Radiocrafts
Embedded Wireless Solutions

RC1692HP-SSM

High Performance RF module for Sigfox 902-928MHz with Integrated Sensor Interfaces

Product Description

The RC1692HP-SSM module is a fully integrated, autonomous, sensor-enabled Sigfox module. It 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 designed for operation under FCC and ACMA. The module include interfaces and drivers for several sensors. This enables a very compact, integrated and efficient solution for wireless sensor measurements that offers minimal time to market and a minimum amount of coding. The modules are easily interfaced and set up through an UART interface. Radiocrafts also provide sensor boards for testing and prototyping. Custom variants can be offered with custom functionalities. Details of interfaces and sensory setup is described in the RC16xxxx-SSM User Manual.

Applications

- Wireless Sensor Networks
- Internet of Things
- Long range sensor applications
- Industrial remote sensing
- Automatic Meter Reading
- Asset Tracking
- Telemetry stations



Features

- Sensor interfaces with support for common sensors: Temperature, Humidity, Voltage and others
- Provides standard electrical interfaces for sensors: I2C, Analog, and Digital GPIOs
- Provides built-in software drivers for common sensors
- Sigfox compatibility (IOT)
- Sigfox Class 0 category
- Sigfox Zone 2 and Zone 4 domains
- 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
- Designed for FCC and ACMA
- Configurable for operation under FCC, or ACMA regulations, most Latin American countries

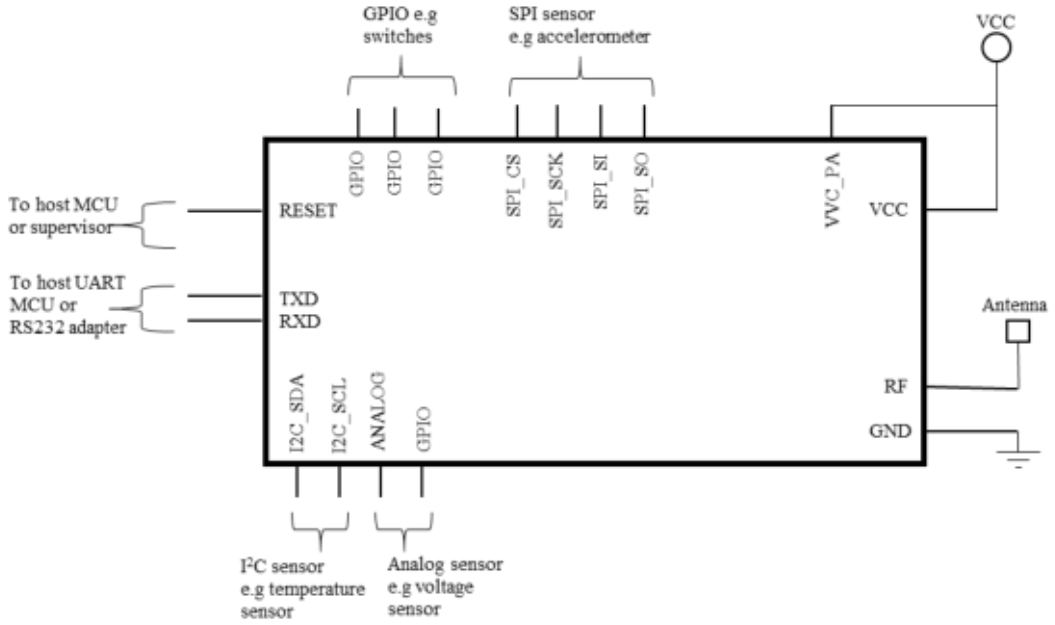
Quick Reference Data

Parameter	RC1692HP-SSM	Unit
Frequency band	902-928	MHz
Data rate (Uplink/Downlink)	600/600	bps
Max output power	+ 24	dBm
Sensitivity	-124	dBm
Supply voltage VCC	2.8 – 3.6	V
Supply voltage Internal PA	2.8 – 3.6	V
Current consumption, TX (+24 dBm)	292	mA
Current consumption, Active mode, no sensors	Typ 17.0	uA
Temperature range	-40 to +85	°C
Electrical sensor interfaces	I²C, 4 GPIOs, Analog Input	

Part Name Overview

Part name	RF Frequency band	Typ output power	VCC / VCC_PA
RC1692HP-SSM	902-928 MHz	+24 dBm	+3.3V

Typical application circuit:



Note that the VCC_PA pin supply the internal power amplifier only, while the rest of the internal blocks run on VCC. They can be connected together (max 3.6V) or separated using individual supply.

