RC16xxxx-SIG User Manual

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Quick Start

How do I transmit data?
Send your data to the RXD pin on the module. Use the UART format with settings (19200, 8, 1, N, no flow control). Up to 12 bytes payload are buffered in the module. The first byte of the message must contain the message length (excluding the length byte itself). The module will transmit the data when the whole packet is received.

How do I receive data?
The module has to be configured to Uplink and downlink mode in order to enable two way communication. Any received RF data packet with correct message format (ID, key, CRC) will be sent on the TXD pin with length byte first. The RSSI value (received signal strength) can optionally be added to the message.

What about the antenna?
In most cases a simple quarter wavelength wire or a PCB track will do. Connect a piece of wire to the RF pin with length corresponding to the quarter of a wavelength. For space limited products, contact Radiocrafts and we will recommend the best antenna solution for your application.

How do I change any configuration parameter?
To change configurable parameters, send one byte to the module with the value 0x00 or assert the CONFIG pin. This will take the module into configuration mode. Special commands are then used to access the configuration registers and test modes. Exit from configuration mode by sending the 'X' command. Parameters can be changed permanently and stored in non-volatile memory in the module.

Introduction - SIGFOX Network

The system can be divided into four main parts as shown on *figure 1*. The host controller is responsible for data collection. It connects to the RC16XXXX-SIG module through a standard UART interface, which can forward the collected information through an RF link (called Uplink) to the SIGFOX Base Station. The Base Station receives the incoming data and pass it to the back-end system, which provides an interface for the back-end users and client applications.

Optionally the SIGFOX Base Station can also send information to the RC16xxxx-SIG module through a wireless link (called Downlink).

Base Stations are deployed and operated by SIGFOX in cooperation with local telecom companies.

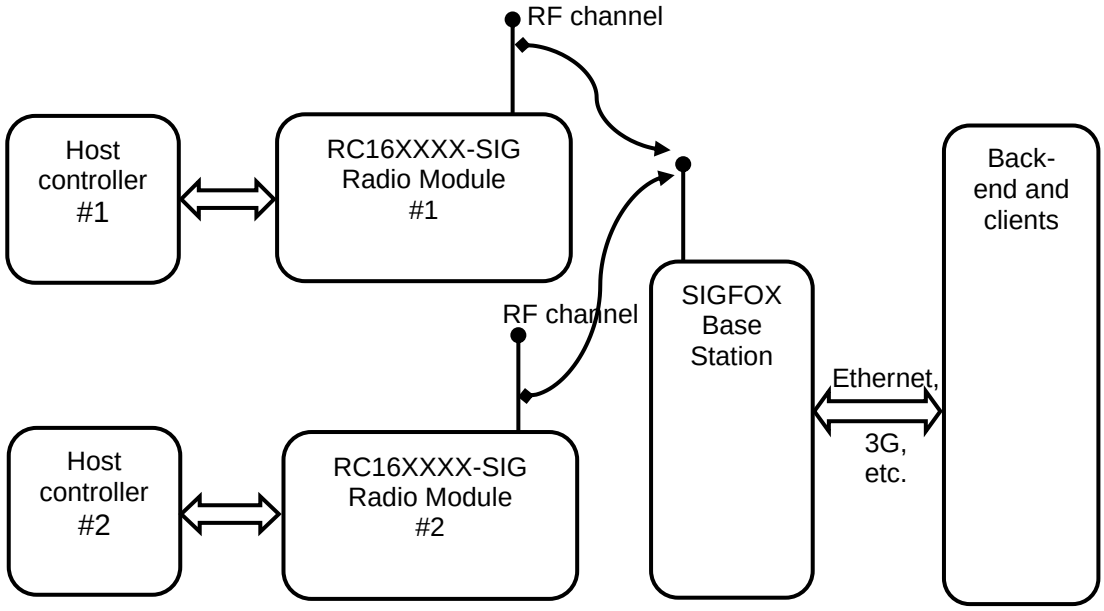


Figure 1: System topology

The global SIGFOX network defines zones/regions where different channel definitions apply. These zones are named as RCZx where x is an index. The following zones are available:

SIGFOX Zones	
Zone	Region
RCZ1	Europe
RCZ2	US
RCZ3	TBD
RCZ4	Australia/New Zealand

SIGFOX protocol

Basic functionality
The SIGFOX protocol defines two types of network modes:

1. Only uplink mode
   Packets are only transmitted from the RC16xxxx-SIG module to the base station. This mode can be used for pure data collection.

