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INTRODUCTION

This chapter contains general information that will be useful to know before using the RN2483 module. Topics discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Website
- Development Systems Customer Change Notification Service
- Customer Support
- Revision History

DOCUMENT LAYOUT

This command reference user's guide provides information for configuring the RN2483 low-power long-range LoRa® technology transceiver module, including a description of communication and command references. The document is organized as follows:

- **Chapter 1. “Introduction”** – This chapter introduces the RN2483 module and provides a brief overview of its features.
- **Chapter 2. “Command Reference”** – This chapter provides information on the commands used to configure the RN2483 module with examples.
- **Appendix A. “Current Firmware Features and Fixes”** – This chapter provides information on the release notes for each revision of the firmware.
## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

<table>
<thead>
<tr>
<th>Description</th>
<th>Represents</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arial font:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Italic characters</td>
<td>Referenced books</td>
<td><em>MPLAB® IDE User’s Guide</em></td>
</tr>
<tr>
<td>Emphasized text</td>
<td></td>
<td><em>...is the only compiler...</em></td>
</tr>
<tr>
<td>Initial caps</td>
<td>A window</td>
<td>the Output window</td>
</tr>
<tr>
<td></td>
<td>A dialog</td>
<td>the Settings dialog</td>
</tr>
<tr>
<td></td>
<td>A menu selection</td>
<td>select Enable Programmer</td>
</tr>
<tr>
<td>Quotes</td>
<td>A field name in a window or dialog</td>
<td><em>“Save project before build”</em></td>
</tr>
<tr>
<td>Underlined, italic text with right angle bracket</td>
<td>A menu path</td>
<td><em>File&gt;Save</em></td>
</tr>
<tr>
<td>Bold characters</td>
<td>A dialog button</td>
<td>Click <strong>OK</strong></td>
</tr>
<tr>
<td></td>
<td>A tab</td>
<td>Click the <strong>Power</strong> tab</td>
</tr>
<tr>
<td><strong>N’Rnnnn</strong></td>
<td>A number in verilog format, where N is the total number of digits, R is the radix and n is a digit.</td>
<td>4'b0010, 2'hF1</td>
</tr>
<tr>
<td>Text in angle brackets &lt; &gt;</td>
<td>A key on the keyboard</td>
<td>Press &lt;Enter&gt;, &lt;F1&gt;</td>
</tr>
<tr>
<td><strong>Courier New font:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plain Courier New</td>
<td>Sample source code</td>
<td><code>#define START</code></td>
</tr>
<tr>
<td>Filenames</td>
<td></td>
<td><code>autoexec.bat</code></td>
</tr>
<tr>
<td>File paths</td>
<td></td>
<td><code>c:\mcc18\h</code></td>
</tr>
<tr>
<td>Keywords</td>
<td></td>
<td><code>_asm, _endasm, static</code></td>
</tr>
<tr>
<td>Command-line options</td>
<td></td>
<td><code>-Opa+, -Opa-</code></td>
</tr>
<tr>
<td>Bit values</td>
<td></td>
<td><code>0, 1</code></td>
</tr>
<tr>
<td>Constants</td>
<td></td>
<td><code>0xFF, ‘A’</code></td>
</tr>
<tr>
<td>Italic Courier New</td>
<td>A variable argument</td>
<td><code>file.o, where file can be any valid filename</code></td>
</tr>
<tr>
<td>Square brackets [ ]</td>
<td>Optional arguments</td>
<td><code>mcc18 [options] file [options]</code></td>
</tr>
<tr>
<td>Curly brackets and pipe character: {</td>
<td>Choice of mutually exclusive arguments; an OR selection</td>
<td>`errorlevel {0</td>
</tr>
<tr>
<td>Ellipses...</td>
<td>Replaces repeated text</td>
<td><code>var_name [, var_name...]</code></td>
</tr>
<tr>
<td></td>
<td>Represents code supplied by user</td>
<td><code>void main (void) { ... }</code></td>
</tr>
</tbody>
</table>

---

*RN2483 LoRa® Technology Module Command Reference User’s Guide*
RECOMMENDED READING

This command reference user’s guide describes how to configure the RN2483 module. The module-specific data sheet contains current information on the module specifications. Other useful documents are listed below. The following documents are available and recommended as supplemental reference resources:

RN2483 Low-Power Long-Range LoRa® Technology Transceiver Module Data Sheet (DS50002346)

This data sheet provides detailed specifications for the RN2483 module.

LoRa® Alliance: LoRaWAN™ Specification

This document describes the LoRaWAN Class A protocol, which is optimized for battery-powered end devices. This specification is available from the LoRa Alliance at http://www.lora-alliance.org.

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- **Emulators** – The latest information on Microchip in-circuit emulators. This includes the MPLAB REAL ICE™ and MPLAB ICE 2000 in-circuit emulators.

- **In-Circuit Debuggers** – The latest information on the Microchip in-circuit debuggers. This includes MPLAB ICD 3 in-circuit debuggers and PICKit™ 3 debug express.

- **MPLAB® IDE** – The latest information on Microchip MPLAB IDE, the Windows® Integrated Development Environment for development systems tools. This list is focused on the MPLAB IDE, MPLAB IDE Project Manager, MPLAB Editor and MPLAB SIM simulator, as well as general editing and debugging features.

- **Programmers** – The latest information on Microchip programmers. These include production programmers such as MPLAB REAL ICE in-circuit emulator, MPLAB ICD 3 in-circuit debugger and MPLAB PM3 device programmers. Also included are non-production development programmers such as PICSTART® Plus and PICkit 2 and 3.

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- Field Application Engineer (FAE)
- Technical Support

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Technical support is available through the website at:

http://www.microchip.com/support.
REVISION HISTORY

Revision A (March 2015)
Initial release of the document.

Revision B (March 2015)
Update to Section 1.4.

Revision C (November 2015)
Added 2.3.6.5, 2.3.6.6, 2.3.6.7, 2.4.8.16, 2.4.8.17 sections; Updated 2-4, 2-6, 2-8 and 2-14 Tables, Updated 2.3.5.2, 2.4.4, 2.4.9.7, 2.4.9.18, and 2.5.5.17 sections; Other minor corrections.

Revision D (February 2016)
Added a new Note box in section 2.4.9.2, updated section 2.4.9.16 and Figure 2-1, added A.3 section; Other minor corrections.

Revision E (February 2016)
Removed Version 1.0.2 in section A.4; Other minor corrections.
Chapter 1. Introduction

1.1 OVERVIEW

The Microchip RN2483 module provides LoRaWAN™ protocol connectivity using a simple UART interface. This module handles the LoRaWAN Class A protocol and provides an optimized text command/response interface to the host system. This document is intended to describe an implementation of the LoRaWAN Class A protocol. LoRaWAN protocol terms are described in more detail in the LoRaWAN Specification available from the LoRa Alliance (http://www.lora-alliance.org). Thus, it is recommended to review the LoRaWAN Specification before using the RN2483 module.

The required configuration for accessing a LoRa technology network is minimal and can be stored in the module’s EEPROM, allowing for factory configuration of these parameters, lowering the requirements for the host system while also increasing system security. The module also features GPIO pins that can be configured through the UART interface.

A simple use case is described in Figure 1-1 where an end device, containing a host MCU which reads a sensor, commands the RN2483 to transmit the sensor reading over the LoRa network. Data are encrypted by the RN2483 and the radio packet is received by one or multiple gateways which forward it to the network server. The network server sends the data to the application server which has the key to decrypt the application data. Similarly, a development platform may consist of an RN2483 directly connected over UART to a PC which becomes the host system in this case. Users can then type commands into the module using a terminal program.

FIGURE 1-1: SIMPLE LoRa® TECHNOLOGY NETWORK DIAGRAM

The flow of data can be followed as it gets generated by an end device and transported on the network.
1.2 FEATURES

- LoRaWAN Class A protocol compliance
- Integrated FSK, GFSK and LoRa technology transceiver allowing the user to transmit custom packets using these protocols
- Globally unique 64-bit identifier (EUI-64™)
- Configurable GPIOs
- Intelligent Low-Power mode with programmable/on-demand wake-up
- Bootloader for firmware upgrade
- All configuration and control done over UART using simple ASCII commands

Refer to the **RN2483, Low-Power Long-Range LoRa® Technology Transceiver Module Data Sheet** (DS50002346) for details on the hardware specifications of the module.

1.3 CONFIGURATION

The RN2483 module’s architecture is described in Figure 1-2 from the command interface point of view. There are three types of commands that can be used, and each allows access to different module functions:

- LoRaWAN Class A configuration and control, using the `mac` group of commands
- Radio configuration and control, using the `radio` group of commands
- Other module functions, using the `sys` group of commands

** FIGURE 1-2:** RN2483 COMMAND INTERFACE (YELLOW) AND ITS RELATIONSHIP TO THE MODULE’S INTERNAL COMPONENTS

The available commands can be used to configure and control the LoRaWAN protocol layer, the radio driver and some system peripherals.

In order to communicate with a LoRa network, a specific number of parameters need to be configured. Since two distinctive methods are offered for a device to become part of the network, each of these requires different parameters:

- Over-the-Air Activation (OTAA), where a device negotiates network encryption keys at the time it joins the network. For this, the device EUI, application EUI and application key need to be configured and then the OTAA procedure can start.
- Activation by Personalization (ABP) where the device already contains the network keys and can directly start communication with the network. Configuring the device address, network session key and application session key is sufficient for this type of initialization.
For increased security, these parameters can be configured and stored in the module’s EEPROM during manufacturing of devices requiring LoRaWAN connectivity. Thus, the keys do not need to be sent over the UART interface by the host system every time the device powers up.

1.4 UART INTERFACE

All of the RN2483 module’s settings and commands are transmitted over UART using the ASCII interface.

All commands need to be terminated with \texttt{<CR><LF>} and any replies they generate will also be terminated by the same sequence.

The default settings for the UART interface are 57600 bps, 8 bits, no parity, 1 Stop bit, no flow control. The baud rate can be changed by triggering the auto-baud detection sequence of the module. To do this, the host system needs to transmit to the module a break condition followed by a \texttt{0x55} character at the new baud rate. The auto-baud detection mechanism can also be triggered during Sleep to wake the module up before the predetermined time has expired.

| Note: | A break condition is signaled to the module by keeping the UART_RX pin low for longer than the time to transmit a complete character. For example, at the default baud rate of 57600 bps keeping the UART_RX pin low for 938 $\mu$s is a valid break condition, whereas at 9600 bps this would be interpreted as a \texttt{0x00} character. Thus, the break condition needs to be long enough to still be interpreted as such at the baud rate that is currently in use. |
Chapter 2. Command Reference

The RN2483 LoRa technology module supports a variety of commands for configuration. This section describes these commands in detail and provides examples.

