Radiocrafts
Embedded Wireless Solutions

RC1682-SIG

High Performance RF Module for SIGFOX 868MHz

Product Description

The RC1682-SIG module is a compact surface-mounted product that measures only 12.7 x 25.4 x 3.7 mm. The module contains a communication controller with embedded SIGFOX protocol software and is pre-certified for operation under the European regulations. Custom variants can be offered with custom functionalities. How to use the embedded SIG protocol is described in the RC16xxxx-SIG User Manual.

Applications

- Internet of Things
- Long range sensor applications
- Asset tracking and monitoring
- Telemetry stations
- Fleet management

Features

- SIGFOX compatibility (IOT)
- SIGFOX Class 0 category
- SIGFOX Zone 1 domain
- Long range, high reliability
- Ultra narrowband, high-performance radio
- High sensitivity and high selectivity
- High blocking properties
- Completely shielded module
- Pin compatible with other products from Radiocrafts
- 12.7 x 25.4 x 3.7 mm compact module for SMD mounting
- 2.8 – 3.6 V supply voltage
- Ultra low power modes
- Conforms with EU RED directive (EN 300 220, EN 301 489, EN 60950)

Note: The number of LGA pads differ from photo, see page 3 for details

Quick Reference Data

Parameter	RC1682-SIG	Unit
Uplink Frequency (TX)	868.13	MHz
Downlink Frequency (RX)	869.525	MHz
Uplink data rate (TX)	100	bps
Downlink data rate (RX)	600	bps
Uplink Modulation (TX)	DBPSK	
Downlink Modulation (RX)	GFSK	
Max output power	+ 14 dBm	dBm
Downlink sensitivity	-126	dBm
Supply voltage VCC	2.8 – 3.6	Volt
Current consumption, RX (3.3 V_{vcc}, 50 ohm)	31	mA
Current consumption, TX (3.3 V_{vcc}, 50 ohm, +14.5dBm)	59	mA
Current consumption, SLEEP	Max 2.0	uA
Uplink Period (12 Bytes payload transmission, without repetition)	Max. 1.76	s
Downlink period (listening window)	Max. 25	s
Temperature range	-30 to +85	°C

Typical application Circuit:
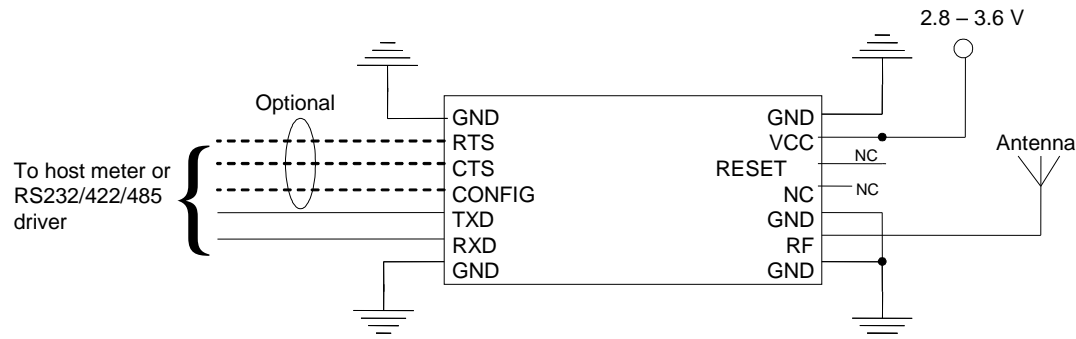
Quick Introduction to the SIG embedded protocol

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.

SIGFOX Protocol

The RC1682-SIG module implements all the necessary features required to communicate with the SIGFOX backend system.

The SIGFOX protocol defines two types of network modes:

1. Only uplink mode
   Packets are only transmitted from the RC1682-SIG module to the base station. This mode can be used for pure data collection.

2. Uplink and downlink mode
   Packets transmitted by the RC1682-SIG module are acknowledged by the base station. This mode can be used for controlling applications.