2. Uplink and downlink mode
   Packets transmitted by the RC16xxxx-SIG module are acknowledged by the base station. This mode can be used for controlling applications.

The user can select the preferred mode in Configuration mode and tune the parameters (timings, retransmission) accordingly.

Public key
SIGFOX offers a USB dongle to ease the product development process. This dongle provides a user interface and is able to receive packets using a public ID and KEY pair. The RC16xxxx-SIG module can be configured to use this public parameters and thus is able to connect to the dongle.

UART Interface for SIGFOX packet handling
The host uses the UART Interface to send and receive SIGFOX data. The UART physical layer (data rate) can be changed in the configuration mode.

When the module receives a packet over RF (downlink), it will send the packet over the UART interface on the TXD line.

When the host MCU wants to transmit a packet over the RF (uplink), it must send the packet through the UART interface on the RXD line.

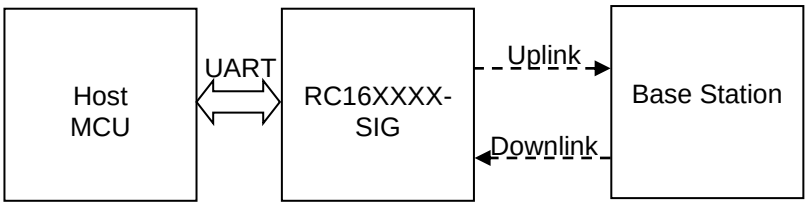


Figure 2: UART interface overview

Frame format for transmitting data
The following frame formats are accepted by the module for packet transmission (uplink):

1. Transmission of 1…12 bytes information (the format of payload is user specific):

Length	1…12bytes payload

2. Transmission of 1 bit information:

Length = 0x10	1byte, where only LS bit is relevant

3. Transmission of OOB (Out of band) packet:

Length = 0x11	-

Figure 3: UART interface packet transmission (RXD pin)

Out of Band (OOB) packet: A special SIGFOX packet generated by the module and contains information about RSSI, temperature and voltage levels. It can be used for supervision of the module and is automatically generated in Uplink and Downlink mode after every packet received by the RC16xxxx-SIG radio module.

Optionally, the user can enable a periodic OOB transmission by setting the configuration parameter '0x2F – OOB_PERIOD' to the required period. The unit then will schedule the packets automatically even if no user data is forwarded. This feature is only available if SLEEP mode is set.

Frame format for receiving data

The following packet format is used in case of reception of downlink packet:

Length	8 bytes payload	Optional RSSI

Figure 4: UART interface packet reception (TXD pin)

The 'Length' byte is calculated over the payload and optional RSSI field only.

UART Interface for Module Configuration

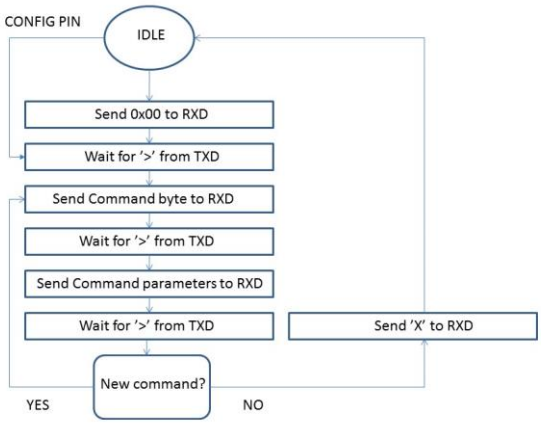


Figure 5: Configuration mode flow diagram

The configuration of the module can be changed in-circuit from the host during operation, at the time of installation of the equipment, at the manufacturing test, or even as a stand-alone module. The configuration is changed by sending commands on the UART interface after the module is set in configuration mode. The configuration mode is entered by sending 00h to the module, or by asserting the CONFIG pin (set low).