2.1 COMMAND SYNTAX

To issue commands to the RN2483 module, the user sends keywords followed by optional parameters. Commands (keywords) are case sensitive, and spaces must not be used in parameters. Hex input data can be uppercase or lowercase. String text data, such as OTAA used for the join procedure, is case-insensitive.

The use of shorthand for parameters is NOT supported.

Depending on the command, the parameter may expect values in either decimal or hexadecimal form; refer to the command description for the expected form. For example, when configuring the frequency, the command expects a decimal value in Hertz such as 868100000 (868.1 MHz). Alternatively, when configuring the LoRaWAN device address, the hex value is entered into the parameter as aabbccdd. To enter a number in hex form, use the value directly. For example, the hex value 0xFF would be entered as FF.

2.2 COMMAND ORGANIZATION

There are three general command categories, as shown in Table 2-1.

<table>
<thead>
<tr>
<th>Command Type</th>
<th>Keyword</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td>&lt;sys&gt;</td>
<td>Issues system level behavior actions, gathers status information on the firmware and hardware version, or accesses the module user EEPROM memory.</td>
</tr>
<tr>
<td>LoRaWAN™ Class A Protocol</td>
<td>&lt;mac&gt;</td>
<td>Issues LoRaWAN Class A protocol network communication behaviors, actions and configurations commands.</td>
</tr>
<tr>
<td>Transceiver commands</td>
<td>&lt;radio&gt;</td>
<td>Issues radio specific configurations, directly accessing and updating the transceiver setup.</td>
</tr>
</tbody>
</table>

Once the LoRaWAN Class A protocol configuration is complete, the user must save the settings to store the configuration data, otherwise it will not take effect upon reboot or Reset.

Note: Upon successful reception of commands, the module will respond with one of the following:

- ok
- invalid_param
- Requested Information
- Descriptive Error Message
2.3 SYSTEM COMMANDS

System commands begin with the system keyword <sys> and include the categories shown in Table 2-2, Table 2-3 and Table 2-4.

Note: To facilitate the sharing of the radio between user custom applications and the LoRaWAN MAC, please refer to the mac pause and mac resume commands. Since no sharing exists between sys and other types of commands, there is no need for additional pause commands.

### TABLE 2-2: SYSTEM COMMANDS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sleep</td>
<td>Puts the system in Sleep for a finite number of milliseconds.</td>
</tr>
<tr>
<td>reset</td>
<td>Resets and restarts the RN2483 module.</td>
</tr>
<tr>
<td>eraseFW</td>
<td>Deletes the current RN2483 module application firmware and prepares it for firmware upgrade. The RN2483 module bootloader is ready to receive new firmware.</td>
</tr>
<tr>
<td>factoryRESET</td>
<td>Resets the RN2483 module’s configuration data and user EEPROM to factory default values and restarts the RN2483 module.</td>
</tr>
<tr>
<td>set(1)</td>
<td>Sets specified system parameter values.</td>
</tr>
<tr>
<td>get(1)</td>
<td>Gets specified system parameter values.</td>
</tr>
</tbody>
</table>

Note 1: Refer to Table 2-3 for system <set> and Table 2-4 for system <get> command summaries.

#### 2.3.1 sys sleep <length>

<length>: decimal number representing the number of milliseconds the system is put to Sleep, from 100 to 4294967296.

Response: ok after the system gets back from Sleep mode

invalid_param if the length is not valid

This command puts the system to Sleep for the specified number of milliseconds. The module can be forced to exit from Sleep by sending a break condition followed by a 0x55 character at the new baud rate. Note that the break condition needs to be long enough not to be interpreted as a valid character at the current baud rate.

Example: sys sleep 120 // Puts the system to Sleep for 120 ms.

#### 2.3.2 sys reset

Response: RN2483 X.Y.Z MMM DD YYYY HH:MM:SS, where X.Y.Z is firmware version, MMM is month, DD is day, HH:MM:SS is hour, minutes, seconds (format: [HW] [FW] [Date] [Time]). [Date] and [Time] refer to the release of the firmware.

This command resets and restarts the RN2483 module; stored internal configurations will be loaded automatically upon reboot.

Example: sys reset // Resets and restarts the RN2483 module.

#### 2.3.3 sys eraseFW

Response: no response

This command deletes the current RN2483 module application firmware and prepares it for firmware upgrade. The RN2483 module bootloader is ready to receive new firmware.

Example: sys eraseFW // Deletes the current RN2483 module application firmware.
2.3.4  sys factoryRESET

Response: RN2483 X.Y.Z MMM DD YYYY HH:MM:SS, where X.Y.Z is firmware version, MMM is month, DD is day, HH:MM:SS is hour, minutes, seconds (format: [HW] [FW] [Date] [Time]). [Date] and [Time] refer to the release of the firmware.

This command resets the module’s configuration data and user EEPROM to factory default values and restarts the module. After factoryRESET, the RN2483 module will automatically reset and all configuration parameters are restored to factory default values.

Example: sys factoryRESET    // Restores factory default values.

2.3.5  System Set Commands

2.3.5.1  sys set nvm <address> <data>

<address>: hexadecimal number representing user EEPROM address, from 300 to 3FF
<data>: hexadecimal number representing data, from 00 to FF

Response: ok if the parameters (address and data) are valid
invalid_param if the parameters (address and data) are not valid

This command allows the user to modify the user EEPROM at <address> with the value supplied by <data>. Both <address> and <data> must be entered as hex values. The user EEPROM memory is located inside the MCU on the module.

Example: sys set nvm 300 A5    // Stores the value 0xA5 at user EEPROM address 0x300.

2.3.5.2  sys set pinmode <pinname> <pinFunc>

<pinname>: string representing the pin. Parameters can be: GPIO0 - GPIO13, UART_CTS, UART_RTS, TEST0, TEST1
<pinFunc>: string representing the function of the pin. Parameters can be: digout, digin or ana.

Response: ok if the parameters are valid
invalid_param if the parameters are not valid

This command allows the user to configure the function on a pin. A pin can be configured as digital output by using the digout parameter. A pin can be configured as digital input by using the digin parameter. A pin can be configured as analog input by using the ana parameter.

Note: Not all pins have analog input functionality.
Example: `sys set pinmode GPIO0 ana` //Configures GPIO0 as analog input

**Note:** This command must be called prior to reading or setting the value of a pin in order to have correct behavior.

2.3.5.3 sys set pindig <pinname> <pinstate>

<piname>: string representing the pin. Parameter values can be:
- GPIO0 - GPIO13, UART_CTS, UART_RTS, TEST0, TEST1
<pinstate>: decimal number representing the state. Parameter values can be: 0 or 1.

**Response:**
- `ok` if the parameters (<pinname>, <pinstate>) are valid
- `invalid_param` if the parameters (<pinname>, <pinstate>) are not valid

This command allows the user to modify the unused pins available for use by the module. The selected <pinname> is driven high or low depending on the desired <pinstate>.

**Default:** GPIO0-GPIO13, UART_CTS, UART_RTS, TEST0 and TEST1 are driven low (value 0).

Example: `sys set pindig GPIO5 1` // Drives GPIO5 high 1, VDD.

**Note:** In order for the pin to be driven to a value, make sure you have first configured the pin to be a digital output using the command `sys set pinmode <pinname> digout`.

---

### 2.3.6 System Get Commands

**TABLE 2-4: SYSTEM GET COMMANDS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>ver</code></td>
<td>Returns the information on hardware platform, firmware version, release date.</td>
</tr>
<tr>
<td><code>nvm</code></td>
<td>Returns data from the requested user EEPROM &lt;address&gt;.</td>
</tr>
<tr>
<td><code>vdd</code></td>
<td>Returns measured voltage in mV.</td>
</tr>
<tr>
<td><code>hweui</code></td>
<td>Returns the preprogrammed EUI node address.</td>
</tr>
<tr>
<td><code>pindig</code></td>
<td>Returns the state of a digital input.</td>
</tr>
<tr>
<td><code>pinana</code></td>
<td>Returns the state of an analog input.</td>
</tr>
</tbody>
</table>

**2.3.6.1 sys get ver**

**Response:** `RN2483 X.Y.Z MMM DD YYYY HH:MM:SS`, where X.Y.Z is firmware version, MMM is month, DD is day, HH:MM:SS is hour, minutes, seconds (format: [HW] [FW] [Date] [Time]). [Date] and [Time] refer to the release of the firmware.

This command returns the information related to the hardware platform, firmware version, release date and time stamp on firmware creation.

Example: `sys get ver` // Returns version-related information.
2.3.6.2  sys get nvm <address>

<Address>: hexadecimal number representing user EEPROM address, from 300 to 3FF
Response: 00 – FF (hexadecimal value from 00 to FF) if the address is valid
invalid_param if the address is not valid
This command returns the data stored in the user EEPROM of the RN2483 module at the requested <address> location.
Example: sys get nvm 300 // Returns the 8-bit hex value stored at 300.

2.3.6.3  sys get vdd

Response: 0–3600 (decimal value from 0 to 3600)
This command informs the RN2483 module to do an ADC conversion on the VDD. The measurement is converted and returned as a voltage (mV).
Example: sys get vdd  // Returns mV measured on the VDD module.

2.3.6.4  sys get hweui

Response: hexadecimal number representing the preprogrammed EUI node address
This command reads the preprogrammed EUI node address from the RN2483 module. The value returned by this command is a globally unique number provided by Microchip.
Example: sys get hweui  // Reads the preprogrammed EUI node address.

Note: The preprogrammed EUI node address is a read-only value and cannot be changed or erased. This value can be used to configure the device EUI using the mac set deveui command (see Section 2.4.8.2).

2.3.6.5  sys get pindig <pinname>

Pinname>: string representing the pin. Parameters can be: GPIO0 – GPIO13, UART_CTS, UART_RTS, TEST0, TEST1
Response: decimal number representing the state (either 0 or 1).
This command allows the user to read the state of a digital input. To be used as a digital input, a pin needs to be configured using the sys set pinmode command.
Example: sys get pindig GPIO0  // Reads the state of the GPIO0 digital input

Note: The sys set pinmode <pinname> digin command must be called to configure the function of the pin prior to reading its digital input value.

2.3.6.6  sys get pinana <pinname>

Pinname>: string representing the pin. Parameters can be: GPIO0 - GPIO3, GPIO5 - GPIO13
Response: decimal number representing the result of the conversion, from 0 to 1023, where 0 represents 0V and 1023 is VDD, the supply voltage of the module.
This command allows the user to read the state of an analog input. To be used as an analog input, a pin needs to be configured using the sys set pinmode command.
Example: sys get pinana GPIO0  // Reads the state of the GPIO0 analog input
2.4 MAC COMMANDS

LoRaWAN Class A protocol commands begin with the system keyword `mac` and include the categories shown in Table 2-5 through Table 2-9.

