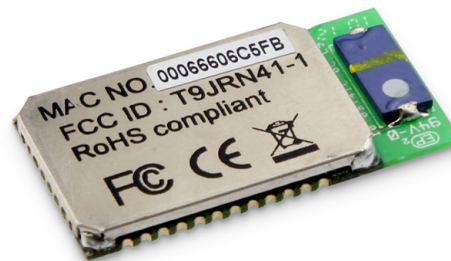


## RN41/RN41N Class 1 Bluetooth Module

### Features

- Fully qualified Bluetooth® version 2.1 module, supports version 2.1 + Enhanced Data Rate (EDR)
- Backwards-compatible with Bluetooth version 2.0, 1.2, and 1.1
- Postage stamp sized form factor, 13.4 mm x 25.8 mm x 2 mm
- Low power (30 mA connected, < 10 mA sniff mode)
- UART (SPP or HCI) and USB (HCI only) data connection interfaces
- Sustained SPP data rates: 240 Kbps (slave), 300 Kbps (master)
- HCI data rates: 1.5 Mbps sustained, 3.0 Mbps burst in HCI mode
- Embedded Bluetooth stack profiles included (requires no host stack): GAP, SDP, RFCOMM, and L2CAP protocols, with SPP and DUN profile support
- Bluetooth SIG qualified, end product listing
- Castellated SMT pads for easy and reliable PCB mounting
- Class 1 high power amplifier with on board ceramic RF chip antenna (RN41) or without antenna (RN41N)
- Certifications: FCC, ICS, CE
- Environmentally friendly, RoHS compliant



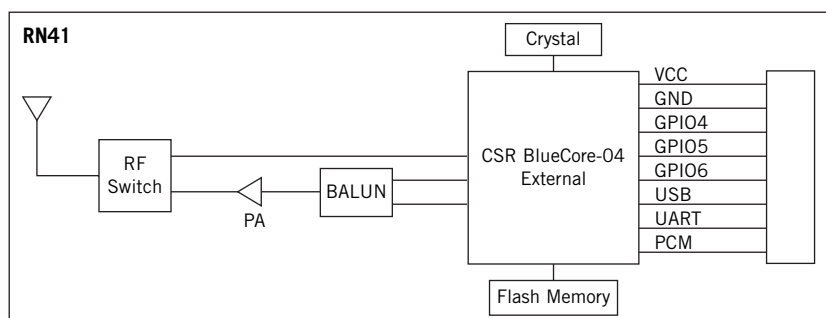
### Applications

- Cable replacement
- Barcode scanners
- Measurement and monitoring systems
- Industrial sensors and controls
- Medical devices
- Asset tracking

### Description

The RN41 module is a small form factor, low power, class 1 Bluetooth radio that is ideal for designers who want to add wireless capability to their products without spending significant time and money developing Bluetooth-specific hardware and software. The RN41 supports multiple interface protocols, is simple to design in, and is fully certified, making it a complete embedded Bluetooth solution. With its high-performance, on-chip antenna and support for Bluetooth EDR, the RN41 delivers up to a 3-Mbps data rate for distances up to 100 meters. The RN41 is also available without an antenna (RN41N).

**Figure 1. RN41 Block Diagram**



## OVERVIEW

- Baud rate speeds: 1,200 bps up to 921 Kbps, non-standard baud rates can be programmed
- Class 1 radio, 330' (100 m) range, 15 dBm output transmitter, -80 dBm typical receive sensitivity
- Frequency 2,402 ~ 2,480 MHz
- FHSS/GFSK modulation, 79 channels at 1-MHz intervals
- Secure communication, 128-bit encryption
- Error correction for guaranteed packet delivery
- Configuration via the local UART and over-the-air RF
- Auto-discovery/pairing does not require software configuration (supports instant cable replacement)
- Auto-connect master, I/O pin (DTR), and character-based trigger modes

The module's moisture sensitivity level (MSL) is 1. Table 1 shows the module's size and weight.