In configuration mode the module will respond by sending a '>' prompt on the TXD pin. This indicates that the module is ready to receive commands. The CONFIG pin (if used) can then be de-asserted. Note that the CONFIG pin must be de-asserted *before* the Exit command ('X') is sent to the module in order to return to normal operation.

After a command is executed, the module responds with the '>' prompt character again, indicating it is ready for a new command. Do not send a new command before the '>' prompt is received. The time required to execute a command can vary depending on the command (see the Timing Information section). There is no '>' prompt after the 'X' exit command.

The parameters that are set by dedicated configuration commands (i.e. 'F') take immediate effect after returning to normal operation (IDLE), but will not be stored in non-volatile memory and will be lost in case the supply power is turned off or if the module is reset.

Permanent changes of parameters can be done by writing to the configuration memory using the memory command 'M'. These are for example *default* RSSI append, *default* LED control, etc, See the Configuration Memory section for details.

The flow diagram above illustrates how to use the UART interface to enter configuration mode, change configuration parameters and return to IDLE mode.

UART Timing Information
A UART byte consist of one start bit, 8 data bits, and one stop bit.

The command-to-prompt wait time ($T_{CONFIG-PROMPT}$) is different from command to command.

The IDLE state is the normal state where the module waits for a character to be received on the UART. RXD is the state when receiving characters from the host filling up the internal buffer. TX/RX state is when the data is transmitted on the air and when data is received from the air. TXD is the state where the received data is sent to the host on the UART.

CONFIG is the configuration mode, the state entered by sending 00h or asserting the CONFIG pin and is entered during parameter configuration, while MEMORY CONFIG is the sub-state entered by the 'M' command where the non-volatile configuration memory is being programmed. Note the limitation on maximum number of write cycles using the 'M' command, see Electrical Specifications in the Data Sheet.

<table>
<tr><th>Symbol</th><th>Value</th><th>Description / Note</th></tr>
<tr><td colspan="3">UPLINK</td></tr>
<tr><td>t_{RXD-TX}</td><td>5.3ms</td><td>Time from last character on RXD line until the first bit is transmitted on RF.</td></tr>
<tr><td>t_{TXD}</td><td>Min 590 us</td><td>t_{TXD} = # bytes received x 590 us/char (10 bits at 19.2 kBd + 70 us delay per character)</td></tr>
<tr><td>t_{UPLINK}</td><td>Max. 10.33s</td><td>Time from first character on RF until the last character is sent on RF.

Formula:

RETRANSMISSION_NUMBER * TX +
(RETRANSMISSION_NUMBER -1) * TX_DELAY

Maximum value:

<table>
<tr><td>SIGFOX Zone</td><td>t_{UPLINK}</td></tr>
<tr><td>RCZ1</td><td>3 * 2.11s + 2 * 2s = 10.3s</td></tr>
<tr><td>RCZ2, RCZ4</td><td>3 * 0.35s + 2 * 0.5s = 2.05s</td></tr>
</table>

The length of TX (1 packet on RF) is determined as:

<table>
<tr><td rowspan="2">SIGFOX Zone</td><td colspan="4">Period [ms]</td></tr>
<tr><td>1 Byte</td><td>2-4 Bytes</td><td>5-8 Bytes</td><td>9-12 Bytes</td></tr>
<tr><td>RCZ1</td><td>1230</td><td>1470</td><td>1780</td><td>2110</td></tr>
<tr><td>RCZ2, RCZ4</td><td>206</td><td>246</td><td>300</td><td>352</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td></tr>
<tr><td>$t_{TX-IDLE}$</td><td>0…2s</td><td>Time from last character is sent on RF until the module is in IDLE mode (ready for RXD).

In only uplink mode, it is equivalent to TX_DELAY.</td></tr>
<tr><td colspan="3">UPLINK & DOWNLINK</td></tr>
<tr><td>$t_{RXD-TX2}$</td><td>5.3ms</td><td>Time from last character on RXD line until the first bit is transmitted on RF.</td></tr>
<tr><td>$t_{UPLINK\&DOWLINK}$</td><td>Max. 50.72s</td><td>Time from first character transmitted on RF until the last bit is sent on RF.

