

## ZigBee®- Ready RF Transceiver Modules

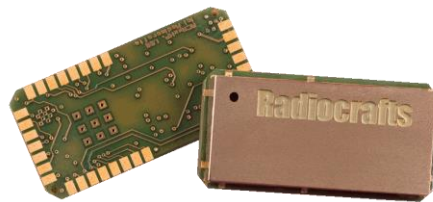
### Product Description

The RC2400 and RC2400HP RF Transceiver Modules are a series of compact surface-mounted modules specially designed for the ZigBee® PRO protocol stack. It can also be used for other for wireless star and mesh networks based on IEEE 802.15.4 compliant PHY and MAC.

The complete shielded module is only 12.7 x 25.4 x 3.3 mm and comes in both a low current variant (RC2400) and a High Power version with LNA and power amplifier for extended range (RC2400HP). The two variants are pin compatible.

### Applications

- Smart Metering / AMR / AMI
  - Electricity, gas, water and heat meters
  - Energy Service Portal (ESP) / Load Control
- IP sensor networks (6LoWPAN)
- RF4CE remote controls
- Wireless sensor networks/Building Automation



### Features

- Complete ZigBee-ready module
- 100mW / 20 dBm option and low-power option in pin compatible packages
- 12.7 x 25.4 x 2.5 mm compact shielded module for SMD mounting
- IEEE 802.15.4 compliant PHY
- Single-cycle high performance 8051 microcontroller core
- 256 kB Flash memory, 8 kB SRAM
- 15 digital and analogue I/Os, 8 channel 12 bit ADC
- UART, SPI and debug interfaces
- On-board 32.768 kHz real time clock (RTC), 4 timers
- High performance direct sequence spread spectrum (DSSS) RF transceiver
- 2.0 – 3.6 V supply voltage, ultra low power modes
- Optional 4 kB internal EEPROM
- Conforms with EN 300 440 and EN 300 328 (Europe), FCC CFR 47 part 15 (US), ARIB STD-T66 (Japan) and G.S.R. 542(E)/45(E) (both for India)

### Quick Reference Data (typical at 3.3V, frequency 2440 MHz)

| Parameter                   | RC2400       | RC2400HP  | Unit   |
|-----------------------------|--------------|-----------|--------|
| Frequency band              | 2.400-2.4835 |           | GHz    |
| Number of channels          | 16           |           |        |
| Data rate                   | 250          |           | kbit/s |
| Max output power            | 4            | 20*       | dBm    |
| Sensitivity (PER 1%)        | -97          | -99       | dBm    |
| Adjacent Channel Rejection  | 49           |           | dB     |
| Alternate Channel Rejection | 57           |           | dB     |
| Supply voltage              | 2.0 - 3.6    | 2.7 - 3.6 | Volt   |
| Current consumption, RX/TX  | 24/34        | 27/175    | mA     |
| Current consumption, PD     | 0.4          | 1.3       | uA     |
| Flash memory                | 256          |           | kB     |
| RAM                         | 8            |           | kB     |

\* Limited to 12 dBm in Europe due to ETSI regulation and limited to 10 dBm in US for frequency 2480MHz due to FCC regulation.

|                            |   |    |
|----------------------------|---|----|
| Internal EEPROM (optional) | 4   | kB |
| Operating Temperature      | -30 to +85<br>(-40 to +85 available on request) | °C |

### Quick Product Introduction

The RC2400 series of modules are specially designed to comply with IEEE 802.15.4-based industry standards like ZigBee PRO, 6LoWPAN, Wireless HART, RC4CE and others. Using the module together with the TI Z-stack is a powerful combination to build any ZigBee profile and application. The module contains qualified RF hardware and enough processor power to run the complete ZigBee mesh network protocol for a full function device including the application.

Using a pre-qualified module is the fastest way to make a ZigBee product and shortest time to market. The embedded RF HW and MCU resources in a 100% RF tested and pre-qualified module shorten the qualification and approval process. No RF design or RF expertise is required to add powerful wireless networking to the product. In most cases you only need supply voltage (for example an external battery) and a sensor/actuator and the module can run the entire application.

The module can be used as

- RC2400/RC2400HP: HW platform. No preloaded firmware.
- RC2400-ZNM/RC2400HP-ZNM : A complete ZigBee PRO network module where the entire ZigBee Pro compliant stack and configurable application software is preloaded in module and available via API on a serial interface.

### About this document

This document is one part of the documentation for the module. It describes the electrical parameters, RF performance, footprint and PCB layout and regulatory information. Depending on the selected FW solution one additional User Manual should be used. See

- RC2400/RC2400HP Firmware Development User Manual for using the module as a hardware platform only
- RC2400/RC2400HP-ZNM User Manual for details on how to use the ZNM module with preloaded ZigBee Pro stack and API through a serial interface.

