

2.14 Additional Precautions

Although all externally available pins are ESD protected, it is strongly recommended to wear an ESD wrist strap and observe proper ESD handling procedures when working with this device.

2.15 Antenna Selection

The correct choice and placement of the antenna is critical and often overlooked design consideration. The range and performance of the RF link are critically dependent upon the antenna. It is not the intention of this document to address in depth many of the aspects regarding antenna selection and positioning, but to give some basic guidelines about it. A wide variety of antennas can be used, provided that they have center frequency at 868MHz and characteristic impedance of 50Ω. Recommended value for VSWR is less than 2:1.

Antenna is connected to the module using coaxial RF cable and UFL connector. This cable can be part of the antenna or it can end with another connector to which the antenna is attached (e.g. SMA connector). Quality of this cable and connections between the module and the antenna is also important. They should also have 50Ω characteristic impedance and as low insertion losses as possible. Length of the cable should be kept as low as possible.

Placement of antenna can have significant impact on range and performance of RF link. For optimal performance, position the antenna so that it's radiation pattern is strongest across the horizon. For example, whip style antennas radiate and receive the best signal perpendicular to the direction they point, so they should be pointed up vertically (upright). Antenna should be positioned away from other antennas, metal objects, trees, buildings and other obstacles. Antenna should not be placed inside metal enclosure.

3 RF characteristics

3.1 Channels and baud rate for radio communication

There are 11 selectable channels for radio communication of which 10 operate on low speed 1200bps and they each occupy 25kHz from the operational frequency band. The 11th channel (channel number 100) is intended for higher data rate, it operates on 19200 bps, and is placed in the middle of the operational frequency band.

Channel	Frequency [MHz]	Baud rate [bps]
1	869,4125	1200
2	869,4375	1200
3	869,4625	1200
4	869,4875	1200
5	869,5125	1200
6	869,5375	1200
7	869,5625	1200
8	869,5875	1200
9	869,6125	1200
10	869,6375	1200
100	869,525	19200

3.2 Output power and sensitivity

Output power is selectable. There are 10 power levels. Lower power levels (1-5) are provided by using only RF Narrowband Transceiver, and for higher power levels (6-10) RF Front End is used to amplify transmitted/received signal, which increases power of transmitted signal and module sensitivity. Sensitivity is also influenced by baud rate.

3.3 Output power

	Output power
Power level 1	10 dBm
Power level 2	11 dBm
Power level 3	12 dBm
Power level 4	13 dBm
Power level 5	14 dBm
Power level 6	18 dBm
Power level 7	22 dBm
Power level 8	24 dBm
Power level 9	26 dBm
Power level 10	27 dBm

3.4 Sensitivity

	Sensitivity
Power level 1-5, Baud rate 1200bps	-123dBm
Power level 6-10, Baud rate 1200bps	-129dBm
Power level 1-5, Baud rate 19200bps	-110dBm
Power level 6-10, Baud rate 19200bps	-116dBm

3.5 Duty cycle

Duty cycle control ensures that module obeys 10% duty cycle restriction, which means that module sends data for less than 6minuts in one hour. After every packet is sent, transmission time is multiplied by 12 and defined as a pause in transmission which needs to be waited in order to obey duty cycle restrictions. Module is not suspending transmission after every packet, but instead permits for certain amount of time in which packets are sent before suspending transmission. This time can be configured by the user, but can't be more than 30s. If accumulated transmission time of 30s is achieved and during that time pause in transmission was less than 12*30s=360s, module will wait for the remaining pause time to expire before allowing the next packet to be transmitted. This means that for every 30s of transmission time and 360s of pause time, one full transmission-pause cycle with maximum permissible transmission time lasts 390s. Worst case scenario results in 9*390s=3510s of full transmission-pause cycles and another 30s of transmission and 20s of pause in one hour. This means that in one hour there can be maximum 10 full 30s transmission, and maximum duty cycle in one hour is (10*30s)/3600s*100%=8,3%

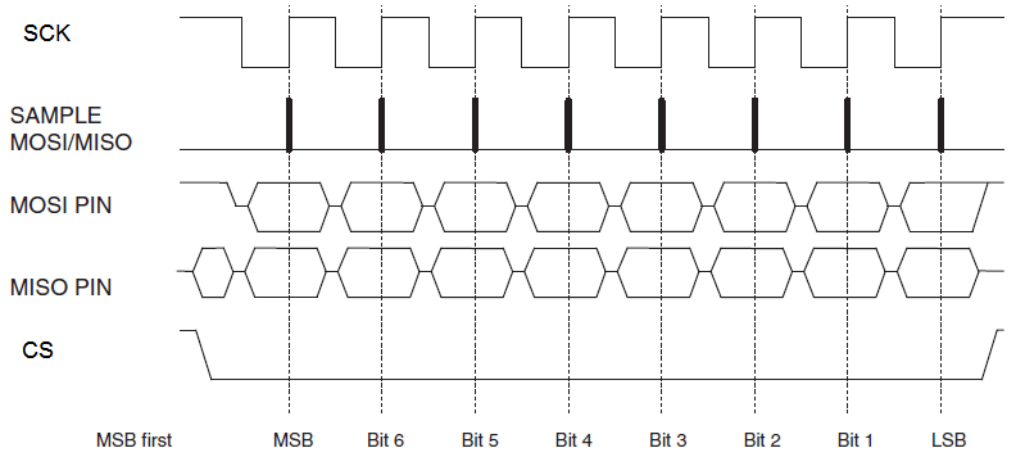
4 Interface characteristics

4.1 SPI communication interface

For SPI communication interface, RF module operates as SPI slave and uses the following 5 pins for communication.