<u>Formula</u>:

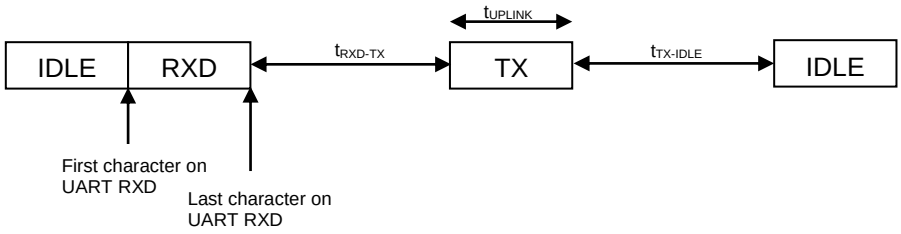
TX + WAIT + RX_WINDOW + OOB_DELAY + OOB

<u>Maximum value</u>:

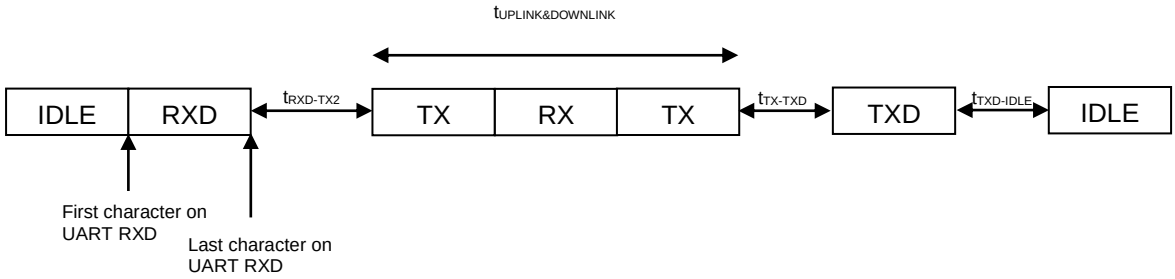
<table><tr><td>SIGFOX Zone</td><td>T_{MAX}</td></tr><tr><td>RCZ1</td><td>2.11s + 20s + 25s + 1.5s + 2.11s = 50.72s</td></tr><tr><td>RCZ2, RCZ4</td><td>0.35s + 20s + 25s + 1.5s + 0.35s = 47.2s</td></tr></table></td></tr>
<tr><td>t_{TX-TXD}</td><td>512ms</td><td>Time from last character is sent on the air until module is in IDLE mode.</td></tr>
<tr><td>$t_{TXD-IDLE}$</td><td>1.1ms</td><td>Time from the last character sent on TXD until the module is in IDLE mode.</td></tr>
<tr><td colspan="3">GENERAL</td></tr>
<tr><td>$t_{OFF-IDLE}$</td><td>13.2ms</td><td>Time from voltage is stabilized until the module is ready to receive on RXD pin.</td></tr>
<tr><td>$t_{RESET-IDLE}$</td><td>13.2ms</td><td>Time from the rising edge of reset pin until the module is ready to receive on RXD pin.</td></tr>
<tr><td>$t_{SLEEP-IDLE}$</td><td>1.8ms</td><td>Time from the falling edge of RXD pin until the module is ready to receive the first (length) byte.</td></tr>
<tr><td colspan="3">CONFIGURATION MODE</td></tr>
<tr><td>$t_{CONFIG-PROMPT}$</td><td>86us</td><td>Time from the edge of config pin until the start bit of prompt.</td></tr>
<tr><td>$t_{C-CONFIG}$</td><td>80us</td><td>Time from the last byte is sent until the prompt.</td></tr>
<tr><td>$t_{CONFIG-IDLE}$</td><td>1ms</td><td>Time from the ‘X’ command is sent until the module is in IDLE mode.</td></tr>
<tr><td>$t_{MEMORY-CONFIG}$</td><td>31ms</td><td>Time from the end character 0xFF until the prompt is issued.</td></tr>
</table>

*SIGFOX Zones: RCZ1 (Europe), RCZ2 (US), RCZ4 (AU/NZ)

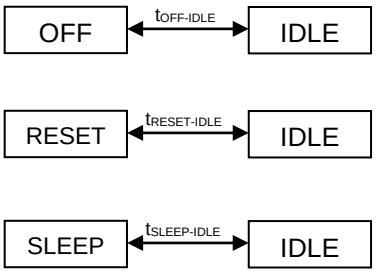
Only uplink:



Uplink and downlink:



General:



Configuration mode:

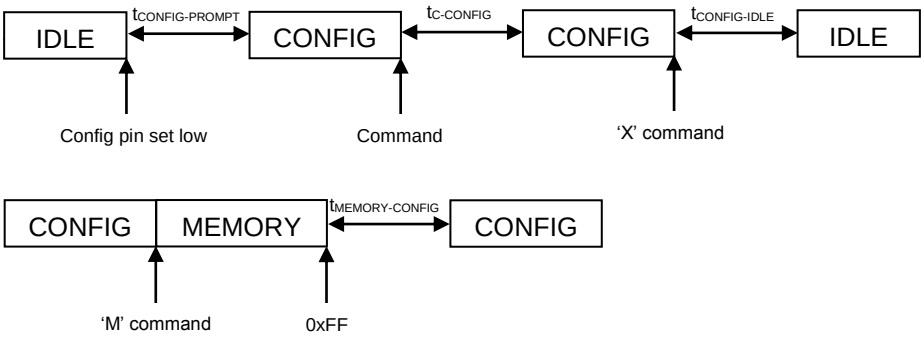


Figure 7: UART timing diagrams

Power Management
The module can be set in SLEEP mode in order to reduce the power consumption.

The low power SLEEP mode is manually entered by using the SLEEP command 'Z' after the module is set in configuration mode. It is also possible to configure the module to enter SLEEP automatically after a message has been transmitted (SLEEP_MODE=1). With this setup the module has to enter TX-mode (transmit a message) after power-on before entering SLEEP mode first time. In SLEEP mode the module will not receive or detect incoming data, neither from the host (UART port) nor from the air. The module is awakened from the SLEEP mode by sending the wake-up byte FFh on the UART RXD line (use a UART Baud rate > 4.8 kBd due to a maximum pulse length requirement). After the module has woken up (see Timing Information) it is ready to receive data on the UART.

All configuration settings and RAM values are retained during SLEEP.

If the module is shut completely off (supply power turned off), all configuration settings in non-volatile memory is restored, but values in RAM are overwritten with default settings.

RSSI Reading
The module provide a digital Received Signal Strength Indicator (RSSI) through the 'S' command, or attached to the received messages. The RSSI value appended to a received message is the signal strength of that received packet. The RSSI value is an 8 bit character (one byte) indicating the current input signal strength or the signal strength of the received message. The signal strength can be used as an indication of fading margin, or as a carrier sense signal to avoid collisions.

The RSSI value increases with increased input signal strength in 0.5 dB steps. Input signal strength is given by (typ.):

P = - RSSI / 2 [dBm]

Temperature Reading
The module provides readings of a digital temperature monitoring sensor (TEMP) through the 'U' command. The module returns an 8 bit character (one byte) indicating the current temperature in degrees Celsius (°C) followed immediately by a second character which is the prompt ('>').

The TEMP value increases with increased temperature in 1 °C steps and has an accuracy of +/- 2 °C. The temperature is given by:

T = TEMP(dec) - 128 [°C] (example: TEMP=0x98 equals +24 °C)

Power Supply voltage Reading
The module provides readings of an internal power supply voltage monitoring sensor (VCC) through the 'V' command. The module returns an 8 bit character (one byte) indicating the current power supply voltage level followed immediately by a second character which is the prompt ('>'). The command can be useful for battery power monitoring.

The VCC value increases with increased supply voltage in 30 mV/step. The power supply voltage is given by:

V = VCC(dec)*0.030 [V] (example: VCC=0x68 equals 3.12 V)

How to register the device in the SIGFOX backend system

To be able to register the final product in the backend system of SIGFOX, the device ID and PAC number has to be delivered to the customer with the final product.

Radiocrafts programs each device with the correspondent ID and PAC in configuration memory. It is the responsibility of product manufacturer to extract these information and forward them to the final customer i.e. to print the ID and PAC onto the label of product.

The exact procedure of registration on the SIGFOX network is described in *RC16xxxx-SIG-DK_Quick_Start* document.