RC2400/RC2400HP  
Firmware Development User Manual

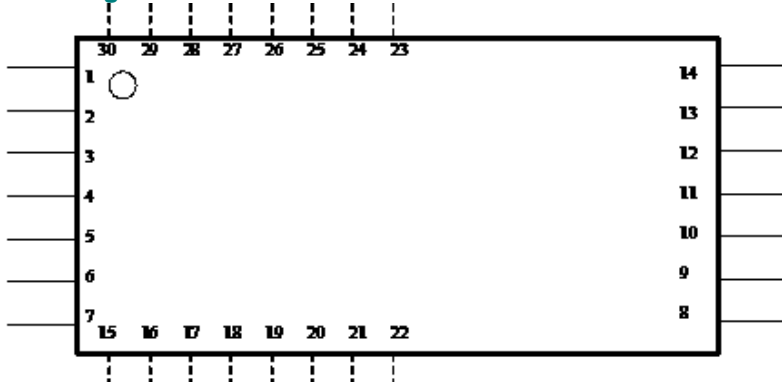
RC2400/RC2400HP-ZNM  
User Manual

*Future  
User Manuals*

RC2400/RC2400HP Datasheet (This document)

Figure 1 Document structure

### Pin Assignment



### Pin Description

| Pin no | Pin name                      | Description  |
|--------|-------------------------------|--|
| 1      | GND                           | System ground  |
| 2      | Digital I/O                   | Digital I/O  |
| 3      | Digital I/O                   | Digital I/O  |
| 4      | Digital I/O                   | Digital I/O  |
| 5      | Digital I/O                   | Digital I/O  |
| 6      | Digital I/O                   | Digital I/O  |
| 7      | GND                           | System ground  |
| 8      | GND                           | System ground  |
| 9      | RF                            | RF I/O connection to antenna   |
| 10     | GND                           | System ground  |
| 11     | NC                            | Not Connected  |
| 12     | Reset                         | Reset. Active Low  |
| 13     | VCC                           | Supply voltage input. Internally regulated.                          |
| 14     | GND                           | System ground  |
| 15     | Digital I/O/<br>LNA Gain mode | Digital I/O/ <b>LNA Gain control for RC2400HP</b>                    |
| 16     | Digital I/O                   | Digital I/O  |
| 17     | Digital I/O                   | Digital I/O  |
| 18     | Digital I/O                   | Digital I/O  |
| 19     | Digital I/O /DD               | Digital I/O. Debug interface is used for programming.                |
| 20     | Digital I/O                   | Digital I/O. Debug interface is used for programming.                |
| 21     | Digital I/O                   | Digital I/O  |
| 22     | Digital I/O<br>LNA_Enable     | Digital I/O / <b>LNA Enable for RC2400HP</b>                         |
| 23     | Digital I/O /32kHz_Q1         | Internal 32 kHz oscillator. Do not connect. (Digital I/O if no xtal) |
| 24     | Digital I/O /32kHz_Q2         | Internal 32 kHz oscillator. Do not connect. (Digital I/O if no xtal) |
| 25     | Digital I/O                   | Digital I/O  |
| 26     | Digital I/O                   | Digital I/O  |
| 27     | Digital I/O                   | Digital I/O  |
| 28     | Digital I/O                   | Digital I/O  |
| 29     | Digital I/O<br>PA_Enable      | Digital I/O / <b>PA Enable for RC2400HP</b>                          |
| 30     | Digital I/O                   | Digital I/O  |

Note 1: For detailed pin description, see respective User Manual

Note 2: Pins 17 and 18 are suggested as I2C interface. They can be configured otherwise, but are connected to an optional internal EEPROM with I2C address = 000. It is recommended to leave these pins as I2C. Sensors and actuators or any other I2C device can be connected to these pins and accessed from the module.

## DC characteristics

T<sub>A</sub> = 25°C, VDD = 3 V, unless otherwise noted.

| PARAMETER                             | TEST CONDITION    | MIN | TYP | MAX | Unit |
|---------------------------------------|-------------------|-----|-----|-----|------|
| Logic-0 input voltage                 |                   |     |     | 0.5 | V    |
| Logic-1 input voltage                 |                   | 2.5 |     |     | V    |
| Logic-0 input current                 | Input equals 0 V  | -50 |     | 50  | nA   |
| Logic-1 input current                 | Input equals VDD  | -50 |     | 50  | nA   |
| I/O-pin pullup and pulldown resistors |                   |     | 20  |     | kΩ   |
| Logic-0 output voltage, 4-mA pins     | Output load 4 mA  |     |     | 0.5 | V    |
| Logic-1 output voltage, 4-mA pins     | Output load 4 mA  | 2.4 |     |     | V    |
| Logic-0 output voltage, 20-mA pins    | Output load 20 mA |     |     | 0.5 | V    |
| Logic-1 output voltage, 20-mA pins    | Output load 20 mA | 2.4 |     |     | V    |