**TABLE 2-5: MAC COMMANDS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>reset</td>
<td>Resets the RN2483 module to a specific frequency band.</td>
</tr>
<tr>
<td>tx</td>
<td>Sends the data string on a specified port number and sets default values for most of the LoRaWAN™ parameters.</td>
</tr>
<tr>
<td>join</td>
<td>Informs the RN2483 module to join the configured network.</td>
</tr>
<tr>
<td>save</td>
<td>Saves LoRaWAN Class A configuration parameters to the user EEPROM.</td>
</tr>
<tr>
<td>forceENABLE</td>
<td>Enables the RN2483 module after the LoRaWAN network server commanded the end device to become silent immediately.</td>
</tr>
<tr>
<td>pause</td>
<td>Pauses LoRaWAN stack functionality to allow transceiver (radio) configuration.</td>
</tr>
<tr>
<td>resume</td>
<td>Restores the LoRaWAN stack functionality.</td>
</tr>
<tr>
<td>set</td>
<td>Accesses and modifies specific MAC related parameters.</td>
</tr>
<tr>
<td>get</td>
<td>Reads back current MAC related parameters from the module.</td>
</tr>
</tbody>
</table>

**2.4.1 mac reset <band>**

*<band>*: decimal number representing the frequency band, either 868 or 433

**Response:** `ok` if band is valid

*invalid_param* if band is not valid

This command will automatically reset the software LoRaWAN stack and initialize it with the parameters for the selected band.

**Example:** `mac reset 868` // Sets the default values and selects the 868 default band.

**Note:** This command will set default values for most of the LoRaWAN™ parameters. Everything set prior to this command will lose its set value.
2.4.2  **mac tx <type> <portno> <data>**

- **<type>:** string representing the uplink payload type, either **cnf** or **uncnf**  
  (cnf – confirmed, uncnf – unconfirmed)
- **<portno>:** decimal number representing the port number, from 1 to 223
- **<data>:** hexadecimal value. The length of <data> bytes capable of being transmitted are dependent upon the set data rate (please refer to the LoRaWAN™ Specification for further details).

**Response:** this command may reply with two responses. The first response will be received immediately after entering the command. In case the command is valid (**ok** reply received), a second reply will be received after the end of the uplink transmission. Please refer to the LoRaWAN™ Specification for further details.

**Response after entering the command:**
- **ok** – if parameters and configurations are valid and the packet was forwarded to the radio transceiver for transmission
- **invalid_param** – if parameters (**<type> <portno> <data>**) are not valid
- **not_joined** – if the network is not joined
- **no_free_ch** – if all channels are busy
- **silent** – if the module is in a Silent Immediately state
- **frame_counter_err_rejoin_needed** – if the frame counter rolled over
- **busy** – if MAC state is not in an Idle state
- **mac_paused** – if MAC was paused and not resumed back
- **invalid_data_len** if application payload length is greater than the maximum application payload length corresponding to the current data rate

**Response after the uplink transmission:**
- **mac_tx_ok** if uplink transmission was successful and no downlink data was received back from the server;
- **mac_rx <portno> <data>** if transmission was successful, **<portno>: port number, from 1 to 223; <data>: hexadecimal value that was received from the server**;
- **mac_err** if transmission was unsuccessful, ACK not received back from the server
- **invalid_data_len** if application payload length is greater than the maximum application payload length corresponding to the current data rate

A confirmed message will expect an acknowledgment from the server; otherwise, the message will be retransmitted by the number indicated by the command **mac set retx <value>**, whereas an unconfirmed message will not expect any acknowledgment back from the server. Please refer to the LoRaWAN™ Specification for further details.
If the automatic reply feature is enabled and the server sets the Frame Pending bit or initiates downlink confirmed transmissions, multiple responses will be displayed after each downlink packet is received by the module. A typical scenario for this case would be (prerequisites: free LoRaWAN channels available and automatic reply enabled):

- The module sends a packet on port 4 with application payload 0xAB
- Radio transmission is successful and the module will display the first response: ok
- The server needs to send two separate downlink confirmed packets back on port 1 with the following data: 0xAC, then 0xAF. First it will transmit the first one (0xAC) and will set the Frame Pending bit. The module will display the second response mac_rx 1 AC
- The module will initiate an automatic uplink unconfirmed transmission with no application payload on the first free channel because the Frame Pending bit was set in the downlink transmission
- The server will send back the second confirmed packet (0xAF). The module will display a third response mac_rx 1 AF
- The module will initiate an automatic unconfirmed transmission with no application payload on the first free channel because the last downlink transmission was confirmed, so the server needs an ACK
- If no reply is received back from the server, the module will display the fourth response after the end of the second Receive window: mac_tx_ok
- After this scenario, the user is allowed to send packets when at least one enabled channel is free

Based on this scenario, the following responses will be displayed by the module:

- mac tx cnf 4 AB
- ok
- mac_rx 1 AC
- mac_rx 1 AF
- mac_tx_ok

Example: mac tx cnf 4 5A5B5B  // Sends a confirmed frame on port 4 with application payload 5A5B5B.
2.4.3  mac join <mode>

<mode>: string representing the join procedure type (case-insensitive), either otaa or abp (otaa – over-the-air activation, abp – activation by personalization).

Response: this command may reply with two responses. The first response will be received immediately after entering the command. In case the command is valid (ok reply received) a second reply will be received after the end of the join procedure. Please refer to the LoRaWAN™ Specification for further details.

Response after entering the command:
- ok – if parameters and configurations are valid and the join request packet was forwarded to the radio transceiver for transmission
- invalid_param – if <mode> is not valid
- keys_not_init – if the keys corresponding to the Join mode (otaa or abp) were not configured
- no_free_ch – if all channels are busy
- silent – if the device is in a Silent Immediately state
- busy – if MAC state is not in an Idle state
- mac_paused – if MAC was paused and not resumed back

Response after the join procedure:
- denied if the join procedure was unsuccessful (the module attempted to join the network, but was rejected);
- accepted if the join procedure was successful;

This command informs the RN2483 module it should attempt to join the configured network. Module activation type is selected with <mode>. Parameter values can be otaa (over-the-air activation) or abp (activation by personalization). The <mode> parameter is not case sensitive. Before joining the network, the specific parameters for each activation type should be configured (for over the air activation: device EUI, application EUI, application key; for activation by personalization: device address, network session key, application session key).

Example: mac join otaa  // Attempts to join the network using over-the-air activation.
2.4.4 mac save

Response: ok

The `mac save` command must be issued after configuration parameters have been appropriately entered from the `mac set <cmd>` commands. This command will save LoRaWAN Class A protocol configuration parameters to the user EEPROM. When the next `sys reset` command is issued, the LoRaWAN Class A protocol configuration will be initialized with the last saved parameters.

The LoRaWAN Class A protocol configuration savable parameters are:

- `band`: Band
- `fcntup`: Uplink Frame Counter
- `fcntdown`: Downlink Frame Counter
- `dr`: Data Rate
- `rx2dr`: Data Rate parameter for the second receive window
- `rx2freq`: Frequency parameter for the second receive window
- `adr`: Adaptive Data Rate state
- `deveui`: End-Device Identifier
- `appeui`: Application Identifier
- `appkey`: Application Key
- `nwkskey`: Network Session Key
- `appskey`: Application Session Key
- `devaddr`: End Device Address
- `ch`: All Channel Parameter
  - `freq`: Frequency
  - `dcycle`: Duty Cycle
  - `drrange`: Data Rate Range
  - `status`: Status

Example: `mac save`  // Saves the LoRaWAN Class A protocol configuration parameters to the user EEPROM.

2.4.5 mac forceENABLE

Response: ok

The network can issue a certain command (Duty Cycle Request frame with parameter 255) that would require the RN2483 module to go silent immediately. This mechanism disables any further communication of the module, effectively isolating it from the network. Using `mac forceENABLE`, after this network command has been received, restores the module’s connectivity by allowing it to send data.

Example: `mac forceENABLE`  // Disables the Silent Immediately state.
2.4.6  **mac pause**

Response: 0 – 4294967295 (decimal number representing the number of milliseconds the mac can be paused)

This command pauses the LoRaWAN stack functionality to allow transceiver (radio) configuration. Through the use of `mac pause`, radio commands can be generated between a LoRaWAN Class A protocol uplink application (`mac tx` command), and the LoRaWAN Class A protocol Receive windows (second response for the `mac tx` command). This command will reply with the time interval in milliseconds that the transceiver can be used without affecting the LoRaWAN functionality. The maximum value (4294967295) is returned whenever the LoRaWAN stack functionality is in Idle state and the transceiver can be used without restrictions. '0' is returned when the LoRaWAN stack functionality cannot be paused. After the radio configuration is complete, the `mac resume` command should be used to return to LoRaWAN Class A protocol commands.

Example: `mac pause` // Pauses the LoRaWAN stack functionality if the response is different from 0.

**Note:** If already joined to a network, this command **MUST** be called **BEFORE** configuring the radio parameters, initiating radio reception, or transmission.

2.4.7  **mac resume**

Response: `ok`

This command resumes LoRaWAN stack functionality, in order to continue normal functionality after being paused.

Example: `mac resume` // Resumes the LoRaWAN stack functionality.