Only uplink mode

Only uplink mode can be summarized as follows:

- The RC1682-SIG module transmits a frame to the base station.
- This frame is repeated 2 times (the packet is transmitted 3 times all together) with <Repeat period> interval. <Repeat> can be [0…2s] and be selected by config parameter '0x27 - Retransmission number' and <Repeat period> is set by '0x2E – TX delay'..
- Frequency hopping is implemented between packets.
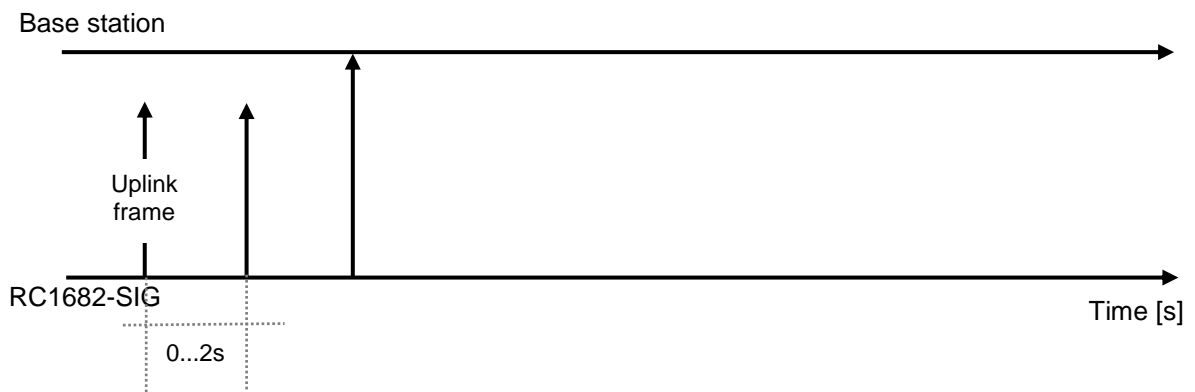
Uplink and downlink mode

With Uplink and downlink mode, two way communication can be established:

- The RC1682-SIG module transmits a frame to the base station.
- The packet is retransmitted <Repeat> times which can be [0,1,2] with 500ms interval.
- Frequency hopping is implemented between packets.
- The Transmission (TX) window lasts until 20s measured from the end of first uplink packet.
- The RC1682-SIG module switches to Reception (RX) mode and listens for frames for 25s.
- If a Downlink frame is received, it is decrypted and verified.
- If it is valid, the module acknowledges it with an OOB (OutOfBand) frame after a fixed 1.5s delay (requirement is 1.4s < T < 4s) and prints the decoded data of downlink frame to UART.
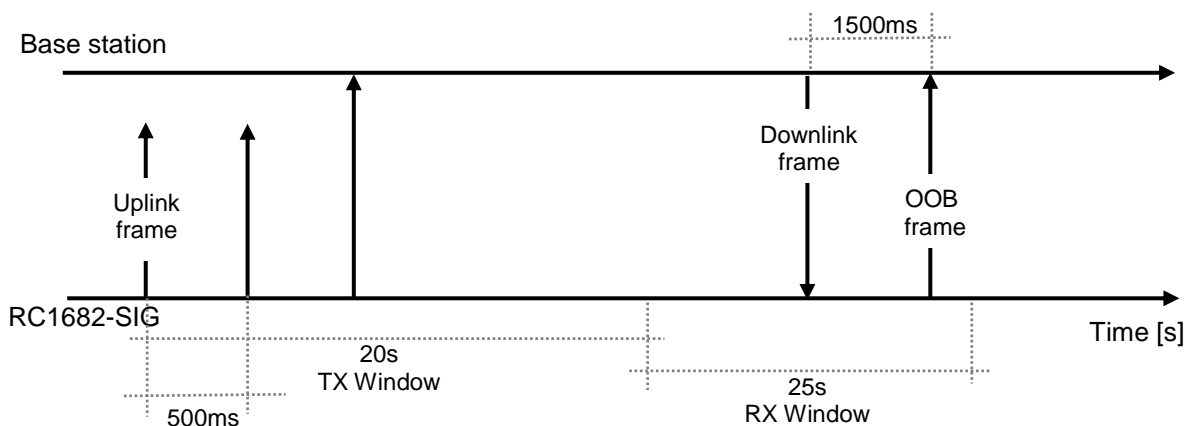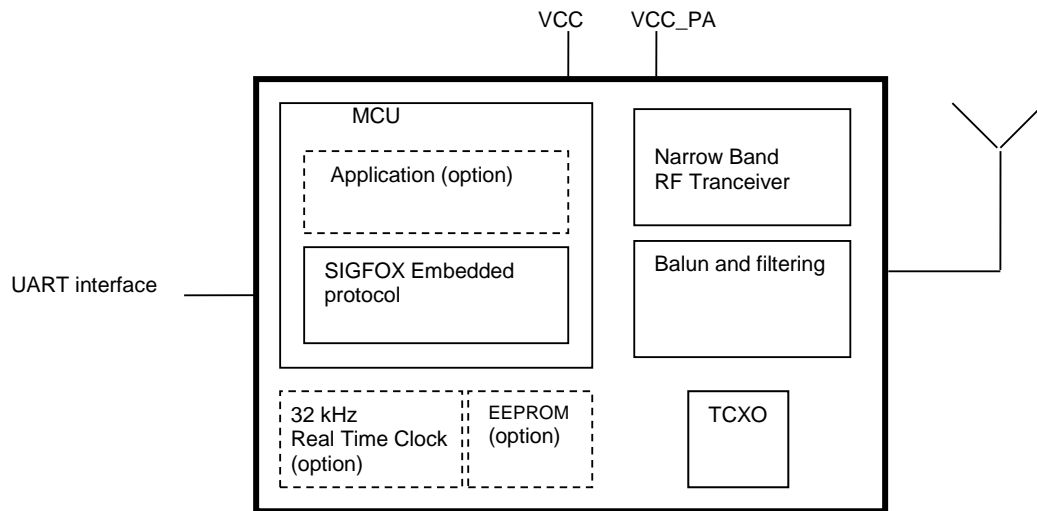