## SPI AC characteristics

(ref CC2530 datasheet)

### SPI AC CHARACTERISTICS

T<sub>A</sub> = -40°C to 125°C, VDD = 2 V to 3.6 V

| PARAMETER                      | TEST CONDITIONS      | MIN | TYP | MAX | UNIT |
|--------------------------------|----------------------|-----|-----|-----|------|
| t <sub>1</sub> SCK period      | Master, RX and TX    | 250 |     |     | ns   |
|                                | Slave, RX and TX     | 250 |     |     |      |
| SCK duty cycle                 | Master               |     | 50% |     |      |
|                                | Slave                |     |     |     |      |
| t <sub>2</sub> SSN low to SCK  | Master               | 63  |     |     | ns   |
|                                | Slave                | 63  |     |     |      |
| t <sub>3</sub> SCK to SSN high | Master               | 63  |     |     | ns   |
|                                | Slave                | 63  |     |     |      |
| t <sub>4</sub> MOSI early out  | Master, load = 10 pF |     |     | 7   | ns   |
| t <sub>5</sub> MOSI late out   | Master, load = 10 pF |     |     | 10  | ns   |
| t <sub>6</sub> MISO setup      | Master               | 90  |     |     | ns   |
| t <sub>7</sub> MISO hold       | Master               | 10  |     |     | ns   |
|                                | Slave                |     | 50% |     |      |
| t <sub>10</sub> MOSI setup     | Slave                | 35  |     |     | ns   |
| t <sub>11</sub> MOSI hold      | Slave                | 10  |     |     | ns   |
| t <sub>9</sub> MISO late out   | Slave, load = 10 pF  |     |     | 95  | ns   |
| Operating frequency            | Master, TX only      |     |     | 8   | MHz  |
|                                | Master, RX and TX    |     |     | 4   |      |
|                                | Slave, RX only       |     |     | 8   |      |
|                                | Slave, RX and TX     |     |     | 4   |      |

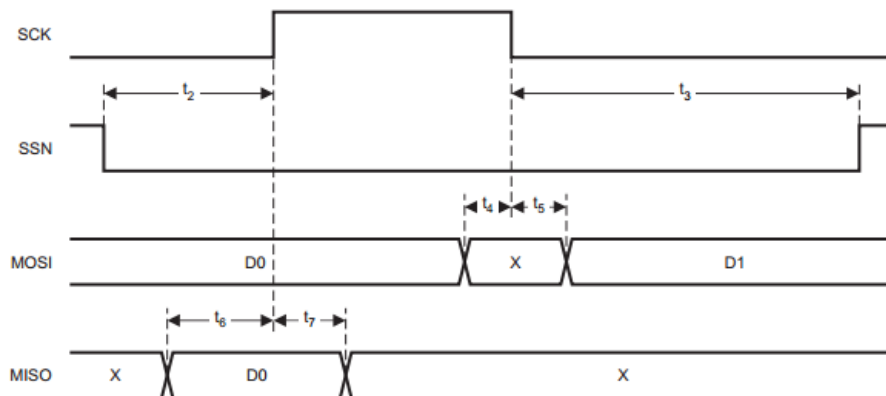


Figure 1 SPI Master AC Characteristics

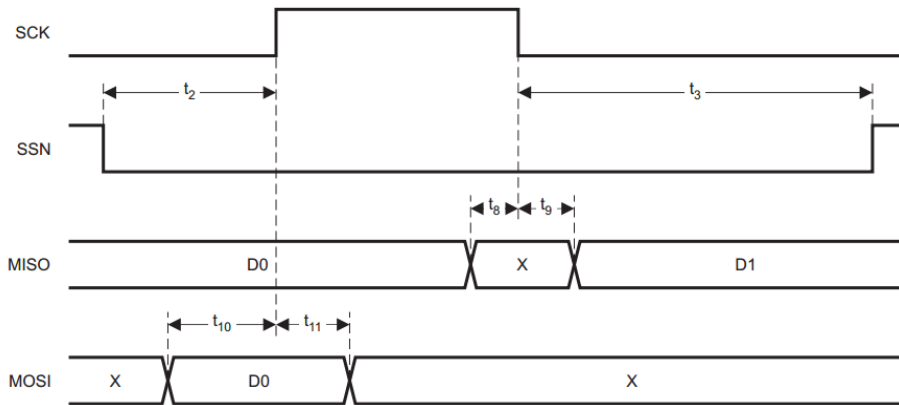
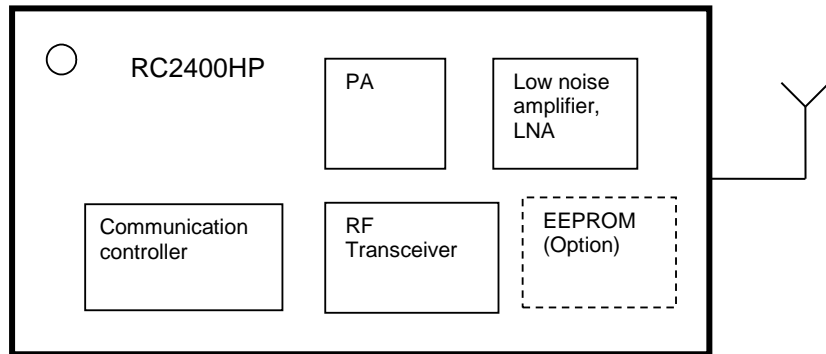