Current Consumption

Current consumption is highly dependent on application. The following table gives an estimate on how much power is used when including different sensors and different sample rates. The numbers are current consumption used by the module in addition to typical current consumption.

Sensor / Frequency	**Every 1 second**	**Every 10 seconds**	**Every 100 seconds**
Sensirion SHT35		2.87 uA	0.29 uA
TI HDC2010		1.02 uA	0.10 uA
GPIO toggle 1 pin every period and sample two others	0.65 uA	0.07uA	0.007 uA
ADC	2.34 uA	0.23 uA	0.023 uA

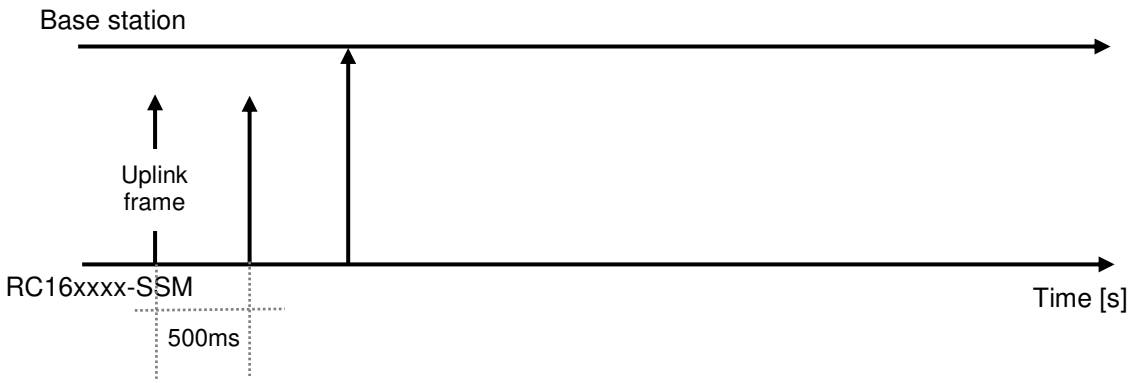
Sigfox Protocol

The RC1692HP-SSM module implements all the necessary features required to communicate with the Sigfox backend system.

Only uplink mode

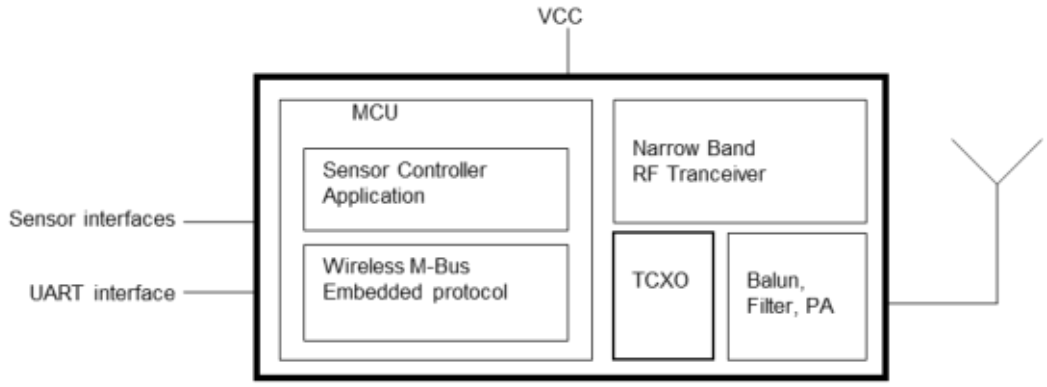
Only uplink mode can be summarized as follows:

- The RC1692HP-SSM module transmits a frame to the base station.
- This frame is repeated 2 times (the packet is transmitted 3 times all together) with 500ms interval. Interval parameter is configurable.
- Frequency hopping is implemented between packets.



The embedded protocol, configuration commands and configuration memory is described in the RC16xxxx-SSM User Manual.