Module configuration

SIG Configuration Commands

A list of commands is shown in the table below. Commands must be sent as ASCII characters or their corresponding binary value. All arguments must be sent as binary values to the module (not as ASCII representation for hex or decimal).

Parameter	Command	Argument in hex (decimal)	Note
Read ID	'9' – 0x39	(none)	Returns with 12 bytes: 4 bytes ID (LSB first) and 8 bytes PAC (MSB first).
Configure ID	'A' – 0x41	4 bytes ID + 16 bytes KEY + 8 bytes PAC	Set ID, KEY and PAC in non-volatile memory.
SIGFOX mode	'F' – 0x46	0: Only uplink 1: Uplink and Downlink	Data is stored in volatile memory only.
Memory configuration	'M' – 0x4D	(Address, Data): see list of parameters below. 0xFF exits memory configuration.	Used to enter memory configuration menu. Parameters changed are stored in non-volatile memory.
Quality Indicator	'Q' – 0x51	Returns one byte indicating the signal quality	Based on bit errors in preamble and synch word
Signal Strength (RSSI)	'S' – 0x53	Returns one byte indicating the signal strength of a detected signal or a valid packet.	If a valid packet has been received when in configuration mode, it will return the RSSI of the last received packet.
Temperature monitoring	'U' – 0x55	Returns one byte indicating the temperature.	See page 12 for details
Battery monitoring	'V' – 0x56	Returns one byte indicating the power supply voltage.	See page 12 for details
Memory Read one byte	'Y' – 0x59	0x00 – 0x7F (The argument is the address in the configuration memory.)	Return one byte value from the configuration memory.
Exit command	'X' – 0x58	(none)	Exit to normal operation mode. All changes of parameters take effect.
Sleep mode	'Z' – 0x5A	(none)	Exit sleep mode by sending 0xFF on UART RXD pin
Test mode 0	'0' – 0x30	(none)	List all configuration memory parameters
Test mode 1	'1' – 0x31	(none)	TX carrier
Test mode 3	'3' – 0x33	(none)	TX Off, RX mode
Test mode 4	'4' – 0x34	(none)	IDLE
**Test mode 5*	'5' – 0x35	(none)	Transmits 1 packet on Channel 200.
**Test mode 6*	'6' – 0x36	(none)	Waits 30s to receive a packet on 200 with the Sequence number 10. The received packet is sent out on UART.
**Test mode 7*	'7' – 0x37	(none)	Send 200 packets with

			frequency hopping.
**Test mode 7	'7' – 0x37	Arg_0, Arg_1	SIGFOX_API_test_mode (Arg_0, Arg_1)
Test mode 8	'8' – 0x38	(none)	Verify EEPROM.

*Available on RC1682-SIG only.
**Available on RC1692HP-SIG only.

Note: ASCII characters are written as 'X', hexadecimal numbers are written like 0x00, and decimal numbers are written like 10 throughout the text. A table of ASCII characters and their respective hex and decimal values are found in the Appendix.

Any invalid command will be ignored and the '>' prompt will be re-sent.

If Test mode 1 or 2 is used, it is important to enter Test mode 3 before exiting the configuration mode ('X') in order to ensure proper operation in normal mode.

Example:
To change the SIGFOX mode to Uplink and Downlink, use the following sequence:

Command	**Hex**	**Response**	**Comment/Note**
Enter	0x00	'>'	Or assert CONFIG pin De-assert CONFIG after '>' prompt
'F'	0x46	'>'	
1	0x01	'>'	Wait for '>' prompt
[A new command could be issued here]			
'X'	0x58	(none)	Module returns to IDLE state

Note that the CONFIG line must be de-asserted after the first '>' prompt was received, but before the 'X' command.

SIG Configuration Memory

The table below shows the complete list of configurable parameters stored in non-volatile memory. These values can be changed using the 'M' command. All addresses and arguments must be sent as binary values to the module (not as ASCII representation for hex or decimal).