**Note:** This command **MUST** be called **AFTER** all radio commands have been issued and all the corresponding asynchronous messages have been replied.
### 2.4.8 MAC Set Commands

#### TABLE 2-6: MAC SET COMMANDS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>devaddr</td>
<td>Sets the unique network device address for the RN2483 module.</td>
</tr>
<tr>
<td>deveui</td>
<td>Sets the globally unique identifier for the RN2483 module.</td>
</tr>
<tr>
<td>appeui</td>
<td>Sets the application identifier for the RN2483 module.</td>
</tr>
<tr>
<td>nwkskey</td>
<td>Sets the network session key for the RN2483 module.</td>
</tr>
<tr>
<td>appskey</td>
<td>Sets the application session key for the RN2483 module.</td>
</tr>
<tr>
<td>appkey</td>
<td>Sets the application key for the RN2483 module.</td>
</tr>
<tr>
<td>pwridx</td>
<td>Sets the output power to be used on the next transmissions.</td>
</tr>
<tr>
<td>dr</td>
<td>Sets the data rate to be used for the next transmissions.</td>
</tr>
<tr>
<td>adr</td>
<td>Sets if the adaptive data rate is to be enabled, or disabled.</td>
</tr>
<tr>
<td>bat</td>
<td>Sets the battery level needed for Device Status Answer frame command response.</td>
</tr>
<tr>
<td>retx</td>
<td>Sets the number of retransmissions to be used for an uplink confirmed packet.</td>
</tr>
<tr>
<td>linkchk</td>
<td>Sets the time interval for the link check process to be triggered.</td>
</tr>
<tr>
<td>rxdelay1</td>
<td>Sets the value used for the first Receive window delay.</td>
</tr>
<tr>
<td>ar</td>
<td>Sets the state of the automatic reply.</td>
</tr>
<tr>
<td>rx2</td>
<td>Sets the data rate and frequency used for the second Receive window.</td>
</tr>
<tr>
<td>sync</td>
<td>Sets the synchronization word for the LoRaWAN™ communication.</td>
</tr>
<tr>
<td>upctr</td>
<td>Sets the value of the uplink frame counter that will be used for the next uplink transmission.</td>
</tr>
<tr>
<td>dnctr</td>
<td>Sets the value of the downlink frame counter that will be used for the next downlink reception.</td>
</tr>
<tr>
<td>ch</td>
<td>Allows modification of channel related parameters.</td>
</tr>
</tbody>
</table>

#### 2.4.8.1 mac set devaddr <address>

**<address>:** 4-byte hexadecimal number representing the device address, from 00000000 – FFFFFFFF

**Response:**
- ok if address is valid
- invalid_param if address is not valid

This command configures the module with a 4-byte unique network device address `<address>`. The `<address>` **MUST** be **UNIQUE** to the current network. This must be directly set solely for activation by personalization devices. This parameter must not be set before attempting to join using over-the-air activation because it will be overwritten once the join process is over.

**Example:** `mac set devaddr ABCDEF01`

**Note:** If this parameter had previously been saved to user EEPROM by issuing the `mac save` command, after modifying its value, the `mac save` command should be called again.
2.4.8.2  mac set deveui <devEUI>

<devEUI>: 8-byte hexadecimal number representing the device EUI
Response:  ok if address is valid
           invalid_param if address is not valid

This command sets the globally unique device identifier for the module. The identifier
must be set by the host MCU. The module contains a pre-programmed unique EUI and
can be retrieved using the sys get hweui command (see Section 2.3.6.4) or user
provided EUI can be configured using the mac set deveui command.
Example: mac set deveui 0004A30B001A55ED

Note:  If this parameter was previously saved to user EEPROM by issuing the
        mac save command, after modifying its value, the mac save command
        should be called again.

2.4.8.3  mac set appeui <appEUI>

<appEUI>: 8-byte hexadecimal number representing the application EUI
Response:  ok if EUI is valid
           invalid_param if EUI is not valid

This command sets the application identifier for the module. The application identifier
should be used to identify device types (sensor device, lighting device, etc.) within the
network.
Example: mac set appeui FEDCBA9876543210

Note:  If this parameter was previously saved to user EEPROM by issuing the
        mac save command, after modifying its value, the mac save command
        should be called again.

2.4.8.4  mac set nwkskey <nwksesskey>

<nwkSessKey>: 16-byte hexadecimal number representing the network session key
Response:  ok if key is valid
           invalid_param if key is not valid

This command sets the network session key for the module. This key is 16 bytes in
length, and provides security for communication between the module and network
server.
Example: mac set nwkskey 1029384756AFBECD5647382910DACFEB

Note:  If this parameter was previously saved to user EEPROM by issuing the
        mac save command, after modifying its value, the mac save command
        should be called again.
2.4.8.5  mac set appskey <appSessKey>

<appSessKey>: 16-byte hexadecimal number representing the application session key

Response:  ok if key is valid
            invalid_param if key is not valid

This command sets the application session key for the module. This key provides
security for communication between module and application server.

Example:  mac set appskey AFBECDF56473829100192837465FAEBDC

Note:  If this parameter was previously saved to user EEPROM by issuing the
        mac save command, after modifying its value, the mac save command
        should be called again.

2.4.8.6  mac set appkey <appKey>

<appKey>: 16-byte hexadecimal number representing the application key

Response:  ok if key is valid
            invalid_param if key is not valid

This command sets the application key for the module. The application key is used to
derive the security credentials for communication during over-the-air activation.

Example:  mac set appkey 00112233445566778899AABBCCDDEEFF

Note:  If this parameter was previously saved to user EEPROM by issuing the
        mac save command, after modifying its value, the mac save command
        should be called again.

2.4.8.7  mac set pwridx <pwrIndex>

<pwrIndex>: decimal number representing the index value for the output power,
            from 0 to 5 for 433 MHz frequency band and from 1 to 5 for 868 MHz
            frequency band.

Response:  ok if power index is valid
            invalid_param if power index is not valid

This command sets the output power to be used on the next transmissions. Refer to
the LoRaWAN™ Specification for the output power corresponding to the <pwrIndex>
and also to the RN2483 Low-Power Long-Range LoRa® Technology Transceiver
Module Data Sheet (DS50002346) for the actual radio power capabilities.

Example:  mac set pwridx 1 // Sets the TX output power to 14 dBm on the
          next transmission for a 868 MHz EU module.

Note:  If this parameter was previously saved to user EEPROM by issuing the
        mac save command, after modifying its value, the mac save command
        should be called again.
2.4.8.8  mac set dr <dataRate>

<dataRate>: decimal number representing the data rate, from 0 and 7, but within the
limits of the data rate range for the defined channels.

Response: ok if data rate is valid
invalid_param if data rate is not valid

This command sets the data rate to be used for the next transmission. Please refer to
the LoRaWAN™ Specification for the description of data rates and the corresponding
spreading factors.

Example: mac set dr 5      // On EU863-870; SF7/125 kHz.

Note: If this parameter had previously been saved to user EEPROM by issuing
the mac save command, after modifying its value, the mac save
command should be called again.

2.4.8.9  mac set adr <state>

<state>: string value representing the state, either on or off.

Response: ok if state is valid
invalid_param if state is not valid

This command sets if the adaptive data rate (ADR) is to be enabled, or disabled. The
server is informed about the status of the module's ADR in every uplink frame it
receives from the ADR field in uplink data packet. If ADR is enabled, the server will
optimize the data rate and the transmission power of the module based on the
information collected from the network.

Example: mac set adr on     // This will enable the ADR mechanism.

Note: If this parameter had previously been saved to user EEPROM by issuing
the mac save command, after modifying its value, the mac save
command should be called again.

2.4.8.10 mac set bat <level>

<level>: decimal number representing the level of the battery, from 0 to 255. 0
means external power, 1 means low level, 254 means high level, 255
means the end device was not able to measure the battery level.

Response: ok if the battery level is valid
invalid_param if the battery level is not valid

This command sets the battery level required for Device Status Answer frame in use
with the LoRaWAN Class A protocol.

Example: mac set bat 127    // Battery is set to ~50%.

2.4.8.11 mac set retx <reTxNb>

<reTxNb>: decimal number representing the number of retransmissions for an uplink
confirmed packet, from 0 to 255.

Response: ok if <reTx> is valid
invalid_param if <reTx> is not valid

This command sets the number of retransmissions to be used for an uplink confirmed
packet, if no downlink acknowledgment is received from the server.

Example: mac set retx 5     // The number of retransmissions made
for an uplink confirmed packet is set to 5.
2.4.8.12  \texttt{mac set linkchk <linkCheck>}

<linkCheck>: decimal number that sets the time interval in seconds for the link check process, from 0 to 65535

Response: \texttt{ok} if the time interval is valid

invalid_param if the time interval is not valid

This command sets the time interval for the link check process to be triggered periodically. A <value> of '0' will disable the link check process. When the time interval expires, the next application packet that will be sent to the server will include also a link check MAC command. Please refer to the \textit{LoRaWAN™ Specification} for more information on the Link Check MAC command.

Example: \texttt{mac set linkchk 600}  // The module will attempt a link check process at 600-second intervals.

\textbf{Note:} If the command \texttt{mac reset} is issued, the link check process will be set as disabled.

2.4.8.13  \texttt{mac set rxdelay1 <rxDelay>}

<rxDelay>: decimal number representing the delay between the transmission and the first Reception window in milliseconds, from 0 to 65535.

Response: \texttt{ok} if <rxDelay> is valid

invalid_param if <rxDelay> is not valid

This command will set the delay between the transmission and the first Reception window to the <rxDelay> in milliseconds. The delay between the transmission and the second Reception window is calculated in software as the delay between the transmission and the first Reception window \( + 1000 \) (ms).

Example: \texttt{mac set rxdelay1 1000}  // Set the delay between the transmission and the first Receive window to 1000 ms.

2.4.8.14  \texttt{mac set ar <state>}

<state>: string value representing the state, either \texttt{on} or \texttt{off}.

Response: \texttt{ok} if state is valid

invalid_param if state is not valid

This command sets the state of the automatic reply. By enabling the automatic reply, the module will transmit a packet without a payload immediately after a confirmed downlink is received, or when the Frame Pending bit has been set by the server. If set to \texttt{OFF}, no automatic reply will be transmitted.

Example: \texttt{mac set ar on}  // Enables the automatic reply process inside the module.

\textbf{Note:} The RN2483 module implementation will initiate automatic transmissions with no application payload if the automatic reply feature is enabled and the server sets the Frame Pending bit or initiates a confirmed downlink transmission. In this case, if all enabled channels are busy due to duty cycle limitations, the stack will wait for the first channel that will become free to transmit. The user will not be able to initiate uplink transmissions until the automatic transmissions are done.
2.4.8.15  mac set rx2 <dataRate> <frequency>

<dataRate>: decimal number representing the data rate, from 0 to 7.

<frequency>: decimal number representing the frequency, from 863000000 to 870000000 or from 433050000 to 434790000, in Hz.

Response: ok if parameters are valid

invalid_param if parameters are not valid

This command sets the data rate and frequency used for the second Receive window. The configuration of the Receive window parameters should be in concordance with the server configuration.

Example: mac set rx2 3 865000000 // Receive window 2 is configured with SF9/125 kHz data rate with a center frequency of 865 MHz.

Note: If this parameter had previously been saved to user EEPROM by issuing the mac save command, after modifying its value, the mac save command should be called again.

2.4.8.16  mac set sync <synchWord>

<synchWord>: one byte long hexadecimal number representing the synchronization word for the LoRaWAN communication

Response: ok if parameters are valid

invalid_param if parameter is not valid

This command sets the synchronization word for the LoRaWAN communication. The configuration of the synchronization word should be in concordance with the Gateway configuration.