Block Diagram



Circuit Description

The module contains a communication controller with embedded Sigfox 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 transmitted is automatically scheduled by the communication controller based on sensor configurations. The data packet is then assembled before it is transmitted on RF.

The high power front end amplifies the signal to +24dBm and advanced filtering topology is included to suppress harmonics and spurs.

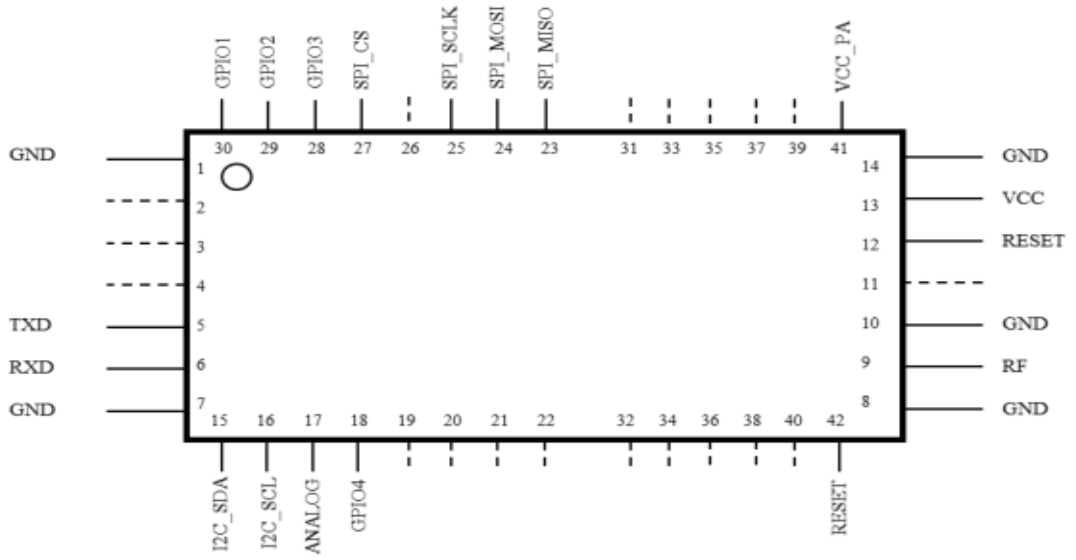
The asynchronous UART interface consists of RXD and TXD.

Configuration mode can be entered by sending 0xFF followed by 0x00 on the UART. See the RCxxxx-SSM User Manual for details.

The supply voltage is connected to the VCC and VCC_PA pin. The module contains an internal voltage regulator for the RF transceiver and can therefore operate over a wide supply voltage range. The module goes automatically to sleep to reduce the power consumption to a minimum.

Sensors are configured using an array of bytes containing all configuration data. This array is put into the module using the standard UART configuration interface. Please see the RCxxxx-SSM User Manual for details on how to configure the sensors.