The embedded protocol, configuration commands and configuration memory is described in the RC1682-SIG User Manual.

RCTools

RCTools-SIG is a powerful and easy to use PC suite that helps you during test, development and deployment of the RC1682-SIG. Visit www.radiocrafts.com for a free download and full documentation.
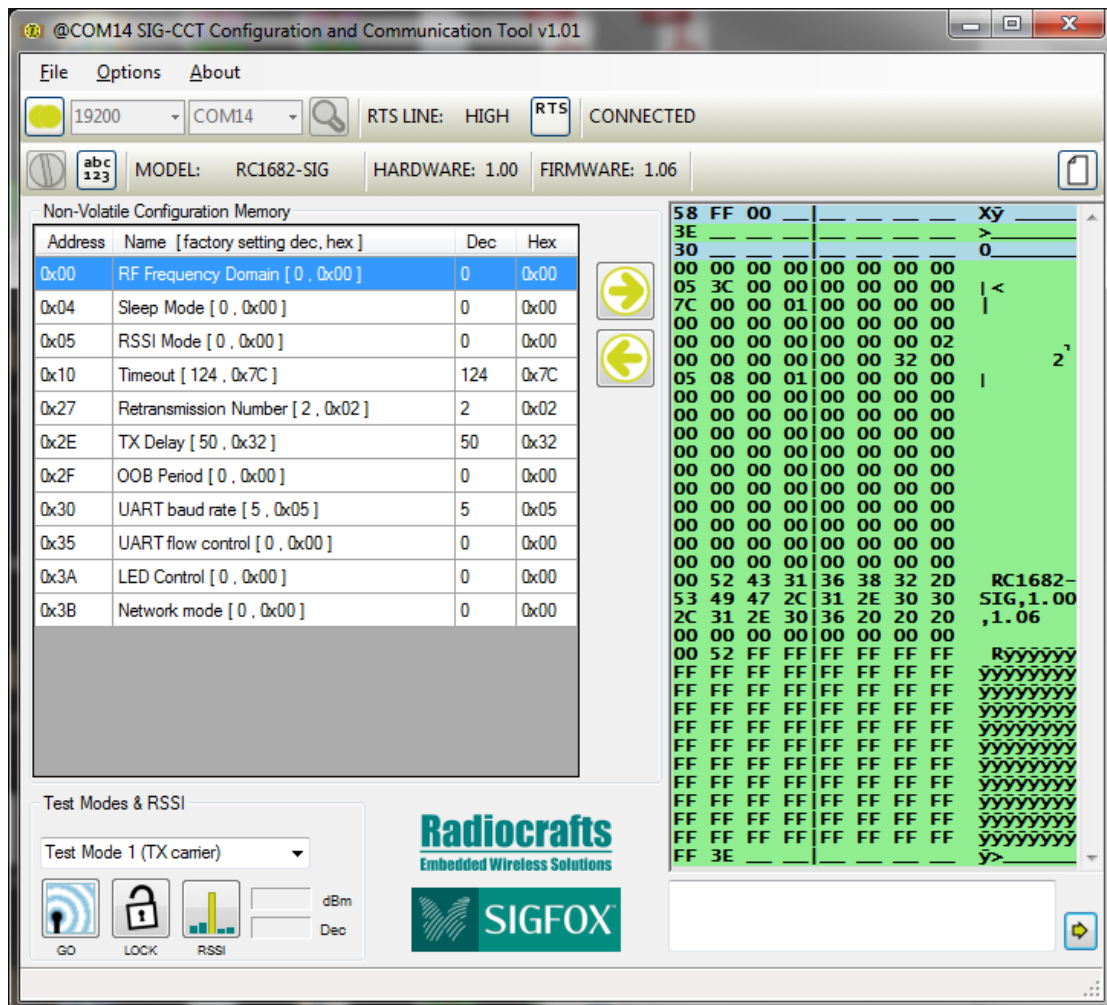
Block Diagram