Parameter	Description	Address hex	Argument dec	Factory setting hex (dec)	Comment
Radio configuration					
RF_FREQUENCY_ DOMAIN	Default RF frequency domain.	0x00	**RC1682-SIG:** 0: Europe (RCZ1) 1: Reserved 2: Reserved 3: Reserved **RC1692HP-SIG:** 0: Reserved 1: US (RCZ2) 2: Reserved 3: AU/NZ (RCZ4)	**RC1682-SIG**: 0 **RC1692HP-SIG**: 1	0: 868 MHZ ETSI 1: 902 MHz FCC 2: Reserved 3: 920MHz AUNZ
*** RF_POWER*	*Power step-down*	*0x01*	*0..255*	*0x05 (5)*	*PA step down value from the maximum power. Default setting gives +25 dBm conducted power.*
SLEEP_MODE	Sleep mode	0x04	0: Disable Sleep 1: Enable Sleep 5: Auto Sleep	0x00 (0)	When enabled the module enter Sleep mode after transmission
RSSI_MODE	Append RSSI to received data	0x05	0: Disabled 1: Enabled	0x00 (0)	When enabled the RSSI value is appended to the received data
TIMEOUT	Timeout after UART bytes.	0x10	1…254 0x01 (1): 32 ms 0x02 (2): 48 ms 0x03 (3): 64 ms 0x7C (124): 2 s 0xF9 (249): 4 s	0x7C (124)	The time to wait to complete a UART message.
*** EOS_CHARACTER*	*Append end-of-string character.*	*0x36*	*0: Disabled* *1: Append '>'* *2: Append 0xFF '>'*	*0x00 (0)*	*Append end-of-sequence characters to indicating that the device is ready to receive the next packet.*
LED_CONTROL	LED indication	0x3A	0: Disabled 1: Enabled	0x00 (0)	Enables LED indication of TX/RX states.
SIGFOX specific settings					
RETRANSMISSION_N UMBER	Number of retransmission after a packet has been sent.	0x27	0…2	0x02 (2)	It only takes effect if uplink and downlink mode is selected. Otherwise, it is fixed to 2.
*** PUBLIC_KEY*	*Enable public id and key.*	*0x28*	*0: Unique ID+KEY* *1: Public ID+KEY*	*0x00 (0)*	*For test and development purposes.*
TX_DELAY	Delay between retransmissions	0x2E	0…200	0x32 (50)	The number is given in 10ms units.
OOB_PERIOD	Hours between automatic OOB transmission	0x2F	0: Disabled 1…15: Hours	0x00 (0)	Set this number will generate automatic OOB transmissions.
NETWORK_MODE	Defines the protocol to be used	0x3B	0: Only uplink 1: Uplink and downlink	0x00 (0)	Selects the default network mode.

Data and configuration interface, UART Serial Port					
UART_BAUD_RATE	Baud rate	0x30	0x00: Not used 0x01: 2400 0x02: 4800 0x03: 9600 0x04. 14400 0x05: 19200 0x06: 28800 0x07: 38400 0x08: 57600 0x09: 76800 0x0A: 115200 0x0B: 230400	0x05 (5)	BE CAREFUL IF CHANGING AS HOST MAY LOOSE CONTACT WITH MODULE! Does not take effect until module is re-booted / reset.
UART_FLOW_CTRL	UART flow control	0x35	0: None 1:CTS only 3:CTS/RTS 4:RXTX(RS485)	0x00 (0)	
Exit from memory configuration		0xFF	No argument should be sent		To exit from command mode the 'X' command must be sent after '>' is received.

**Available on RC1692HP-SIG only.

To make permanent changes to default values and other parameters, the Memory Configuration command 'M' is used. This command should be followed by pairs of byte being the memory address and the new value to be stored at that address. In order to exit the Memory Configuration mode, the 'address' 0xFF must be sent, but without any data argument. Then wait for the '>' prompt while the internal memory is re-programmed (see Timing Information for typical delay). To completely exit from command mode, the normal exit command 'X' must be sent.

Example:
To change the RETRANSMISSION_NUMBER (at address 0x27) and set it to (1), send the following sequence:

Command	**Hex**	**Response**	**Comment/Note**
Enter	0x00	'>'	Or assert CONFIG pin De-assert CONFIG after '>' prompt
'M'	0x4D	'>'	Module ready to receive address
0x27	0x27	(none)	Address of parameter
1	0x01	(none)	Value of parameter
[new address could be sent here]			
[new value could be sent here]			
0xFF	0xFF	'>'	Wait for '>' prompt
'X'	0x58	(none)	Module returns to IDLE state

Test mode 0 ('0' command) can be used to list all parameters stored in non-volatile memory. This command can be used to verify and check the module configuration.