Pin Assignment

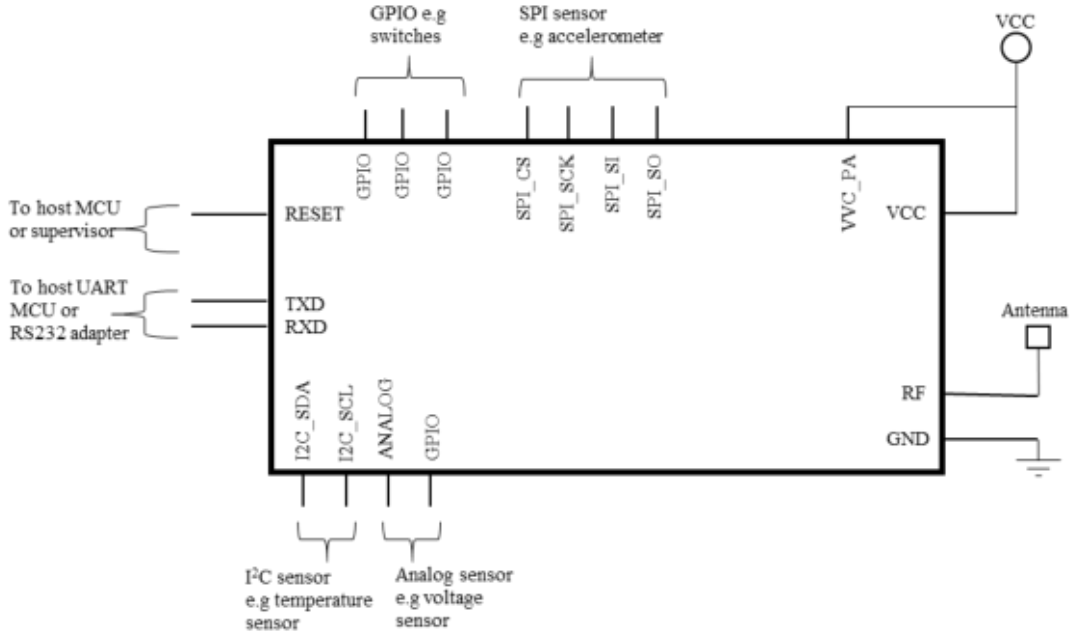


Pin Description

Pin no	Pin name	Description
1	GND	System ground
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
12	Reset	RESET_N. Active Low
13	VCC	Supply voltage input. Internally regulated.
14	GND	System ground
15	I2C_SDA	I²C-bus data pin. Connect I²C peripherals (sensors) to this pin
16	I2C_SCL	I²C-bus clock pin. Connect I²C peripherals (sensors) to this pin
17	ANALOG	Analog input
18	GPIO4	General purpose digital I/O
19	DD	Programming interface.
20	DC	Programming interface.
23	SPI_MISO	SPI Master In Slave Out. Connect SPI peripherals (sensors) to this pin
24	SPI_MOSI	SPI Master Out Slave In. Connect SPI peripherals (sensors) to this pin
25	SPI_SCLK	SPI Clock. Connect SPI peripherals (sensors) to this pin
27	SPI_CS	SPI Chip Select. Connect SPI peripherals (sensors) to this pin
28	GPIO3	General purpose digital I/O
29	GPIO2	General purpose digital I/O
30	GPIO1	General purpose digital I/O
41	VCC_PA	Power amplifier supply pin
2,3, 4, 11, 21-22, 26, 31-40, 42	**DNC**	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 and RESET line does not need to be connected to any controllers such as a host MCU. However, for initial configuration (or reconfiguration), access to the UART is needed. It is also recommended to have access to the RESET and TXD/RXD lines for debugging and test.



Sensor Interface

The module provides four main electrical sensor interfaces: Digital GPIOs, analog input, SPI and I²C.

The GPIOs can be configured as either input or output. For lowest current consumption, floating GPIOs should be avoided, so pullups should be used when they are configured as inputs with no (or tristate capable) connections.

The analog input is capable of reading any arbitrary voltage between zero and 1.25v.

The I²C is running standard mode, and support clock stretching. External pullup resistors are usually not needed on the I²C bus, as the I²C lines are internally pulled up by 4.7 kOhms resistors, which will work for most applications.

External connection considerations

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

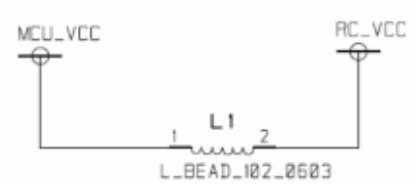
In noisy surroundings and where RESET is not driven by a push-pull output, it is recommended to add an external pull-up on RESET using a 5k6 resistor. If the pull-up is stronger the external programmer used for firmware upgrade will not be able to assert RESET low.

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.

Power Supply

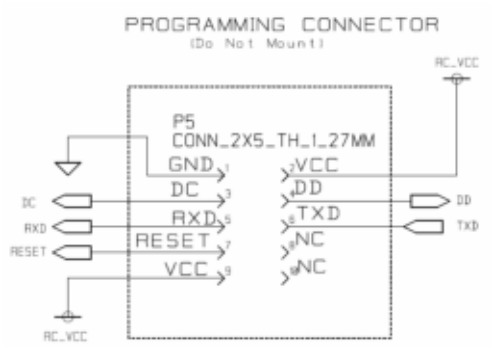
Noisy external circuitry may under certain scenarios affect the transmitted signal on RC1692HP-SSM and precaution should be taken for FCC conformity. Example of circuits that can generate noise on the RC1692HP-SSM transmitted spectrum may be DC/DC converters and some level converters like RS232 and RS485. To increase spectrum margin you can add an EMI filter bead (L1) on the VCC pin of the RC1692HP-SSM module. Alternatively, the RC1692HP-SSM module 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 module.