Example: mac set sync 34 //Synchronization word is configured to use the 0x34 value

2.4.8.17  mac set upctr <fCntUp>

<fCntUp>: decimal number representing the value of the uplink frame counter that will be used for the next uplink transmission, from 0 to 4294967295.

Response: ok if parameter is valid

invalid_param if parameter is not valid

This command sets the value of the uplink frame counter that will be used for the next uplink transmission.

Example: mac set upctr 10

Note: If this parameter had previously been saved to user EEPROM by issuing the mac save command, after modifying its value, the mac save command should be called again.
2.4.8.18  mac set dnctr <fCntDown>

<fCntDown>: decimal number representing the value of the downlink frame counter that will be used for the next downlink reception, from 0 to 4294967295.
Response: ok if parameter is valid
            invalid_param if parameter is not valid

This command sets the value of the downlink frame counter that will be used for the next downlink reception.
Example: mac set dnctr 30

Note: If this parameter had previously been saved to user EEPROM by issuing the mac save command, after modifying its value, the mac save command should be called again.

2.4.8.19  MAC SET CHANNEL COMMANDS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>freq</td>
<td>Sets the module operation frequency on a given channel ID.</td>
</tr>
<tr>
<td>dcycle</td>
<td>Sets the module operation duty cycle on a given channel ID.</td>
</tr>
<tr>
<td>drrange</td>
<td>Sets the module allowed data rate range (min.- max.) allowed on a given channel ID.</td>
</tr>
<tr>
<td>status</td>
<td>Sets the use of the specified channel ID.</td>
</tr>
</tbody>
</table>

2.4.8.19.1  mac set ch freq <channelID> <frequency>

<channelID>: decimal number representing the channel number, from 3 to 15.
<br>
<frequency>: decimal number representing the frequency, from 863000000 to 870000000 or from 433050000 to 434790000, in Hz.
Response: ok if parameters are valid
            invalid_param if parameters are not valid

This command sets the operational frequency on the given channel ID. The default channels (0-2) cannot be modified in terms of frequency.
Example: mac set ch freq 13 864000000  // Define frequency for channel 13 to be 864 MHz.

Note: If this parameter was previously saved to user EEPROM by issuing the mac save command, after modifying its value, the mac save command should be called again.
2.4.8.19.2  mac set ch dcycle <channelID> <dutyCycle>

<channelID>: decimal number representing the channel number, from 0 to 15.
<dutyCycle>: decimal number representing the duty cycle, from 0 to 65535.

Response: ok if parameters are valid
invalid_param if parameters are not valid

This command sets the duty cycle used on the given channel ID on the module. The <dutyCycle> value that needs to be configured can be obtained from the actual duty cycle X (in percentage) using the following formula: <dutyCycle> = (100/X) – 1. The default settings consider only the three default channels (0-2), and their default duty cycle is 0.33%. If a new channel is created either by the server or by the user, all the channels (including the default ones) must be updated by the user in terms of duty cycle to comply with the ETSI regulations.

Example: mac set ch dcycle 13 9  // Defines duty cycle for channel 13 to be 10%. Since (100/10) – 1 = 9, the parameter that gets configured is 9.

Note: If this parameter was previously saved to user EEPROM by issuing the mac save command, after modifying its value, the mac save command should be called again.

2.4.8.19.3  mac set ch drrange <channelID> <minRange> <maxRange>

<channelID>: decimal number representing the channel number, from 0 to 15
<minRange>: decimal number representing the minimum data rate, from 0 to 7
<maxRange>: decimal number representing the maximum data rate, from 0 to 7

Response: ok if parameters are valid
invalid_param if parameters are not valid

This command sets the operating data rate range, min. to max., for the given <channelID>. By doing this the module can vary data rates between the <minRange> and <maxRange> on the specified <channelID>. Please refer to the LoRaWAN™ Specification for the actual values of the data rates and the corresponding spreading factors (SF).

Example: mac set ch drrange 13 0 2  // Using EU863-870 band: on channel 13 the data rate can range from 0 (SF12/125 kHz) to 2 (SF10/125 kHz) as required.

Note: If this parameter was previously saved to user EEPROM by issuing the mac save command, after modifying its value, the mac save command should be called again.
2.4.8.19.4  `mac set ch status <channel ID> <status>`

<channelId>: decimal number representing the channel number, from 0 to 15.
<status>: string value representing the state, either on or off.

Response:  ok if parameters are valid
invalid_param if parameters are not valid

This command sets the operation of the given <channelId>.

Example: `mac set ch status 4 off`  // Channel ID 4 is disabled from use.

---

**WARNING**

<ChannelId> parameters (frequency, data range, duty cycle) must be issued prior to enabling the status of that channel.

---

**Note:** If this parameter was previously saved to user EEPROM by issuing the `mac save` command, after modifying its value, the `mac save` command should be called again.

2.4.9  MAC Get Commands

### TABLE 2-8: MAC GET COMMANDS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>devaddr</td>
<td>Gets the current stored unique network device address for that specific end device.</td>
</tr>
<tr>
<td>deveui</td>
<td>Gets the current stored globally unique identifier for that specific end device.</td>
</tr>
<tr>
<td>appeui</td>
<td>Gets the application identifier for the end device.</td>
</tr>
<tr>
<td>dr</td>
<td>Gets the data rate to be used for the next transmission.</td>
</tr>
<tr>
<td>band</td>
<td>Gets the current frequency band in operation.</td>
</tr>
<tr>
<td>pwridx</td>
<td>Gets the output power index value.</td>
</tr>
<tr>
<td>adr</td>
<td>Gets the state of adaptive data rate for the device.</td>
</tr>
<tr>
<td>retx</td>
<td>Gets the number of retransmissions to be used for an uplink confirmed packet.</td>
</tr>
<tr>
<td>rxdelay1</td>
<td>Gets the interval value stored for rxdelay1.</td>
</tr>
<tr>
<td>rxdelay2</td>
<td>Gets the interval value stored for rxdelay2.</td>
</tr>
<tr>
<td>ar</td>
<td>Gets the state of the automatic reply.</td>
</tr>
<tr>
<td>rx2</td>
<td>Gets the data rate and frequency used for the second Receive window.</td>
</tr>
<tr>
<td>dcycleps</td>
<td>Gets the duty cycle prescaler which can only be configured by the server.</td>
</tr>
<tr>
<td>mrgn</td>
<td>Gets the demodulation margin as received in the last Link Check Answer frame.</td>
</tr>
<tr>
<td>gwnb</td>
<td>Gets the number of gateways that successfully received the last Link Check Request frame.</td>
</tr>
<tr>
<td>status</td>
<td>Gets the current status of the RN2483 module.</td>
</tr>
<tr>
<td>sync</td>
<td>Gets the synchronization word for the LoRaWAN communication.</td>
</tr>
<tr>
<td>upctr</td>
<td>Gets the value of the uplink frame counter that will be used for the next uplink transmission.</td>
</tr>
<tr>
<td>dnctr</td>
<td>Gets the value of the downlink frame counter that will be used for the next downlink reception.</td>
</tr>
<tr>
<td>ch</td>
<td>Gets parameters related information which pertains to channel operation and behaviors.</td>
</tr>
</tbody>
</table>
2.4.9.1  mac get devaddr
Response: 4-byte hexadecimal number representing the device address, from 00000000 to FFFFFFFF.
This command will return the current end-device address of the module.
Default: 00000000
Example: mac get devaddr

2.4.9.2  mac get deveui
Response: 8-byte hexadecimal number representing the device EUI.
This command returns the globally unique end-device identifier, as set in the module.
Default: pre-programmed EUI node address
Example: mac get deveui

Note: After the mac reset <band> command is explicitly called, the device EUI value will be set to all zeros. Make certain that a valid value is given to the device EUI.

2.4.9.3  mac get appeui
Response: 8-byte hexadecimal number representing the application EUI.
This command will return the application identifier for the module. The application identifier is a value given to the device by the network.
Default: 0000000000000000
Example: mac get appeui

2.4.9.4  mac get dr
Response: decimal number representing the current data rate.
This command will return the current data rate.
Default: 5
Example: mac get dr

2.4.9.5  mac get band
Response: decimal number representing the frequency band, either 868 or 433.
This command returns the current frequency band of operation. The band reflects the module's operation types.
Default: 868
Example: mac get band

2.4.9.6  mac get pwridx
Response: decimal number representing the current output power index value, from 0 to 5.
This command returns the current output power index value.
Default: 1
Example: mac get pwridx
2.4.9.7   mac get adr  
Response: string representing the state of the adaptive data rate mechanism, either on or off. 
This command will return the state of the adaptive data rate mechanism. It will reflect if the ADR is on or off on the requested device. 
Default: off  
Example: mac get adr

2.4.9.8   mac get retx  
Response: decimal number representing the number of retransmissions, from 0 to 255. 
This command will return the currently configured number of retransmissions which are attempted for a confirmed uplink communication when no downlink response has been received. 
Default: 7  
Example: mac get retx

2.4.9.9   mac get rxdelay1  
Response: decimal number representing the interval, in milliseconds, for rxdelay1, from 0 to 65535. 
This command will return the interval, in milliseconds, for rxdelay1. 
Default: 1000  
Example: mac get rxdelay1

2.4.9.10   mac get rxdelay2  
Response: decimal number representing the interval, in milliseconds, for rxdelay2, from 0 to 65535. 
This command will return the interval, in milliseconds, for rxdelay2. 
Default: 2000  
Example: mac get rxdelay2

2.4.9.11   mac get ar  
Response: string representing the state of the automatic reply, either on or off. 
This command will return the current state for the automatic reply (AR) parameter. The response will indicate if the AR is on or off. 
Default: off  
Example: mac get ar
2.4.9.12  mac get rx2 <freqBand>

`<freqBand>`: decimal number representing the frequency band, either 868 or 433.
Response: decimal number representing the data rate configured for the second Receive window, from 0 to 7 and a decimal number for the frequency configured for the second Receive window, from 863000000 to 870000000 or from 433050000 to 434790000, in Hz.
This command will return the current data rate and frequency configured to be used during the second Receive window.
Default: 0 869525000  // for 868 band
                  0 434665000  // for 433 band
Example: `mac get rx2 868`

2.4.9.13  mac get dcycleps
Response: decimal number representing the prescaler value, from 0 to 65535.
This command returns the duty cycle prescaler. The value of the prescaler can be configured **ONLY** by the SERVER through use of the Duty Cycle Request frame. Upon reception of this command from the server, the duty cycle prescaler is changed for all enabled channels.
Default: 1
Example: `mac get dcycleps`

2.4.9.14  mac get mrgn
Response: decimal number representing the demodulation margin, from 0 to 255.
This command will return the demodulation margin as received in the last Link Check Answer frame. Please refer to the *LoRaWAN™ Specification* for the description of the values.
Default: 255
Example: `mac get mrgn`