Circuit Description

The module contains a communication controller with embedded SIG protocol software and a high performance narrow band RF transceiver. As an option the module can support a real time clock oscillator and EEPROM memory for application specific products.

The communication controller handles the radio packet protocol, the UART interface and controls the RF transceiver. Data to be sent by the host is received at the RXD pin and buffered in the communication controller. The data packet is then assembled before it is transmitted on RF.

The RF transceiver modulates the data to be transmitted on RF frequency, and demodulates data that are received. Digital signal processing technology is used to enhance sensitivity and selectivity.

The RF power front end amplifies the signal up to +14dBm and advanced filtering topology is included to suppress harmonics and spurs.

Received data are checked for correct CRC by the communication controller. If no CRC errors were detected, the data packet is sent to the host on the TXD line. The data format is configurable, and optionally an RSSI value (signal strength of received packet) can be added to the message.

The asynchronous UART interface consists of RXD and TXD. Optionally CTS or RTS can be used for hardware handshake flow control.

When the CONFIG pin is asserted, the module enters configuration mode and the communication controller interprets data received on the RXD pin as configuration commands.

The module goes automatically to sleep after TX or RX to reduce the power consumption to a minimum.

Pin Assignment
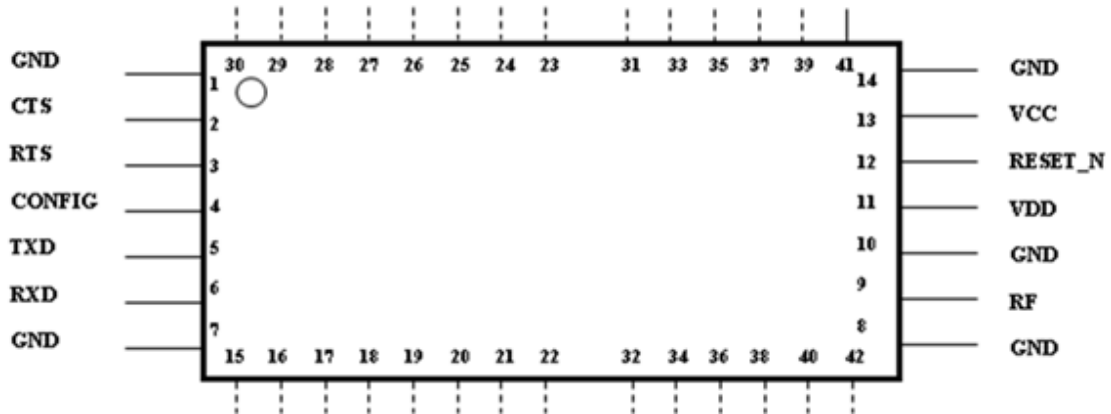
Pin Description

Pin no	Pin name	Description
1	GND	System ground
2	CTS/RXTX	UART Clear to Send / RXTX control (RS485)
3	RTS	UART Request to Send
4	CONFIG	Configuration Enable. Active low.
5	TXD	UART TX Data
6	RXD	UART RX Data
7	GND	System ground
8	GND	System ground
9	RF	RF I/O connection to antenna
10	GND	System ground
11	VDD	Not Connected, Internal Regulator Output
12	Reset	RESET_N. Active Low
13	VCC	Supply voltage input. Internally regulated.
14	GND	System ground
15-18	I/O	For future use and test status pin, Do not connect
19	DD	Programming interface. See page 7 for details.
20	DC	Programming interface. See page 7 for details.
21-42	I/O	For future use and test status pin, Do not connect