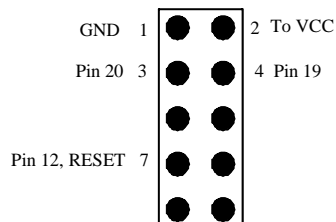
Figure 2 SPI Slave AC Characteristics

## Block Diagram



## Programming and debugging Interface

For downloading firmware to the module it is required to include a 2x5 pins programming connector to the modules programming pins. The connector should be a 2.54 mm pitch pin-row (same pitch in both directions), SMD or through-hole version, with the following connections:



### RF Frequency, Output Power Levels and Data Rates

The following table shows the RF channels as defined by the IEEE 802.15.4 standard.

| RF channel | Frequency |
|------------|-----------|
| 11         | 2405 MHz  |
| 12         | 2410 MHz  |
| 13         | 2415 MHz  |
| 14         | 2420 MHz  |
| 15         | 2425 MHz  |
| 16         | 2430 MHz  |
| 17         | 2435 MHz  |
| 18         | 2440 MHz  |
| 19         | 2445 MHz  |
| 20         | 2450 MHz  |
| 21         | 2455 MHz  |
| 22         | 2460 MHz  |
| 23         | 2465 MHz  |
| 24         | 2470 MHz  |
| 25         | 2475 MHz  |
| 26         | 2480 MHz  |

For proprietary solutions (non-IEEE 802.15.4), the RF transceiver can be programmed in steps of 1 MHz.

The RF transceiver uses direct sequence spread spectrum (DSSS) with 2 Mchip/s chip rate, giving a raw data rate of 250 kbit/s. The modulation format is Offset – Quadrature Phase Shift Keying (O-QPSK). The DSSS makes the communication link robust in noisy environments, which is beneficial when sharing the same frequency band with other applications.

### Output power

The output power can be programmed in a 25-27 dB range. Maximum power setting (TXPOWER=0xF5) gives 20 dBm output power for RC2400HP and 4 dBm output power for RC2400. Battery lifetime considerations and compliance to local maximum output power regulations will influence the output power setting.

Battery operation might require lower peak currents and hence reduced output power, especially for the RC2400HP. See table below.

Typical values for RC2400HP at 25°C, 3.3V, Freq = 2440 MHz, 50 ohm matched antenna impedance.

| Power setting (TXPOWER) | Output power (dBm) | Peak current (mA) |
|-------------------------|--------------------|-------------------|
| 0xF5                    | 20,3               | 218               |
| 0xE5                    | 19,5               | 192               |
| 0xD5                    | 18,8               | 174               |
| 0xC5                    | 18,1               | 160               |
| 0xB5                    | 17,2               | 145               |
| 0xA5                    | 16,2               | 134               |
| 0x95                    | 14,5               | 121               |
| 0x85                    | 13,5               | 112               |
| 0x75                    | 12,0               | 99                |
| 0x65                    | 10,5               | 93                |

### Regulatory Compliance Information

The use of RF frequencies and maximum allowed transmitted RF power is limited by national regulations. The RC2400HP has been designed to comply with world wide regulations (R&TTE directive 1999/5/EC in Europe FCC, ARIB and G.S.R. 542(E)/45(E) for India). The RC2400 (non-HP) complies with all directives and regulations at any power lever setting. In order to comply with the different standards, the output power for RC2400HP should be configured as commented below.

#### R&TTE directive (EU)

According to R&TTE directive it is the responsibility of Radiocrafts' customers to check that the host product (i.e. final product) is compliant with R&TTE 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 established by Radiocrafts. A Declaration of Conformity is available from Radiocrafts on request.

In terms of R&TTE the RC241XHP is a wideband radio and must comply with EN 300 328 on those premises. RC241xHP is tested and assessed in compliance with EN 300 328 for EIRP up to 10 dBm EIRP. For 0dBi in antenna this is equal to power setting 0x55. For lower gain antenna (or loss in antenna feed) higher output settings can be used.

Products using RC241xHP can be certified up to 12dBm EIRP, but there are specific requirement to radio protocol. Such assessment is left to the manufacturer of end equipment.