Pin	Pin name	Pin type	Description
11	PA3/INT	Output	Digital output – module ready for SPI interface
20	SPI CS	Input	SPI chip select, active low. The module operates as SPI slave.
21	SPI MOSI	Input	SPI data input
22	SPI MISO	Output	SPI data output
23	SPI SCK	Input	SPI clock

Maximum SPI clock frequency on which module can operate is 1MHz. Data is transmitted with most significant bit (MSB) transmitted first.
First bit and all following bits are written on falling edge of SPI SCK and sampled on raising edge of SPI SCK as illustrated on diagram



SPI communication is based on protocol in which SPI master sends command in one transmission cycle, RF module processes command, signals when reply is ready and master reads reply in the next transmission cycle.
The SPI data exchange consists of the following steps:

1. SPI master initiates communication with falling edge on SPI CS pin
2. Module responds with falling edge on PA3/INT pin to indicate it is ready to receive data
3. Master sends data message with command data, which can't be more than 250Bytes long
4. Master indicates when complete command message is sent with raising edge on SPI CS pin
5. Module processes message and, when reply is ready, responds with falling edge on PA3/INT pin to indicate that reply is ready
6. Master initiates new data exchange with falling edge on SPI CS pin
7. Master starts to send data over SPI, which doesn't contain any information and only provides clock to read reply data from the module. The first byte from master indicates read operation and all other bytes are not important. Header of the message read from the RF module contains information about the amount of data in the reply message.
8. Master reeds the amount of data indicated in the reply message header
9. Master stops SPI communication with raising edge on SPI CS pin

There will be no additional falling edge on PA3/INT pin between steps 6. and 7., since RF module indicated that it is ready to exchange the data and send reply with falling edge in step 5.

4.2 UART communication interface

For UART communication interface, RF module uses the following 4 pins for communication

Pin	Pin name	Pin type	Description
5	CTS	Input	UART clear to send, active low. Indicates whether the module can send serial data to user (Active, on low state) or not (inactive, on high state).
6	RTS	Output	UART request to send, active low. Indicates whether the user can transmit serial data (active, on low state) or not (inactive, on high state).
7	RX	Input	UART serial data reception.
8	TX	Output	UART serial data transmission

UART works on 115200 baud rate. It uses communication protocol similar to the one used with SPI interface, but with data exchanged as ASCII characters. RF module responds to the commands sent by the user. The same command and reply messages as used in SPI communication interface are transferred over UART interface in ASCII characters, with numbers represented in hex format.

4.3 Power saving sleep mode

If user sends SLEEP command over SPI or UART communication interface, it initiates procedure for entering power saving sleep mode. Module enters power saving sleep mode immediately after it sends reply to received SLEEP command, or after 100ms from receiving SLEEP command, if the reply is not read by the user. When module enters sleep mode, it switches off power supply for RF Narrowband Transceiver and RF Front End, and MCU operates in sleep mode. The only way to awake module from this mode is by falling edge on pin 24 PD2/WAKE1. After falling edge on PD2/WAKE1 pin is detected and module is awaken, it resumes full functionality and reconfigures radio link to the same configuration it had before entering power saving sleep mode. During sleep mode, pause time for duty cycle control is monitored and updated.

SLOVENSKA AKREDITACIJA
SIST EN ISO/IEC 17025
LP-009

Test report

Number:	**T251-0858/18**	Project file:	C20182557
		Date:	2018-11-21
		Pages:	60
Product:	**RF communication module**		
Type reference:	**GES-RF869**		
Ratings:	Module: 3,3 Vdc Test board: 5 Vdc (Via USB)		
Trademark:	GES		
Applicant:	**Global Electronic Solutions D.O.O.** **Cara Dušana 75/37, RS-21000 Novi Sad, Serbia**		
Manufacturer:	Global Electronic Solutions D.O.O. Cara Dušana 75/37, RS-21000 Novi Sad, Serbia		
Place of manufacture:	Global Electronic Solutions D.O.O. Cara Dušana 75/37, RS-21000 Novi Sad, Serbia		

Summary of testing

Testing method:	EN 300 220-2 V3.1.1
Testing location:	SIQ Ljubljana, Mašera-Spasićeva ulica 10, SI-1000 Ljubljana, Slovenia
Remarks:	Date of receipt of test items: 2018-06-06 Number of items tested: 1 Date of performance of tests: 2018-07-23 - 2018-10-02 The test results presented in this report relate only to the items tested. The product complies with the requirements of the testing methods.

Tested by: Andrej Škof

Approved by: Marjan Mak

SIQ Ljubljana, Tržaška cesta 2, SI-1000 Ljubljana, Slovenia
T +386 1 4778 100, F +386 1 4778 444, info@siq.si, www.siq.si