Application circuit

A typical application circuit is shown where a MCU is connected to the Radiocrafts module. In normal cases the UART (CTS/RTS is optional) and RESET line is connected to a host MCU running the application. CONFIG pin is needed to set the SIG modules into configuration mode.
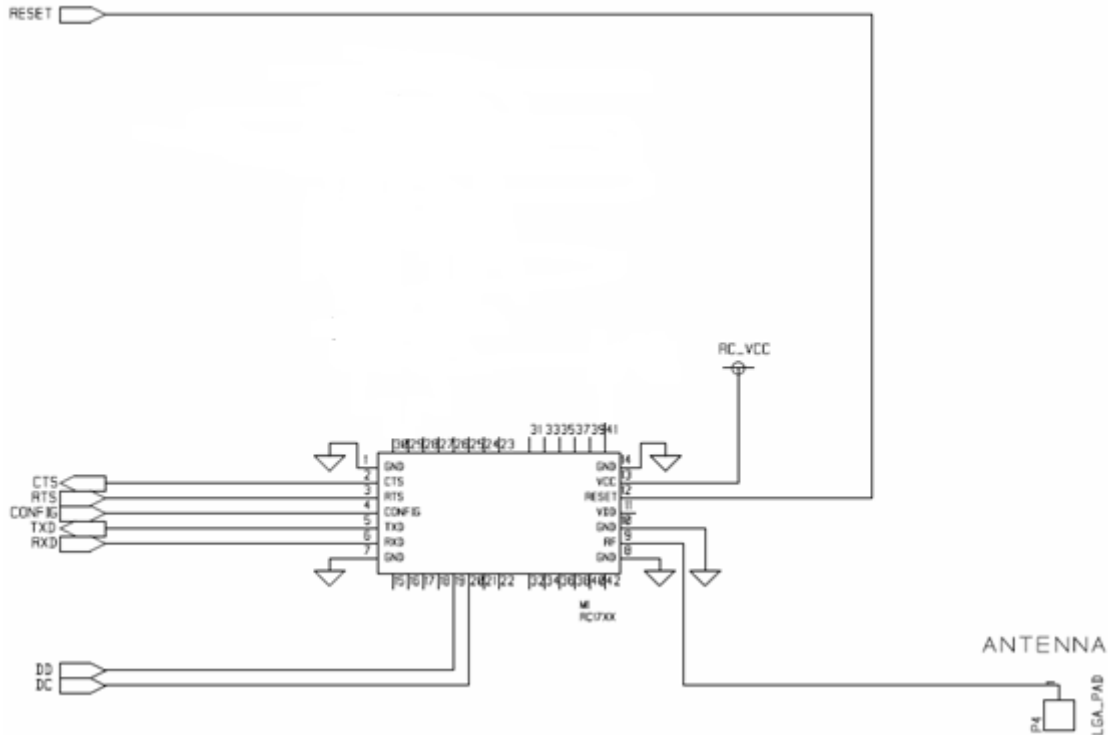

MCU considerations

Some additional external components is needed depending on MCU output driver properties connected to the Radiocrafts module.

If the RESET is driven by a push-pull output, an additional 0 ohm series resistor (R4) shall be inserted as shown in the figure, to allow an external programmer used for firmware upgrade to assert Reset low. During firmware upgrade, R4 must in this case be removed.

In noisy surroundings and where RESET is not driven by a push-pull output, it is recommended to add an external pull-up on RESET using a 5k6 resistor (R3). If the pull-up is stronger the external programmer used for firmware upgrade will not be able to assert RESET low.

In noisy surroundings and where RXD is not driven by a push-pull output, it is recommended to add an external pull-up on RXD using a 5k6 resistor (R3).
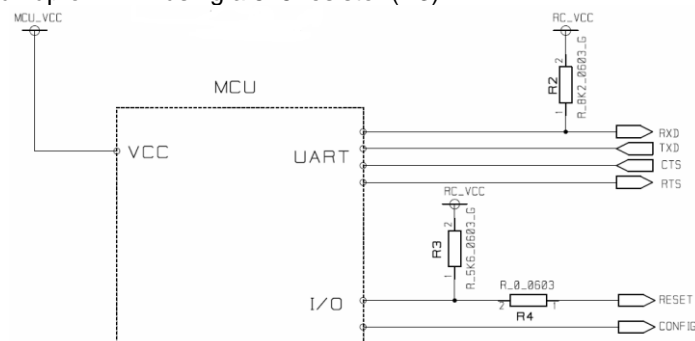
Power Supply

Noisy external circuitry may under certain scenarios affect the transmitted signal on RC1682-SIG and precaution should be taken for EU RED conformity. Example of circuits that can generate noise on the RC1682-SIG transmitted spectrum may be DC/DC converters and some level converters like RS232 and RS485. To increase spectrum margin it is important to add an EMI filter bead (L1) on the VCC pin of the RC1682-SIG module. Alternatively, the RC1682-SIG may be powered (RC_VCC) from a separate voltage regulator. This will ensure that potential switching noise is filtered out from the power supply (RC_VCC) to the RC1682-SIG.