**Table 1. Module Size & Weight**

| Parameter | RN41            | RN41N         | Units |
|-----------|-----------------|---------------|-------|
| Size      | 13.4 x 25.8 x 2 | 13.4 x 19 x 2 | mm    |
| Weight    | 0.055           | 0.020         | Oz.   |

Tables 2 through 5 provide detailed specifications for the module.

**Table 2. Environmental Conditions**

| Parameter                     | Value          |
|-------------------------------|----------------|
| Temperature Range (Operating) | -40° C ~ 85° C |
| Temperature Range (Storage)   | -40° C ~ 85° C |
| Relative Humidity (Operating) | ≤ 90%          |
| Relative Humidity (Storage)   | ≤ 90%          |

**Table 3. Electrical Characteristics**

| Parameter                         | Min. | Typ. | Max. | Units |
|-----------------------------------|------|------|------|-------|
| Supply Voltage (DC)               | 3.0  | 3.3  | 3.6  | V     |
| RX Supply Current                 |      | 35   | 60   | mA    |
| TX Supply Current                 |      | 65   | 100  | mA    |
| <b>Average Power Consumption</b>  |      |      |      |       |
| Standby/Idle (Default Settings)   |      | 25   |      | mA    |
| Connected (Normal Mode)           |      | 30   |      | mA    |
| Connected (Low-Power Sniff)       |      | 8    |      | mA    |
| Standby/Idle (Deep Sleep Enabled) | 250  | 2.5  |      | mA    |