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.

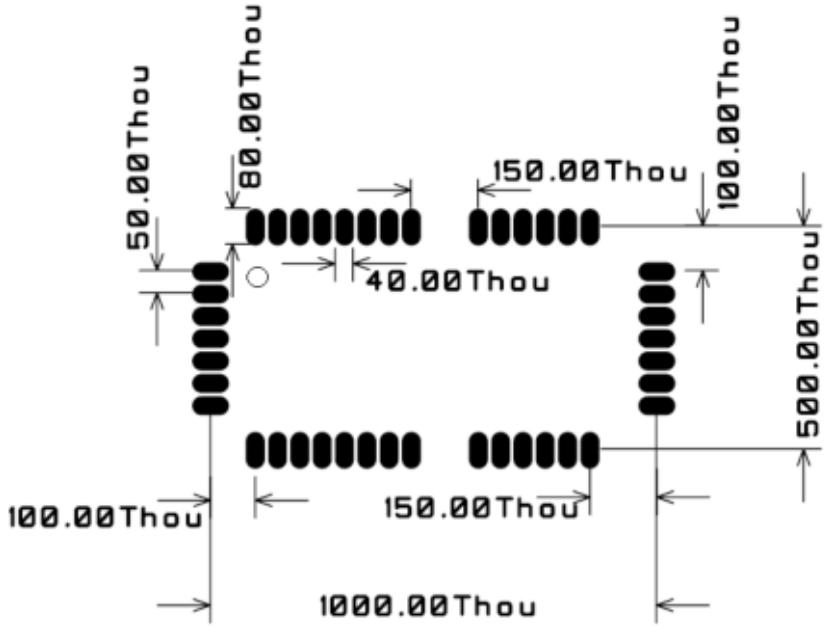
A PCB antenna can be made as a copper track where the ground plane is removed on the back side. The rest of the PCB board should have a ground plane as large as possible, preferably as large as the antenna itself, to make it act as a counterweight to the antenna. If the track is shorter than a quarter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

RCTools

RCTools-SIG is a powerful and easy to use PC suite that helps you during test, development and deployment of the RC1692HP-SSM. Also, a sensor configuration tool is available to help configuring the sensors. Visit www.radiocrafts.com for a free download and full documentation on both tools.

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.



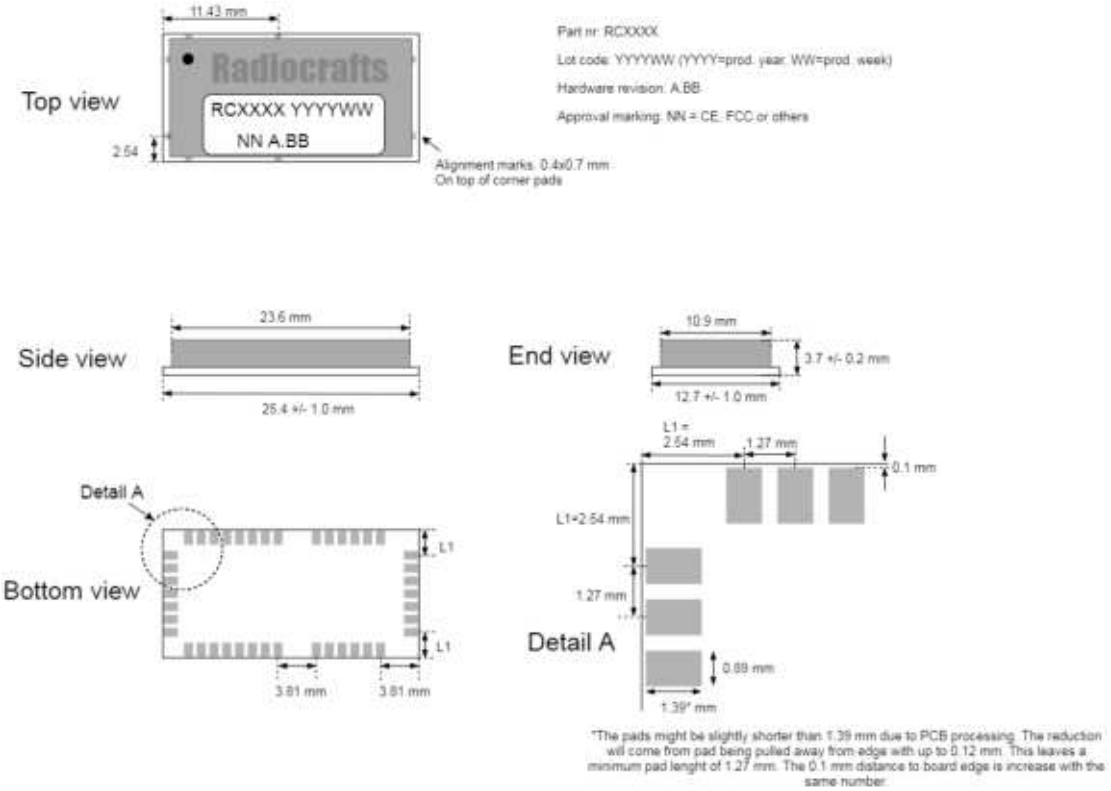
A PCB with two or more layers and with a solid ground plane in one of the inner- or bottom layer(s) is recommended. All GND-pins of the module shall be connected to this ground plane with vias with shortest possible routing, one via per GND-pin.