Component	Manufacturer	Part number
EMI filter bead (L1), 1500 mA	Murata	Ordering code BLM18SG331TN1
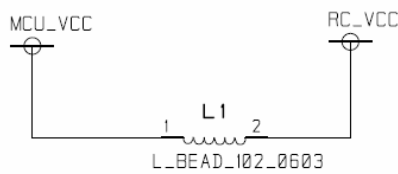
Programming Interface

For future firmware updates and possible custom variants it is recommended to include a 2x5 pins programming connector to the module programming pins. The connector should be a 1.27 mm pitch pin-row (same pitch in both directions), SMD or through-hole version, with the connections shown below. RXD/TXD lines is not in use for firmware upgrade, but is included on spare pins on the connector for debugging purposes.
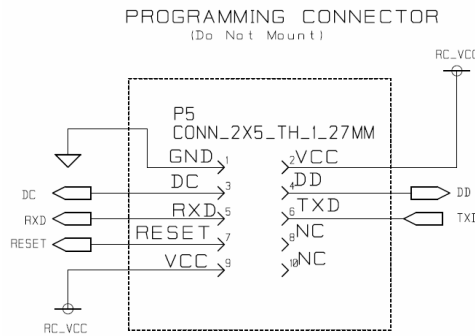
Antenna Connection

The antenna should be connected to the RF pin. The RF pin is matched to 50 Ohm. If the antenna connector is placed away from the module at the motherboard, the track between the RF pin and the connector should be a 50 Ohm transmission line.

On a two layer board made of FR4 the width of a microstrip transmission line should be 1.8 times the thickness of the board, assuming a dielectric constant of 4.8. The line should be run at the top of the board, and the bottom side should be a ground plane.

Example: For a 1.6 mm thick FR4 board, the width of the trace on the top side should be 1.8 x 1.6 mm = 2.88 mm.

The simplest antenna to use is the quarter wave whip antenna. A quarter wave whip antenna above a ground plane yields 37 Ohm impedance and a matching circuit for 50 Ohm are usually not required.

A PCB antenna can be made as a copper track where the ground plane is removed on the back side. The rest of the PCB board should have a ground plane as large as possible, preferably as large as the antenna itself, to make it act as a counterweight to the antenna. If the track is shorter than a quarter of a wavelength, the antenna should be matched to 50 ohms.

Max output power conducted of the module is +15 dBm. Using an efficient antenna (Gain > -1 dB) will give higher radiated power than limited by EU regulations (+14 dBm). A good practice is for this reason to add a pi filter between module and antenna to be able to tune the antenna impedance for CE compliance.

Regulatory Compliance Information

The use of RF frequencies and maximum allowed RF power is limited by national regulations. The RC1682-SIG has been designed to comply with the RED directive 2014/53/EU when used in European license free bands.

According to RED directives, it is the responsibility of Radiocrafts' customers (i.e. RC1682-SIG end user) to check that the host product (i.e. final product) is compliant with RED essential requirements. The use of a CE marked radio module can avoid re-certification of the final product, provided that the end user respects the recommendations given by Radiocrafts. A Declaration of Conformity is available from Radiocrafts on request.

The relevant regulations are subject to change. Radiocrafts AS do not take responsibility for the validity and accuracy of the understanding of the regulations referred above. Radiocrafts only guarantee that this product meets the specifications in this document. Radiocrafts is exempt from any responsibilities related to regulatory compliance.

PCB Layout Recommendations

The recommended layout pads for the module are shown in the figure below. All dimensions are in thousands of an inch (mil). The circle in upper left corner is an orientation mark only, and should not be a part of the copper pattern.