2.4.9.15  mac get gwnb
Response: decimal number representing the number of gateways, from 0 to 255.
This command will return the number of gateways that successfully received the last Link Check Request frame command, as received in the last Link Check Answer.
Default: 0
Example: `mac get gwnb`
2.4.9.16  mac get status
Response: 4-byte hexadecimal number representing the current status of the module.
This command will return the current status of the module. The value returned is a bit
mask represented in hexadecimal form. Please refer to Figure 2-1 for the significance
of the bit mask.
Default: 00000000
Example: **mac get status**

2.4.9.17  mac get sync
Response: one byte long hexadecimal number representing the synchronization word
for the LoRaWAN communication.
This command will return the synchronization word for the LoRaWAN communication.
Default: 34
Example: **mac get sync**

2.4.9.18  mac get upctr
Response: decimal number representing the value of the uplink frame counter that will
be used for the next uplink transmission, from 0 to 4294967295.
This command will return the value of the uplink frame counter that will be used for the
next uplink transmission.
Default: 0
Example: **mac get upctr**

2.4.9.19  mac get dnctr
Response: decimal number representing the value of the downlink frame counter that will
be used for the next downlink reception, from 0 to 4294967295.
This command will return the value of the downlink frame counter that will be used for the
next downlink reception.
Default: 0
Example: **mac get dnctr**
FIGURE 2-1: MAC STATUS BIT-MAPPED REGISTER (1)

<table>
<thead>
<tr>
<th>Bit</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Join status (‘0’ – network not joined, ‘1’ – network joined)</td>
</tr>
<tr>
<td>14</td>
<td>Mac state (2)</td>
</tr>
<tr>
<td>13</td>
<td>Automatic reply status (‘0’ – disabled, ‘1’ – enabled)</td>
</tr>
<tr>
<td>12</td>
<td>ADR status (‘0’ – ADR is disabled, ‘1’ – ADR is disabled)</td>
</tr>
<tr>
<td>11</td>
<td>Silent immediately status (‘0’ – disabled, ‘1’ – enabled)</td>
</tr>
<tr>
<td>10</td>
<td>Mac pause status (‘0’ – mac is not paused, ‘1’ – mac is paused)</td>
</tr>
<tr>
<td>9</td>
<td>RFU</td>
</tr>
<tr>
<td>8</td>
<td>Link check status (‘0’ – link check is disabled, ‘1’ – link check is enabled)</td>
</tr>
<tr>
<td>7</td>
<td>Output power updated (‘0’ – not updated, ‘1’ – updated via LinkADRReq MAC command)</td>
</tr>
<tr>
<td>6</td>
<td>NbRep updated (‘0’ – not updated, ‘1’ – updated via LinkADRReq MAC command)</td>
</tr>
<tr>
<td>5</td>
<td>Prescaler updated (‘0’ – not updated, ‘1’ – updated via DutyCycleReq MAC command)</td>
</tr>
<tr>
<td>4</td>
<td>Second Receive window parameters updated (‘0’ – not updated, ‘1’ – updated RX ParamSetupReq command)</td>
</tr>
<tr>
<td>3</td>
<td>TX timing setup updated (‘0’ – not updated, ‘1’ – updated via RX TimingSetupReq MAC command)</td>
</tr>
<tr>
<td>2</td>
<td>Rejoin needed (‘0’ – end device functional, ‘1’ – end device not functional and rejoin is needed)</td>
</tr>
<tr>
<td>1</td>
<td>RFU</td>
</tr>
<tr>
<td>0</td>
<td>Rejoin needed (‘0’ – end device functional, ‘1’ – end device not functional and rejoin is needed)</td>
</tr>
</tbody>
</table>

**Note 1:** Bits 10 (Channels updated), 11 (Output power updated), 12 (NbRep updated), 13 (Prescaler updated), 14 (Second Receive window parameters updated) and 15 (TX timing setup updated) are cleared after issuing a "mac get status" command.

**Note 2:** Mac state:
0 – Idle (transmissions are possible)
1 – Transmission occurring
2 – Before the opening of Receive window 1
3 – Receive window 1 is open
4 – Between Receive window 1 and Receive window 2
5 – Receive window 2 is open
6 – Ack_timeout (Ack_timeout is described in more detail in the LoRaWAN™ specification)

**Note 3:** NbRep is the number of repetitions for unconfirmed packets (please refer to the LoRaWAN™ Specification for more details).
2.4.9.20  MAC GET CHANNEL COMMANDS

**TABLE 2-9: MAC GET CHANNEL COMMANDS**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>freq</td>
<td>Gets the module operation frequency for the specified channel ID.</td>
</tr>
<tr>
<td>dcycle</td>
<td>Gets the module duty cycle used for transmission on the specified channel ID.</td>
</tr>
<tr>
<td>drrange</td>
<td>Gets the valid data rate range (min. to max.) allowed for the module on the specified channel ID.</td>
</tr>
<tr>
<td>status</td>
<td>Gets the status for the specified channel ID to indicate if it is enabled for use.</td>
</tr>
</tbody>
</table>

**TABLE 2-10: DEFAULT PARAMETERS FOR CHANNELS**

<table>
<thead>
<tr>
<th>Channel Number</th>
<th>Parameters</th>
<th>Frequency band</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>868</td>
</tr>
<tr>
<td>Channel 0</td>
<td>Frequency (Hz)</td>
<td>868100000</td>
</tr>
<tr>
<td></td>
<td>Duty cycle</td>
<td>302</td>
</tr>
<tr>
<td></td>
<td>Data rate range</td>
<td>0-5</td>
</tr>
<tr>
<td></td>
<td>Status</td>
<td>On</td>
</tr>
<tr>
<td>Channel 1</td>
<td>Frequency (Hz)</td>
<td>868300000</td>
</tr>
<tr>
<td></td>
<td>Duty cycle</td>
<td>302</td>
</tr>
<tr>
<td></td>
<td>Data rate range</td>
<td>0-5</td>
</tr>
<tr>
<td></td>
<td>Status</td>
<td>On</td>
</tr>
<tr>
<td>Channel 2</td>
<td>Frequency (Hz)</td>
<td>868500000</td>
</tr>
<tr>
<td></td>
<td>Duty cycle</td>
<td>302</td>
</tr>
<tr>
<td></td>
<td>Data rate range</td>
<td>0-5</td>
</tr>
<tr>
<td></td>
<td>Status</td>
<td>On</td>
</tr>
<tr>
<td>Channels 3-15</td>
<td>Frequency (Hz)</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Duty cycle</td>
<td>65535</td>
</tr>
<tr>
<td></td>
<td>Data rate range</td>
<td>15 15</td>
</tr>
<tr>
<td></td>
<td>Status</td>
<td>Off</td>
</tr>
</tbody>
</table>

**Note 1:** The default settings consider only the three default channels (0-2), and their default duty cycle is 0.33%. If a new channel is created either by the server or by the user, all the channels (including the default ones) must be updated by the user in terms of duty cycle to comply with the ETSI regulations.

2.4.9.20.1  mac get ch freq <ChannelId>

- `<channelId>`: decimal number representing the channel number, from 0 to 15.

**Response:** decimal number representing the frequency of the channel, from 863000000 to 870000000 or from 433050000 to 434790000, in Hz, depending on the frequency band selected.

**This command returns the frequency on the requested `<channelId>`, entered in decimal form.**

**Default:** see Table 2-10

**Example:** `mac get ch freq 0`
2.4.9.20.2  \texttt{mac get ch dcycle <channelId>}

\texttt{<channelId>}: decimal number representing the channel number, from 0 to 15.

Response: decimal number representing the duty cycle of the channel, from 0 to 65535.

This command returns the duty cycle on the requested \texttt{<channelId>}. The duty cycle is returned in decimal value. The actual duty cycle (in percentage) can be obtained using the returned value \( V \) as: \( \text{percent} = \frac{100}{V + 1} \).

Default: see Table 2-10

Example: \texttt{mac get ch dcycle 0}  // Reads back duty cycle setting on Channel ID 0. If the value reported back is 99, the actual duty cycle on the channel (in percentage) is \( \frac{100}{99 + 1} = 1 \).

2.4.9.20.3  \texttt{mac get ch drange <channelId>}

\texttt{<channelId>}: decimal number representing the channel number, from 0 to 15.

Response: decimal number representing the minimum data rate of the channel, from 0 to 7 and a decimal number representing the maximum data rate of the channel, from 0 to 7

This command returns the allowed data rate index range on the requested \texttt{<channelId>}, entered in decimal form. The \texttt{<minRate>} and \texttt{<maxRate>} index values are returned in decimal form and reflect index values. Please refer to the \textit{LoRaWAN™ Specification} for the description of data rates and the corresponding spreading factors.

Default: see Table 2-10

Example: \texttt{mac get ch drange 0}

2.4.9.20.4  \texttt{mac get ch status <channelId>}

\texttt{<channelId>}: decimal number representing the channel number, from 0 to 15.

Response: string representing the state of the channel, either on or off.

This command returns if \texttt{<channelId>} is currently enabled for use. \texttt{<channelId>} is entered in decimal form and the response will be on or off reflecting the channel is enabled or disabled appropriately.

Default: see Table 2-10

Example: \texttt{mac get ch status 2}

\textbf{Note:} \texttt{<ChannelId>} parameters must be issued prior to enabling the status of that channel. If a channel is disabled through the \texttt{<status>}, all channel parameters must be reconfigured prior to enabling.
2.5 RADIO COMMANDS

TABLE 2-11: RADIO COMMANDS(1)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>rx</td>
<td>This command configures the radio to receive simple radio packets according to prior configuration settings.</td>
</tr>
<tr>
<td>tx</td>
<td>This command configures a simple radio packet transmission according to prior configuration settings.</td>
</tr>
<tr>
<td>cw</td>
<td>This command will put the module into a Continuous Wave (cw) Transmission for system tuning or certification use.</td>
</tr>
<tr>
<td>set</td>
<td>This command allows modification to the radio setting directly. This command allows for the user to change the method of radio operation within module type band limits.</td>
</tr>
<tr>
<td>get</td>
<td>This command grants the ability to read out radio settings as they are currently configured.</td>
</tr>
</tbody>
</table>

Note 1: The mac pause command must be called before any radio transmission or reception, even if no MAC operations have been initiated before.