#### FCC/IC compliance (US, Canada)

These devices comply with Part 15 of the FCC Rules.

| Part number | FCC ID      | IC ID             |
|-------------|-------------|-------------------|
| RC2400      | Y2NRC24XX   | IC 9402A-RC24XX   |
| RC2400HP    | Y2NRC24XXHP | IC 9402A-RC24XXHP |

Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

*Son fonctionnement est soumis aux deux conditions: (1) cet appareil ne doit pas créer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent en perturber le fonctionnement.*

Changes or modifications to the equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

If a detachable RF connector is introduced in RF path it must be a non-standard type RP-SMA, U.FI etc. The modules have been approved with the following external quarter wave antennas:

| Manufacturer | Part number             |
|--------------|-------------------------|
| EAD          | Acara                   |
| Taoglas      | FXP73.07.0100A          |
| Antennova    | Titanis                 |
|              | PCB inverted F antenna* |

\* Contact support@radiocrafts.com for specification of antenna in order to comply with FCC certification.

Any use of other antenna with gain > 2.5 dBi is strictly forbidden.

Warning for RC2400HP: This is device complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. The antenna used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter. For approval of end product as portable device, separate SAR tests and approval is required for end product.

*Avertissement concernant le module RC2400HP: Le module RC2400 HP est conforme à l'exposition aux limites de rayonnements RF FCC acceptées pour un environnement non contrôlé. L'antenne utilisée pour cet émetteur doit être installée pour fournir une distance minimum 20 cm par rapport à toute personne et ne doit pas être à côté ou fonctionner conjointement avec une autre antenne ou transmetteur. Pour l'approbation du produit final en tant que périphérique portable, des tests et homologations SAR propres au produit sont requis.*

The output power of RC2400 is below the FCC threshold requiring that it be tested for SAR compliance.

*La puissance de sortie du RC2400 est inférieure au seuil FCC nécessitant que des tests de conformité SAR soient réalisés*

This device has been designed to operate with an quarter wave antenna having a maximum gain of 2.5 dBi. Antenna having a higher gain is strictly prohibited per regulations of Industry Canada. The required antenna impedance is 50 ohms.

*Cet appareil a été conçu pour fonctionner avec une antenne 1/4 d'ondes ayant un gain maximum de 2,5 dBi. Utiliser une antenne à gain plus élevé est strictement interdite par les règlements d'Industrie Canada. L'impédance d'antenne requise est de 50 ohms*

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (EIRP) is not more than that required for successful communication.

*Pour réduire le risque d'interférence pour les autres utilisateurs, le type d'antenne et son gain doivent être choisis de façon que la puissance isotrope rayonnée équivalente (PIRE) n'est pas supérieure à celle requise pour une communication réussie.*

The installer of this radio equipment must ensure that the antenna is located or pointed such that it does not emit RF field in excess of Health Canada limits for the general population; consult Safety Code 6, obtainable from Health Canada's website [www.hc-sc.gc.ca/rpb](http://www.hc-sc.gc.ca/rpb)

*Le programme d'installation de cet équipement radio doit s'assurer que l'antenne est située ou orientée de façon à ne pas émettre de champ RF dépassant les limites de Santé Canada pour la population en général, consulter le Code de sécurité 6, disponible sur le site Web de Santé Canada [www.hc-sc.gc.ca/rpb](http://www.hc-sc.gc.ca/rpb)*

### End product marking FCC/IC

The end product including the module must include the following text on a visible label: The French part is only required for product with IC compliance.

#### For RC240x

Contains Transmitter Module FCC ID: Y2NRC24XX/IC: 9402A-RC24XX  
Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Module transmetteur ID IC: 9402A-RC24XX  
Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent perturber le fonctionnement.

#### For RC240xHP

Contains Transmitter Module FCC ID: Y2NRC24XXHP/IC: 9402A-RC24XXHP  
Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Module transmetteur ID IC: 9402A-RC24XX  
Son fonctionnement est soumis aux deux conditions suivantes: (1) cet appareil ne doit pas causer d'interférences nuisibles et (2) cet appareil doit accepter toute interférence reçue, y compris les interférences qui peuvent perturber le fonctionnement.

### WPC compliance (India)

License based operation in India is based on case by case grant and the basis is often a compliance to the R&TTE directive or to FCC.

### ARIB compliance

The RC2400HP has been designed to comply with the requirements given by the Japanese ARIB STD-T66 for low power (short range) devices in the 2.4GHz range. However, it has not been formally assessed for conformity with the appropriate regulations. Users must assess and verify that their final product meets the appropriate specifications and to perform the required procedures for regulatory compliance.

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.