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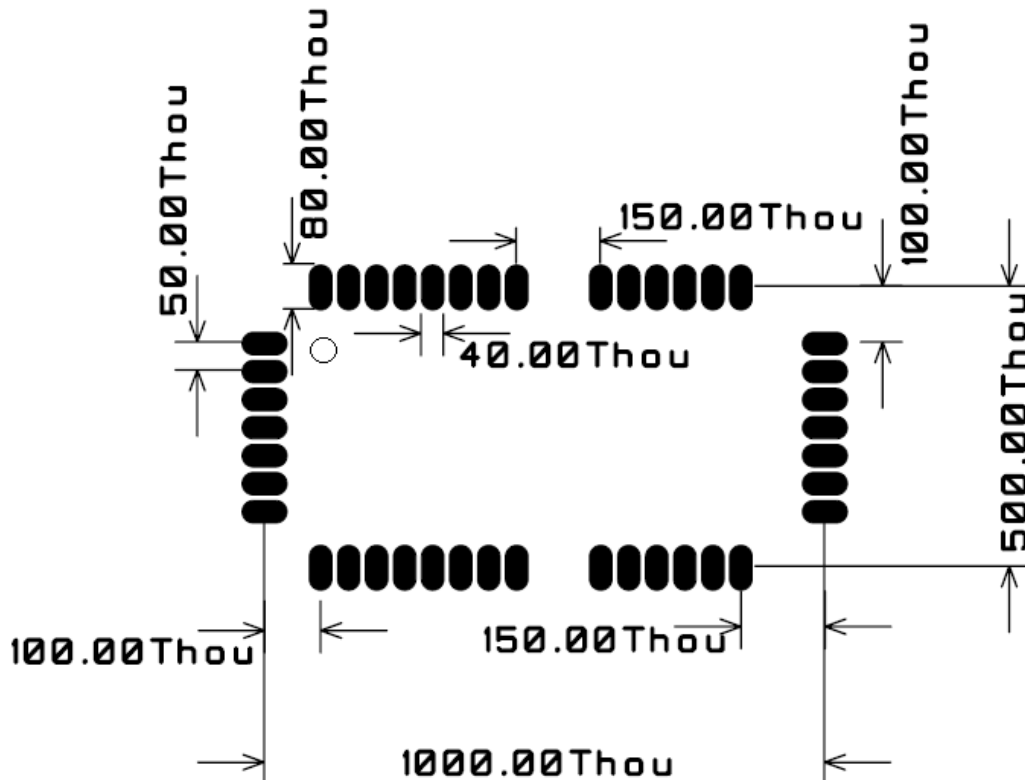
A PCB with two or more layers and with a solid ground plane in one of the inner- or bottom layer(s) is recommended. All GND-pins of the module shall be connected to this ground plane with vias with shortest possible routing, one via per GND-pin.

On the back side of the module there are several test pads. These test pads shall not be connected, and the area underneath the module should be covered with solder resist. If any routing or vias is required under the module, the routing and vias must be covered with solder resist to prevent short circuiting of the test pads. It is recommended that vias are tented.

Reserved pins should be soldered to the pads but the pads must be left floating.

Mechanical Drawing

Top view

11.43 mm

2.54

Part nr: RCXXXX
Lot code: YYYYWW (YYYY=prod. year, WW=prod. week)
Hardware revision: A.BB
Approval marking: NN = CE, FCC or others

RCXXXX YYYYWW
NN A.BB

Alignment marks. 0.4x0.7 mm
On top of corner pads

Side view

23.6 mm

25.4 +/- 1.0 mm

End view

10.9 mm

3.7 +/- 0.2 mm

12.7 +/- 1.0 mm

Detail A

Bottom view

L1

L1

3.81 mm   3.81 mm

L1 = 2.54 mm

1.27 mm

0.1 mm

L1=2.54 mm

1.27 mm

Detail A

0.89 mm

1.39* mm

*The pads might be slightly shorter than 1.39 mm due to PCB processing. The reduction will come from pad being pulled away from edge with up to 0.12 mm. This leaves a minimum pad lenght of 1.27 mm. The 0.1 mm distance to board edge is increase with the same number.

Mechanical Dimensions
The module size is 12.7 x 25.4 x 3.7 mm

Carrier Tape and Reel Specification
Carrier tape and reel is in accordance with EIA Specification 481.

Tape width	Component pitch	Hole pitch	Reel diameter	Units per reel
44 mm	16 mm	4 mm	13"	Max 1000

Soldering Profile Recommendation
JEDEC standard IEC/JEDEC J-STD-020B (page 11 and 12), Pb-Free Assembly is recommended.

The standard requires that the heat dissipated in the "surroundings" on the PCB is taken into account. The peak temperature should be adjusted so that it is within the window specified in the standard for the actual motherboard.

Aperture for paste stencil is normally areal-reduced by 20-35%, please consult your production facility for best experience aperture reduction.

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RC1682-SIG

Absolute Maximum Ratings

Parameter	Min	Max	Unit
Supply voltage, VCC	-0.3	3.9	V
Voltage on any pin	-0.3	VCC+0.3V Max 3.9 V	V
Input RF level		10	dBm
Storage temperature	-50	150	°C
Operating temperature	-40	85	°C
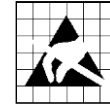
Caution ! *ESD sensitive device. Precaution should be used when handling the device in order to prevent permanent damage.*

Under no circumstances the absolute maximum ratings given above should be violated. Stress exceeding one or more of the limiting values may cause permanent damage to the device.