Factory values of configuration memory

RC1682-SIG

00	00	00	00	00	00	00	00
05	3C	00	00	00	00	00	00
7C	00	00	01	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	02
00	00	00	00	00	00	32	00
05	08	00	01	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	52	43	31	36	38	32	2D
53	49	47	2C	31	2E	30	30
2C	31	2E	30	36	20	20	20
00	00	00	00	00	00	00	00
00	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF							

RC1692HP-SIG

01	05	00	00	00	00	00	00
05	3C	00	00	00	00	00	00
7C	00	00	01	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	02
00	00	00	00	00	00	32	00
05	08	00	01	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	00	00	00	00	00	00	00
00	52	43	31	36	38	32	2D
53	49	47	2C	31	2E	30	30
2C	31	2E	30	36	20	20	20
00	00	00	00	00	00	00	00
00	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF	FF	FF	FF	FF	FF	FF	FF
FF							

Each value is represented as hex number.

Appendix 1: ASCII Table

HEX	DEC	CHR	CTRL
0	0	NUL	^@
1	1	SOH	^A
2	2	STX	^B
3	3	ETX	^C
4	4	EOT	^D
5	5	ENQ	^E
6	6	ACK	^F
7	7	BEL	^G
8	8	BS	^H
9	9	HT	^I
0A	10	LF	^J
0B	11	VT	^K
0C	12	FF	^L
0D	13	CR	^M
0E	14	SO	^N
0F	15	SI	^O
10	16	DLE	^P
11	17	DC1	^Q
12	18	DC2	^R
13	19	DC3	^S
14	20	DC4	^T
15	21	NAK	^U
16	22	SYN	^V
17	23	ETB	^W
18	24	CAN	^X
19	25	EM	^Y
1A	26	SUB	^Z
1B	27	ESC	
1C	28	FS	
1D	29	GS	
1E	30	RS	
1F	31	US	
20	32	SP	
21	33	!	
22	34	"	
23	35	#	
24	36	$	
25	37	%	
26	38	&	
27	39	'	
28	40	(	
29	41	)	
2A	42	*	
2B	43	+	
2C	44	,	
2D	45	–	
2E	46	.	
2F	47	/	
30	48	0	
31	49	1	
32	50	2	
33	51	3	
34	52	4	
35	53	5	
36	54	6	
37	55	7	
38	56	8	
39	57	9	
3A	58	:	
3B	59	;	
3C	60	<	
3D	61	=	
3E	62	>	
3F	63	?	

HEX	DEC	CHR
40	64	@
41	65	A
42	66	B
43	67	C
44	68	D
45	69	E
46	70	F
47	71	G
48	72	H
49	73	I
4A	74	J
4B	75	K
4C	76	L
4D	77	M
4E	78	N
4F	79	O
50	80	P
51	81	Q
52	82	R
53	83	S
54	84	T
55	85	U
56	86	V
57	87	W
58	88	X
59	89	Y
5A	90	Z
5B	91	[
5C	92	\
5D	93	]
5E	94	^
5F	95	_
60	96	`
61	97	a
62	98	b
63	99	c
64	100	d
65	101	e
66	102	f
67	103	g
68	104	h
69	105	i
6A	106	j
6B	107	k
6C	108	l
6D	109	m
6E	110	n
6F	111	o
70	112	p
71	113	q
72	114	r
73	115	s
74	116	t
75	117	u
76	118	v
77	119	w
78	120	x
79	121	y
7A	122	z
7B	123	{
7C	124	|
7D	125	}
7E	126	~
7F	127	DEL

Document Revision History

Document Revision	Changes
1.0	First release
1.1	Expanded information is available on periodic OOB frame transmission. Corrected formal errors. Added Length byte to RX.
1.2	Corrected range of OOB period to 15h.
1.3 – 1.5	Internal releases
1.6	Timing information added
1.7	Corrected texts.
1.8	Corrected text.
1.9	Renamed document to RC16xxxx-SIG and added details related to the RC1692HP-SIG variant.

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