### Antenna and Range Considerations

The module needs an antenna to operate. The following antenna options could be considered.

| Antenna                      | Advantage  | Disadvantage                  | Estimated LOS range (meters) RC2400 | Estimated LOS range (meters) RC2400HP (100 mW) |
|------------------------------|--|-------------------------------|-------------------------------------|--|
| PCB, quarter wave monopole   | Low cost, easy to implement                      |                               | 250-400                             | 2000-2500                                      |
| PCB Pifa                     | Low cost   | Sensitive to surroundings     | 300-500                             | 2500-3000                                      |
| Chip antenna (7x2mm example) | Small size                                       | Medium performance            | 200-300                             | 1500-2000                                      |
| External whip monopole       | High performance                                 | Physically large, higher cost | 500-700                             | 3000-4000                                      |
| External whip dipole         | High performance, no large ground plane required | Physically large, higher cost | 500-700                             | 3000-4000                                      |

Using an antenna, the VSWR (Voltage Standing Wave Ratio) of the antenna should be less than 2:1. The VSWR is normally specified in the antenna datasheet and most commercial available antennas fulfil this requirement. If you design a PCB antenna this is an important input requirement for such a design. Using a VSWR higher than 2:1, will result in unwanted reflected power into the module and reducing both the module performance and radiated power. This will in turn reduce the range. Using a VSWR higher than 3:1 is not recommended.

The antenna shall be connected to the RF pin. The RF pin is matched to 50 Ohm. In the case that an antenna connector for an external antenna is placed away from the module at the motherboard, the trace between the RF pin and the connector should be a 50 Ohm transmission line. Follow these general guidelines;

On a two layer board made of FR4 the width of the routing trace, from the RF-pin to any connector or contact point for a PCB-antenna, should be 1.8 times the thickness of the board, assuming a dielectric constant of 4.8 (normal value for a FR-4 board). The line should be run at the top of the board and on the bottom side there should be a ground plane. This will give a transmission line with close to 50 ohm characteristic impedance.

Example: For a 1.6 mm thick FR4 board, the width of the trace on the top side should be  $1.8 \times 1.6 \text{ mm} = 2.88 \text{ mm}$ .

The easiest 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 is not required. A quarter wave antenna implemented with a piece of wire normal to the ground plane should have a length equivalent to 95% of the free space wavelength.

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 (in one dimension) as the antenna itself, to make it act as an electrical counterweight to the antenna. A quarter wavelength antenna on a PCB must be shorter than the wire antenna due to the influence of the dielectric material of the PCB. The length reduction depends on the PCB thickness and material, as well as how close to the edge of the board the antenna is placed. Typical reduction is to 75-90 % of the length in free space

but exact length must be found empirically. A 1.0 or 1.6 mm FR4 PCB with the antenna trace > 1 cm from conducting obstacles normally reduces the length of a quarter wave antenna to about 2.4 cm.

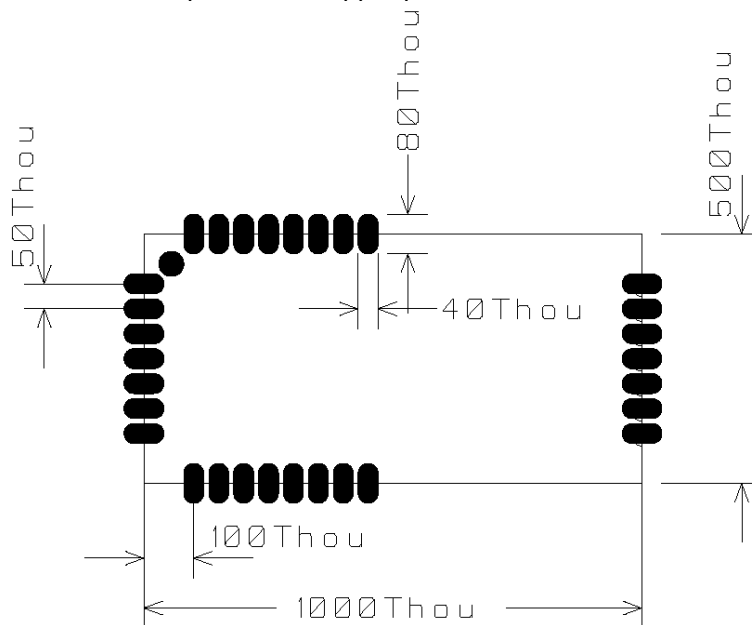
If, for space reasons, the track is made even shorter than the resonating quarter of a wavelength, the antenna should be matched to 50 ohms using a series inductor and a shunt capacitor.