Fresh 3.6V Li batteries normally have a higher open circuit voltage than the nominal 3.6V, but can still be used to power the module as long as it is not exceeding the absolute maximum rating (3.9V). When the module operates in IDLE/RX/TX the loaded battery voltage will usually drop below 3.6V, which is inside the operation voltage range (2.8V – 3.6V).

Electrical Specifications

T=25°C, VCC = 3.3V, if nothing else stated.

Parameter	Min	Typ.	Max	Unit	Condition / Note
Operating frequency	868.13		869.525	MHz	TX: 868.13 MHz (uplink mid.) RX: 869.525 MHz (downlink)
Input/output impedance		50		Ohm	
Data rate	100		600	bps	TX: 100 bps DBPSK (uplink) RX: 600 bps GFSK (downlink)
Frequency tolerance			+/-1.5	ppm	Including 10 years of aging.
Frequency stability aging			1 5	ppm/year ppm/ 10 year	Starting after 10 years
Transmit power		14	15	dBm	
Adjacent channel power:			<-20	dBm	12.5 kHz channels
Spurious emission, TX < 1 GHz > 1 GHz Restricted bands			-36 -30 -54	dBm	Restricted bands: 47 MHz – 74 MHz 87.5 MHz – 118 MHz 174 MHz – 230 MHz 470 MHz – 862 MHz
Sensitivity Downlink:		-126		dBm	
Adjacent channel rejection		62		dB	
Alternate channel selectivity		63		dB	
Image channel rejection		58		dB	
Blocking +/- 1 MHz +/- 2 MHz +/- 10 MHz	30 35 60	83 87 91		dB	Wanted signal 3 dB above sensitivity level, CW interferer.
Saturation		+10		dBm	
Input IP3		-14		dBm	
Spurious emission, RX			-57	dBm	
Supply voltage, VCC	2.8	3.3	3.6	V	
Current consumption, RX/IDLE TX SLEEP		33 58 0.6	2.0	mA mA uA	Apply over entire supply voltage range
TX period			1.76	s	Single TX window of 12 bytes payload without repetition.
RX period			25s	s	Only in Uplink & Downlink mode, if reply is not received.
Digital I/O Input logic level, low Input logic level, high Output logic level, low (1µA) Output logic level, high(-1µA)	70 % 0		30 % VCC	V	Of VCC Of VCC
RESET pin Input logic level, low Input logic level, high	70 %		30 %	V	Minimum 250 ns pulse width
UART Baud Rate tolerance		+/- 2		%	UART receiver and transmitter
Configuration memory write cycles	1000				The guaranteed number of write cycles using the 'M' command is limited

Document Revision History

Document Revision	Changes
1.00	First release
1.01-1.02	Corrected texts.
1.03	Added SIGFOX class and zone.
1.04	Corrected footer and mechanical height.
1.05	Product status changed to full production
1.06	Updated Mechanical drawing and height information. Please refer to Hardware PCN for revision history. Updated regulatory compliance

Product Status and Definitions

Current Status	Data Sheet Identification	Product Status	Definition
	Advance Information	Planned or under development	This data sheet contains the design specifications for product development. Specifications may change in any manner without notice.
	Preliminary	Engineering Samples and First Production	This data sheet contains preliminary data, and supplementary data will be published at a later date. Radiocrafts reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
X	**No Identification Noted**	**Full Production**	**This data sheet contains final specifications. Radiocrafts reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.**
	Obsolete	Not in Production	This data sheet contains specifications on a product that has been discontinued by Radiocrafts. The data sheet is printed for reference information only.

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As far as possible, major changes of product specifications and functionality, will be stated in product specific Errata Notes published at the Radiocrafts website. Customers are encouraged to check regularly for the most recent updates on products and support tools.

Trademarks

RC232™ is a trademark of Radiocrafts AS. The RC232™ Embedded RF Protocol is used in a range of products from Radiocrafts. The protocol handles host communication, data buffering, error check, addressing and broadcasting. It supports point-to-point, point-to-multipoint and peer-to-peer network topologies.

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This Radiocrafts product is not designed for use in life support appliances, devices, or other systems where malfunction can reasonably be expected to result in significant personal injury to the user, or as a critical component in any life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness. Radiocrafts AS customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Radiocrafts AS for any damages resulting from any improper use or sale.

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