On the back side of the module there are several vias and pads. These vias and 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 to the module bottom side vias and pads. It is recommended that vias are tented.

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

Note that Radiocrafts technical support team is available for schematic and layout review of your design.

Mechanical Drawing



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.

Absolute Maximum Ratings

Parameter	Min	Max	Unit
VCC VCC_PA	-0.3 -0.3	3.8 3.7	V V
Voltage on any pin	-0.3	VCC+0.3V	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 (3.8V). 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.

Electrical Specifications

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

Parameter	Min	Typ.	Max	Unit	Condition / Note
Operating frequency	902		920	MHz	
Input/output impedance		50		Ohm	
Data rate		600		bit/s	
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 RC1692HP-SSM		24	25	dBm	Typical values are for default settings
Adjacent channel power: 12.5 kHz channels			<-20	dBm	
Spurious emission, TX < 1 GHz > 1 GHz Restricted bands			 -20 dBc -20 dBc -41 dBm		
Sensitivity: 600 bps		-124		dBm	
Adjacent channel rejection		64		dB	
Alternate channel selectivity		66		dB	
Image channel rejection		66		dB	
Blocking / Interferer rejection / desensitization +/- 1 MHz +/- 2 MHz +/- 10 MHz		 82 83 89		 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 VCC_PA	 2.8 2.8	 3.3 3.3	 3.6 3.6	 V V	
TX VCC_PA = 3.3V (+24 dBm)		VCC+VCC_PA 292		 mA	
Current consumption, No sensors configured VCC VCC_PA		 17.00 0.02		 uA uA	

Parameter	Min	Typ.	Max	Unit	Condition / Note
Digital I/O Input logic level, low Input logic level, high Output logic level, low (1µA) Output logic level, high(-1µA)	 70 % 0 TBD		 30 % TBD 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

Sigfox zones

The RC1692HP-SSM module can operate in two different zones / domains:

Model	RF domain	Frequency	Sigfox Zone
RC1692HP-SSM	0: Reserved **1: US** 2: Reserved **3: AU/NZ, Latin America**	Reserved **902MHz** Reserved **920MHz**	RCZ1 **RCZ2** RCZ3 **RCZ4**

The proper Sigfox zone can be selected by the user in configuration mode.

The use of RF frequencies, maximum allowed RF power and duty-cycles are limited by national regulations. The RC1692HP-SSM is complying with the applicable directives and requirements of FCC, Australia/New Zealand and most Latin American countries.

Document Revision History

Document Revision	Changes
1.00	First release
1.10	Added SSM V2 features
1.11	Updated pinouts
1.12	Added sensor configuration tool
1.13	Updated Mechanical drawing and height information. Please refer to Hardware PCN for revision history

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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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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