TABLE 2-12: RADIO PARAMETERS AVAILABILITY FOR DIFFERENT OPERATIONS

<table>
<thead>
<tr>
<th>Command</th>
<th>radio get</th>
<th>radio set</th>
<th>Availability for LoRa® Modulation</th>
<th>Availability for FSK Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>bt</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>mod</td>
<td>√</td>
<td>√</td>
<td>√</td>
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<td>bw</td>
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<td>snr</td>
<td>√</td>
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</tbody>
</table>
2.5.1  radio rx <rxWindowSize>

.rxWindowSize>: decimal number representing the number of symbols (for LoRa modulation) or time-out (in milliseconds, for FSK modulation) that the receiver will be opened, from 0 to 65535. Set <rxWindowSize> to '0' in order to enable the Continuous Reception mode. Continuous Reception mode will be exited once a valid packet is received.

Response: this command may reply with two responses. The first response will be received immediately after entering the command. If the command is valid (**ok** reply received), a second reply will be received after the reception of a packet or after the time-out occurred.

Response after entering the command:
- **ok** – if parameter is valid and the transceiver is configured in Receive mode
- **invalid_param** – if parameter is not valid
- **busy** – if the transceiver is currently busy

Response after the receive process:
- **radio_rx <data>** – if reception was successful, <data>: hexadecimal value that was received;
- **radio_err** – if reception was not successful, reception time-out occurred

Example: **radio rx 0**  // Puts the radio into continuous Receive mode.

Ensure the radio Watchdog Timer time-out is higher than the Receive window size.

**Note:** The **mac pause** command must be called before any radio transmission or reception, even if no MAC operations have been initiated before.

**Note:** When transmitting FSK packets, the payload and the 2-byte CRC is whitened by being XORed with a pseudorandom sequence generated by an LFSR with the polynomial $X^9 + X^5 + 1$. This process is automatically reverted on reception so that it is transparent to the user.
2.5.2  radio tx <data>

<data>: hexadecimal value representing the data to be transmitted, from 0 to 255 bytes for LoRa modulation and from 0 to 64 bytes for FSK modulation.

Response: this command may reply with two responses. The first response will be received immediately after entering the command. If the command is valid (ok reply received), a second reply will be received after the effective transmission.

Response after entering the command:
- ok – if parameter is valid and the transceiver is configured in Transmit mode
- invalid_param – if parameter is not valid
- busy – if the transceiver is currently busy

Response after the effective transmission:
- radio_tx_ok – if transmission was successful
- radio_err – if transmission was unsuccessful (interrupted by radio Watchdog Timer time-out)

This command transmits the <data> passed.

Example: radio tx 48656C6C6F // Transmits a packet of [0x48][0x65][0x6C][0x6C][0x6F]; Hello.

Note: In order to meet ETSI regulations in the given frequency bands, the radio has to use either Listen Before Talk (LBT) + Adaptive Frequency Agility (AFA) or duty cycle limitations. By issuing the radio tx <data> command the module does not perform LBT before transmission, thus the user has to make sure that duty cycle limits are not violated. For more information on duty cycle limits please check the EN 300 220-2 v2.4.1 standard.

Note: The mac_pause command must be called before any radio transmission or reception, even if no MAC operations have been initiated before.

Note: When transmitting FSK packets, the payload and the 2-byte CRC is whitened by being XORed with a pseudorandom sequence generated by an LFSR with the polynomial X^9 + X^5 + 1. This process is automatically reverted on reception so that it is transparent to the user.

2.5.3  radio cw <state>

<state>: string representing the state of the Continuous Wave (CW) mode, either on or off.

Response: ok if state is valid
- invalid_param if state is not valid

This command will enable or disable the CW mode on the module. CW mode allows the user to put the transceiver into Transmission mode to observe the generated signal. By altering the settings for the radio the user can observe the changes in transmissions levels.

Example: radio cw on

Note: Please note that using radio cw off resets the module, this command being semantically identical to sys reset.
2.5.4 Radio Set Commands

### TABLE 2-13: RADIO SET COMMANDS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>bt</td>
<td>Set the data shaping for frequency shift keying (FSK) modulation type.</td>
</tr>
<tr>
<td>mod</td>
<td>Set the module Modulation mode.</td>
</tr>
<tr>
<td>freq</td>
<td>Set the current operation frequency for the radio.</td>
</tr>
<tr>
<td>pwr</td>
<td>Set the output power level used by the radio during transmission.</td>
</tr>
<tr>
<td>sf</td>
<td>Set the requested spreading factor (SF) to be used during transmission.</td>
</tr>
<tr>
<td>afcbw</td>
<td>Set the value used by the automatic frequency correction bandwidth.</td>
</tr>
<tr>
<td>rxbw</td>
<td>Set the operational receive bandwidth.</td>
</tr>
<tr>
<td>bitrate</td>
<td>Set the frequency shift keying (FSK) bit rate.</td>
</tr>
<tr>
<td>fdev</td>
<td>Set the frequency deviation allowed by the end device.</td>
</tr>
<tr>
<td>prlen</td>
<td>Set the preamble length used during transmissions.</td>
</tr>
<tr>
<td>crc</td>
<td>Set if a CRC header is to be used.</td>
</tr>
<tr>
<td>iq1</td>
<td>Set if IQ inversion is used.</td>
</tr>
<tr>
<td>cr</td>
<td>Set the coding rate used by the radio.</td>
</tr>
<tr>
<td>wdt</td>
<td>Set the time-out limit for the radio Watchdog Timer.</td>
</tr>
<tr>
<td>sync</td>
<td>Set the sync word used.</td>
</tr>
<tr>
<td>bw</td>
<td>Set the value used for the radio bandwidth.</td>
</tr>
</tbody>
</table>

#### 2.5.4.1 radio set bt <gfBT>

- **<gfBT>:** string representing the Gaussian baseband data shaping, enabling GFSK modulation. Parameter values can be: none, 1.0, 0.5, 0.3.
- **Response:** *ok* if the data shaping is valid
  - *invalid_param* if the data shaping is not valid

This command modifies the data shaping applied to FSK transmissions. Entering any `<gfBT>` other than `none` will result in a Gaussian Filter BT being applied to transmissions in FSK mode.

**Example:** `radio set bt none` // Data shaping in FSK mode is disabled or null.

#### 2.5.4.2 radio set mod <mode>

- **<mode>:** string representing the modulation method, either *lora* or *fsk*.
- **Response:** *ok* if the modulation is valid
  - *invalid_param* if the modulation is not valid

This command changes the modulation method being used by the module. Altering the mode of operation does not affect previously set parameters, variables or registers.

FSK mode also allows GFSK transmissions when data shaping is enabled.

**Example:** `radio set mod lora`

#### 2.5.4.3 radio set freq <frequency>

- **<frequency>:** decimal representing the frequency, from 433050000 to 434790000 or from 863000000 to 870000000, in Hz.
- **Response:** *ok* if the frequency is valid
  - *invalid_param* if the frequency is not valid

This command changes the communication frequency of the radio transceiver.

**Example:** `radio set freq 868000000`
2.5.4.4 radio set pwr \(<pwrOut>\)  
\(<pwrOut>\): signed decimal number representing the transceiver output power, from -3 to 15.  
Response: ok if the output power is valid  
invalid_param if the output power is not valid  
This command changes the transceiver output power. However, note that the transceiver is designed to transmit a maximum of +14 dBm. It is possible to set the output power above the regulatory limits. This power setting allows some compensation on the cable or transmission line loss. For more details on output power please check the RN2483 Low-Power Long-Range LoRa® Technology Transceiver Module Data Sheet.  
Example: radio set pwr 14  
2.5.4.5 radio set sf \(<spreadingFactor>\)  
\(<spreadingFactor>\): string representing the spreading factor. Parameter values can be: sf7, sf8, sf9, sf10, sf11 or sf12.  
Response: ok if the spreading factor is valid  
invalid_param if the spreading factor is not valid  
This command sets the spreading factor used during transmission.  
Example: radio set sf sf7  
2.5.4.6 radio set afcbw \(<autoFreqBand>\)  
\(<autoFreqBand>\): float representing the automatic frequency correction, in kHz. Parameter values can be: 250, 125, 62.5, 31.3, 15.6, 7.8, 3.9, 200, 100, 50, 25, 12.5, 6.3, 3.1, 166.7, 83.3, 41.7, 20.8, 10.4, 5.2, 2.6.  
Response: ok if the automatic frequency correction is valid  
invalid_param if the automatic frequency correction is not valid  
This command modifies the automatic frequency correction bandwidth for receiving/transmitting.  
Example: radio set afcbw 125  
2.5.4.7 radio set rxbw \(<rxBandwidth>\)  
\(<rxBandwidth>\): float representing the signal bandwidth, in kHz. Parameter values can be: 250, 125, 62.5, 31.3, 15.6, 7.8, 3.9, 200, 100, 50, 25, 12.5, 6.3, 3.1, 166.7, 83.3, 41.7, 20.8, 10.4, 5.2, 2.6.  
Response: ok if the signal bandwidth is valid  
invalid_param if signal bandwidth is not valid  
This command sets the signal bandwidth when receiving.  
Example: radio set rxbw 250 // Signal bandwidth for receiving is 250 kHz.  
2.5.4.8 radio set bitrate \(<fskBitRate>\)  
\(<fskBitRate>\): decimal number representing the FSK bit rate value, from 1 to 300000.  
Response: ok if the bit rate value is valid  
invalid_param if the bit rate value is not valid  
This command sets the FSK bit rate value.  
Example: radio set bitrate 5000 // FSK bit rate is set to 5 kb/s.
2.5.4.9  radio set fdev <freqdev>

<freqDev>: decimal number representing the frequency deviation, from 0 to 200000.
Response: ok if the frequency deviation is valid
           invalid_param if frequency deviation is not valid
This command sets the frequency deviation during operation.
Example: radio set fdev 5000  // Frequency deviation is 5 kHz.

2.5.4.10 radio set prlen <preamble>

<preamble>: decimal number representing the preamble length, from 0 to 65535.
Response: ok if the preamble length is valid
           invalid_param if the preamble length is not valid
This command sets the preamble length for transmit/receive.
Example: radio set prlen 8     // Preamble length is 8.

2.5.4.11 radio set crc <crcHeader>

<crcHeader>: string representing the state of the CRC header, either on or off.
Response: ok if the state is valid
           invalid_param if the state is not valid
This command enables or disables the CRC header for communications.
Example: radio set crc on      // Enables the CRC header.

2.5.4.12 radio set iqi <iqInvert>

<iqInvert>: string representing the state of the invert IQ, either on or off.
Response: ok if the state is valid
           invalid_param if the state is not valid
This command enables or disables the Invert IQ for communications.
Example: radio set iqi on      // Invert IQ is enabled.