The length of a quarter-wave antenna is given in the table below.

| Frequency [MHz] | Length of whip antenna [cm] | Length of PCB track [cm] |
|-----------------|-----------------------------|--------------------------|
| 2450            | 2.9                         | 2.25 – 2.7               |

### 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.



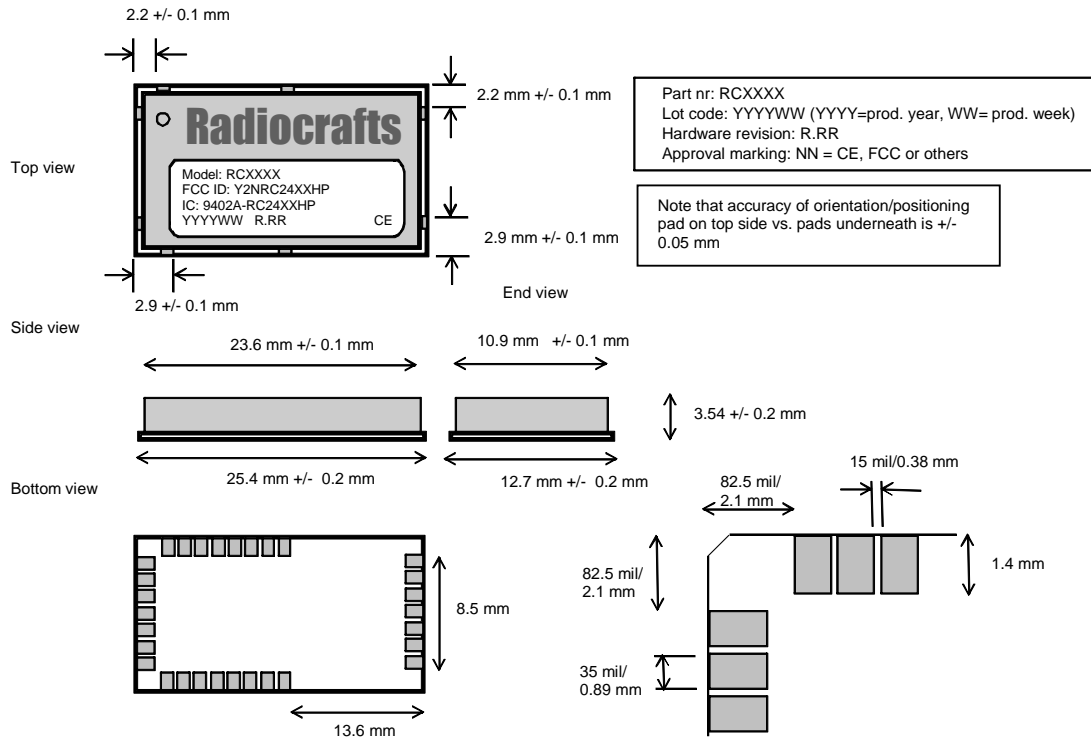
A PCB with two or more layers and with a solid ground plane in one of the inner- or bottom layer(s) is recommended. All GND-pins of the module shall be connected to this ground plane with vias with shortest possible routing, one via per GND-pin.

On the back side of the module there are several 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.

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

## Mechanical Drawing



Drawings are not to scale

## Mechanical Dimensions

The module size is 12.7 x 25.4 x 3.5 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

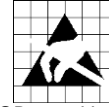
JEDEC standard IPC/JEDEC J-STD-020D.1 (page 7 and 8), Pb-Free Assembly is recommended.

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. Nominal stencil thickness of 0.1-0.12 mm recommended.

### Absolute Maximum Ratings

| Parameter             | Min  | Max     | Unit |
|-----------------------|------|---------|------|
| Supply voltage, VCC   | -0.3 | 3.6     | V    |
| Voltage on any pin    | -0.3 | VCC+0.5 | V    |
| Input RF level        |      | 10      | dBm  |
| Storage temperature   | -40  | 85      | °C   |
| Operating temperature | -30  | 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.

### Electrical Specifications

T=25°C, VCC = 3.3V, 50 ohm if nothing else stated.

| Parameter  | Min       | Typ.                     | Max  | Unit   | Condition / Note  |
|--|-----------|--------------------------|--|--------|---|
| Operating frequency  | 2400      |                          | 2483                                       | MHz    | Programmable in 1 MHz steps, 5 MHz steps for IEEE 802.15.4 compliance   |
| Number of channels   |           | 16                       |  |        | For IEEE 802.15.4 compliance  |
| Channel spacing  |           | 5                        |  | MHz    | For IEEE 802.15.4 compliance  |
| Input/output impedance   |           | 50                       |  | Ohm    |   |
| Data rate  |           | 250                      |  | kbit/s |   |
| DSSS chip rate   |           | 2                        |  | Mc/s   |   |
| Frequency stability  |           |                          | +/-40                                      | ppm    |   |
| Transmit power<br>RC2400<br>RC2400HP   | -23<br>-6 |                          | 4<br>20                                    | dBm    | Programmable from firmware  |
| Harmonics<br>RC2400<br>2 <sup>nd</sup> harmonic<br>3 <sup>rd</sup> harmonic<br>RC2400HP (19 dBm Pout)<br>2 <sup>nd</sup> harmonic<br>3 <sup>rd</sup> harmonic    |           | -42<br>-55<br>-44<br>-42 |  |        | Compliance to FCC requires less than - 27 dBm given TX duty cycle of 20% and 0dBi antenna gain at harmonic frequencies. |
| Spurious emission<br>RC2400HP, TX, 20 dBm<br>30 – 1000 MHz<br>1-12.75 GHz<br><br>RC2400 TX, 4 dBm<br>30 – 1000 MHz<br>1-12.75 GHz<br>1.8-1.9 GHz<br>5.15-5.3 GHz |           |                          | -50<br>-45<br><br>-56<br>-48<br>-53<br>-60 | dBm    | Complies with EN 300 328, EN 300 440, FCC CRF47 Part 15 and ARIB STD-T66  |
| Sensitivity<br>RC2400<br>RC2400HP  |           | -97<br>-99               |  | dBm    | PER = 1%  |
| Adjacent channel rejection<br>+/- 5 MHz  |           | 49                       |  | dB     | At -82 dBm, PER = 1%.<br>0 dB for IEEE 802.15.4 compliance  |
| Alternate channel selectivity<br>+/- 10 MHz  |           | 57                       |  | dB     | At -82 dBm, PER = 1%.<br>30 dB for IEEE 802.15.4 compliance   |

| Parameter   | Min        | Typ.       | Max        | Unit | Condition / Note   |
|---|------------|------------|------------|------|--|
| Saturation  |            | 10         |            | dBm  |  |
| Spurious emission, RX<br>30 -1000 MHz<br>1-12.75 GHz        |            |            | -57<br>-47 | dBm  | Complies with EN 300 328, EN 300 440, FCC CRF47 Part 15 and ARIB STD-T66 |
| Supply voltage<br>RC2400<br>RC2400HP                        | 2.0<br>2.7 |            | 3.6<br>3.6 | V    |  |
| Current consumption, RX<br>RC2400<br>RC2400HP               |            | 24<br>27   |            | mA   | MCU in Idle mode using the 32 MHz oscillator.                            |
| Current consumption, TX<br>RC2400, 4dBm<br>RC2400HP, 19 dBm |            | 34<br>175  |            | mA   | MCU in Idle mode using the 32 MHz oscillator.                            |
| Current consumption, Power down<br>RC2400<br>RC2400HP       |            | 0.4<br>1.3 |            | μA   | Wake-up time to power mode 0 is 54 uS                                    |
| RAM memory  |            | 8          |            | kB   |  |
| MCU clock frequency   |            | 32         |            | MHz  |  |
| MCU low frequency crystal                                   |            | 32.768     |            | kHz  |  |
| Antenna VSWR  |            | <2:1       | 3:1        |      |  |

### Ordering Information

| Ordering Part Number | Description  |
|----------------------|--|
| RC2400               | ZigBee-ready RF module, 256 kB Flash   |
| RC2400HP             | ZigBee-ready RF module, 256 kB Flash. High power, long range   |
| RC2400 -EE           | ZigBee-ready RF module, 256 kB Flash, including EEPROM   |
| RC2400HP -EE         | ZigBee-ready RF module, 256 kB Flash. High power, long range, including EEPROM   |
| RC2400-ZNM           | ZigBee-ready RF module, embedded ZigBee stack with API through serial interface  |
| RC2400HP-ZNM         | ZigBee-ready RF module, embedded ZigBee stack with API through serial interface. High power, long range  |
| RC2400-ZNM-SE        | ZigBee-ready RF module, embedded ZigBee stack with API through serial interface. Includes support for Smart Energy Security.                         |
| RC2400HP-ZNM-SE      | ZigBee-ready RF module, embedded ZigBee stack with API through serial interface. High power, long range. Includes support for Smart Energy Security. |

### Document Revision History

| Document Revision | Changes   |
|-------------------|---|
| 1.0               | First release   |
| 1.1               | Corrected soldering profile info<br>Added info in RC2405 and ZNM-SE variants<br>Updated FCC information<br>Updated Adjacent channel rejection |
| 1.2               | Updated FCC/IC information<br>Status changed to Full Production   |
| 1.3               | Updated mechanical drawing<br>Added DC and SPI AC characteristics<br>Updated regulatory information for CE according to EN300 328             |

### 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. |
| <b>X</b>       | No Identification Noted         | Full Production                          | <b>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.</b>  |
|                | Not recommended for new designs | Last time buy available                  | Product close to end of lifetime  |

| Current Status | Data Sheet Identification | Product Status  | Definition  |
|----------------|---------------------------|---|---|
|                | Obsolete                  | Not in Production<br>Optionally accepting order with Minimum Order Quantity | 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.

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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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