2.5.4.13 radio set cr <codingRate>

<codingRate>: string representing the coding rate. Parameter values can be: 4/5, 4/6, 4/7, 4/8.
Response: ok if the coding rate is valid
           invalid_param if the coding rate is not valid
This command modifies the coding rate currently being used by the radio.
Example: radio set cr 4/7   // The coding rate is set to 4/7.
2.5.4.14  radio set wdt <watchDog>

<watchDog>: decimal number representing the time-out length for the Watchdog Timer, from 0 to 4294967295. Set to '0' to disable this functionality.

Response:  
- ok if the watchdog time-out is valid
- invalid_param if the watchdog time-out is not valid

This command updates the time-out length, in milliseconds, applied to the radio Watchdog Timer. If this functionality is enabled, then the Watchdog Timer is started for every transceiver reception or transmission. The Watchdog Timer is stopped when the operation in progress in finished.


Note:  Ensure the value configured for the Watchdog Timer matches the radio configurations. For example, set the <watchDog> value to '0' in order to disable this functionality during the radio continuous reception.

2.5.4.15  radio set sync <syncWord>

<syncWord>: hexadecimal value representing the Sync word used during communication. For LoRa modulation one byte is used, for FSK up to eight bytes can be entered.

Response:  
- ok if the sync word is valid
- invalid_param if the sync word is not valid

This command configures the sync word used during communication.

Example: radio set sync 12 // Set the sync word to a single byte with the value 0x12.

2.5.4.16  radio set bw <bandWidth>

<bandWidth>: decimal representing the operating radio bandwidth, in kHz. Parameter values can be: 125, 250, 500.

Response:  
- ok if the bandwidth is valid
- invalid_param if the bandwidth is not valid

This command sets the operating radio bandwidth for LoRa operation.

Example: radio set bw 250 // The operating bandwidth is 250 kHz.
2.5.5  Radio Get Commands

### TABLE 2-14: RADIO GET COMMANDS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
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<td>bt</td>
<td>Get the data shaping for frequency shift keying (FSK) modulation type.</td>
</tr>
<tr>
<td>mod</td>
<td>Get the module Modulation mode.</td>
</tr>
<tr>
<td>freq</td>
<td>Get the current operation frequency for the radio.</td>
</tr>
<tr>
<td>pwr</td>
<td>Get the output power level used by the radio during transmission.</td>
</tr>
<tr>
<td>sf</td>
<td>Get the requested spreading factor (SF) to be used during transmission.</td>
</tr>
<tr>
<td>afcbw</td>
<td>Get the value used by the automatic frequency correction bandwidth.</td>
</tr>
<tr>
<td>rxbw</td>
<td>Get the operational receive bandwidth.</td>
</tr>
<tr>
<td>bitrate</td>
<td>Get the frequency shift keying (FSK) bit rate.</td>
</tr>
<tr>
<td>fdev</td>
<td>Get the frequency deviation allowed by the end device.</td>
</tr>
<tr>
<td>prlen</td>
<td>Get the preamble length used during transmissions.</td>
</tr>
<tr>
<td>crc</td>
<td>Get if a CRC header is to be used.</td>
</tr>
<tr>
<td>iqi</td>
<td>Get if IQ inversion is used.</td>
</tr>
<tr>
<td>cr</td>
<td>Get the coding rate used by the radio.</td>
</tr>
<tr>
<td>wdt</td>
<td>Get the time-out limit for the Watchdog Timer.</td>
</tr>
<tr>
<td>bw</td>
<td>Get the value used for the radio bandwidth.</td>
</tr>
<tr>
<td>snr</td>
<td>Get the signal noise ratio (SNR) of the last received packet.</td>
</tr>
<tr>
<td>sync</td>
<td>Get the synchronization word used for communication.</td>
</tr>
</tbody>
</table>

#### 2.5.5.1 radio get bt

Response: string representing the configuration for data shaping. Parameter values can be: none, 1.0, 0.5, 0.3.

This command reads back the current configuration for data shaping applied to FSK transmissions.

Default: 0.5

Example: `radio get bt`  // Reads the current data shaping FSK configuration.

#### 2.5.5.2 radio get mod

Response: string representing the current mode of operation of the module, either lora or fsk.

This command reads back the current mode of operation of the module.

Default: lora

Example: `radio get mod`  // Reads if module is modulating in LoRa or FSK.
2.5.5.3  radio get freq
Response: decimal number representing the frequency, from 433050000 to 434790000 or from 863000000 to 870000000, in Hz.
This command reads back the current operation frequency of the module.
Default: 868100000
Example: `radio get freq`  // Reads back the current frequency the transceiver communicates on.

2.5.5.4  radio get pwr
Response: signed decimal representing the current power level, from -3 to 15.
This command reads back the current power level settings used in operation.
Default: 1
Example: `radio get pwr`  // Reads back the current transmit output power.

2.5.5.5  radio get sf
Response: string representing the current spreading factor.
This command reads back the current spreading factor being used by the transceiver.
Parameter values can be: `sf7, sf8, sf9, sf10, sf11, sf12`
Default: sf12
Example: `radio get sf`  // Reads back the current spreading factor settings.

2.5.5.6  radio get afcbw
Response: float representing the automatic frequency correction band, in kHz.
Parameter values can be: 250, 125, 62.5, 31.3, 15.6, 7.8, 3.9, 200, 100, 50, 25, 12.5, 6.3, 3.1, 166.7, 83.3, 41.7, 20.8, 10.4, 5.2, 2.6.
This command reads back the status of the Automatic Frequency Correction Bandwidth.
Default: 41.7
Example: `radio get afcbw`  // Reads back the current automatic frequency correction bandwidth.

2.5.5.7  radio get rxbw
Response: float representing the signal bandwidth, in kHz. Parameter values can be: 250, 125, 62.5, 31.3, 15.6, 7.8, 3.9, 200, 100, 50, 25, 12.5, 6.3, 3.1, 166.7, 83.3, 41.7, 20.8, 10.4, 5.2, 2.6.
This command reads back the signal bandwidth used for receiving.
Default: 25
Example: `radio get rxbw`  // Reads back the receive signal bandwidth.
2.5.5.8  radio get bitrate
Response: signed decimal representing the configured bit rate, from 1 to 300000.
This command reads back the configured bit rate for FSK communications.
Default: 50000
Example: radio get bitrate // Reads back the current FSK bit rate setting.

2.5.5.9  radio get fdev
Response: signed decimal representing the frequency deviation setting, from 0 to 200000.
This command reads frequency deviation setting on the transceiver.
Default: 25000
Example: radio get fdev // Reads back current configured frequency deviation setting.

2.5.5.10 radio get prlen
Response: signed decimal representing the preamble length, from 0 to 65535.
This command reads the current preamble length used for communication.
Default: 8
Example: radio get prlen // Reads back the preamble length used by the transceiver.

2.5.5.11 radio get crc
Response: string representing the status of the CRC header, either on or off
This command reads back the status of the CRC header, to determine if it is to be included during operation.
Default: on
Example: radio get crc // Reads back if the CRC header is enabled for use.

2.5.5.12 radio get iqi
Response: string representing the status of the Invert IQ functionality, either on or off.
This command reads back the status of the Invert IQ functionality.
Default: off
Example: radio get iqi // Reads back the status of the Invert IQ functionality.

2.5.5.13 radio get cr
Response: string representing the current value settings used for the coding rate.
Parameter values can be: 4/5, 4/6, 4/7, 4/8.
This command reads back the current value settings used for the coding rate during communication.
Default: 4/5
Example: radio get cr // Reads back the current coding rate transceiver settings.
2.5.5.14  radio get wdt
Response: decimal number representing the length used for the watchdog time-out, from 0 to 4294967295.
This command reads back, in milliseconds, the length used for the watchdog time-out.
Default: 15000
Example: radio get wdt // Reads back the current time-out value applied to the Watchdog Timer

2.5.5.15  radio get bw
Response: decimal representing the current operating radio bandwidth, in kHz.
Parameter values can be: 125, 250 or 500.
This command reads back the current operating radio bandwidth used by the transceiver.
Default: 125
Example: radio get bw // Reads back the current operational bandwidth applied to transmissions.

2.5.5.16  radio get snr
Response: signed decimal number representing the signal to noise ratio (SNR), from -128 to 127.
This command reads back the Signal Noise Ratio (SNR) for the last received packet.
Default: -128
Example: radio get snr // Reads back the measured SNR for the previously packet reception.

2.5.5.17  radio get sync
Response: hexadecimal number representing the synchronization word used for radio communication.
This command reads back the configured synchronization word used for radio communication. One byte long synchronization word is used for the LoRa modulation while up to eight bytes can be entered for FSK.
Default: 34
Example: radio get sync
Appendix A. Current Firmware Features and Fixes

Please check the product web page for the current RN2483 firmware version at www.microchip.com/lora.

A.1. Version 0.9.5
Initial release of the firmware.

A.2. Version 1.0.0
Release for LoRaWAN specification V1.0
• Added support for additional RN2483 commands:
  mac set sync
  mac get sync
  mac set upctr
  mac get upctr
  mac set dnctr
  mac get dnctr
  sys set pinmode
  sys get pindig
  sys get pinana
  radio get sync
• Added new parameters to be saved in nonvolatile memory whenever a mac save command is triggered
  LoRaWAN current data rate
  LoRaWAN RX2 window parameters (data rate and frequency)
  Adaptive Data Rate status
  LoRaWAN uplink frame counter
  LoRaWAN downlink frame counter
• Changed the default value for the LoRaWAN End-Device Identifier (deveui)
• Changed the valid range for the radio set fdev parameter to [0.. 200000]
• Changed the valid range for the radio set bitrate parameter to [1.. 300000]
• Changed sys sleep command behavior to not influence the GPIO configuration
• Changed the 433 MHz radio frequency band to [433050000 .. 434790000]
• Fixed an issue that may have caused the RN2483 module to mishandle data on LoRaWAN port 0
• Fixed an issue that may have caused the module to fail joining
• Fixed radio get snr command to display correct value
A.3. Version 1.0.1

Release containing modifications needed to successfully pass the LoRaWAN Certification Program testing in 868 MHz band.

- Added support for usage of the reserved ports, from 224 to 255 for transmitting and receiving Application Data
- Increased the size of the value returned by the `mac get status` command from 2 bytes to 4 bytes
- Updated the size of the LoRaWAN receive windows and the moment in time at which these are opened
- Fixed an issue that may have caused the RN2483 module to mishandle packets received with DR = 7
- Fixed an issue that may have caused the RN2483 module to mishandle the LoRaWAN RXParamSetupReq command
- Fixed an issue that may have caused the RN2483 module to mishandle the usage of LoraWAN ADRACKReq in packets
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<table>
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<th>Phone</th>
<th>Fax</th>
</tr>
</thead>
</table>
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