**Table 4. Radio Characteristics**

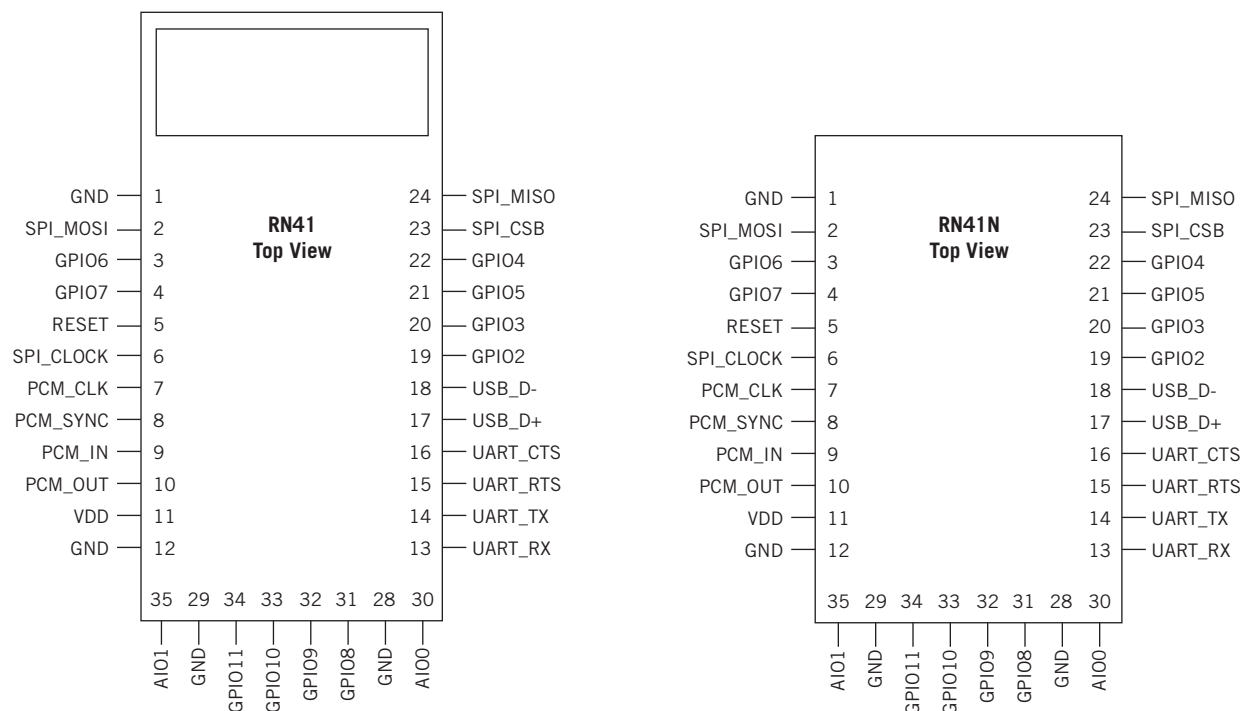
| Parameter                                   | Frequency (GHz) | Min. | Typ. | Max. | Bluetooth Specification | Units |
|---------------------------------------------|-----------------|------|------|------|-------------------------|-------|
| Sensitivity at 0.1% BER                     | 2.402           | -    | -80  | -86  | $\leq -70$              | dBm   |
|                                             | 2.441           | -    | -80  | -86  |                         | dBm   |
|                                             | 2.480           | -    | -80  | -86  |                         | dBm   |
| RF Transmit Power                           | 2.402           | 15.0 | 16.0 |      | $\leq 20$               | dBm   |
|                                             | 2.441           | 15.0 | 16.0 |      |                         | dBm   |
|                                             | 2.480           | 15.0 | 16.0 |      |                         | dBm   |
| Initial Carrier Frequency Tolerance         | 2.402           | -    | 5    | 75   | 75                      | kHz   |
|                                             | 2.441           | -    | 5    | 75   |                         | kHz   |
|                                             | 2.480           | -    | 5    | 75   |                         | kHz   |
| 20-dB Bandwidth for Modulated Carrier       |                 | -    | 900  | 1000 | $\leq 1000$             | kHz   |
| Drift (Five Slots Packet)                   |                 | -    | 15   | -    | 40                      | kHz   |
| Drift Rate                                  |                 | -    | 13   | -    | 20                      | kHz   |
| $\Delta f_{1\text{avg}}$ Maximum Modulation | 2.402           | 140  | 165  | 175  | $> 140$                 | kHz   |
|                                             | 2.441           | 140  | 165  | 175  |                         | kHz   |
|                                             | 2.480           | 140  | 165  | 175  |                         | kHz   |
| $\Delta f_{2\text{avg}}$ Minimum Modulation | 2.402           | 140  | 190  | -    | 115                     | kHz   |
|                                             | 2.441           | 140  | 190  | -    |                         | kHz   |
|                                             | 2.480           | 140  | 190  | -    |                         | kHz   |

**Table 5. Digital I/O Characteristics**

| $3.0\text{ V} \leq \text{VDD} \leq 3.3\text{ V}$      | Min.      | Typ. | Max.      | Units         |
|-------------------------------------------------------|-----------|------|-----------|---------------|
| Input Logic Level Low                                 | -0.4      | -    | +0.8      | V             |
| Input Logic Level High                                | 0.7 VDD   | -    | VDD + 0.4 | V             |
| Output Logic Level Low                                | -         | -    | 0.2       | V             |
| Output Logic Level High                               | VDD - 0.2 | -    | -         | V             |
| All I/O pins (Except reset) Default to Weak Pull Down | +0.2      | +1.0 | +5.0      | $\mu\text{A}$ |

Figure 2 shows the pinout and Table 6 describes the pins.

**Figure 2. RN41/RN41N Pinout**



**Table 6. Pin Description**

| Pin | Name     | Description                                                         | Default                          |
|-----|----------|---------------------------------------------------------------------|----------------------------------|
| 1   | GND      | Ground                                                              | –                                |
| 2   | SPI_MOSI | Programming only                                                    | No connect                       |
| 3   | GPIO6    | Set Bluetooth master (high = auto-master mode)                      | Input to RN41 with weak pulldown |
| 4   | GPIO7    | Set baud rate (high = force 9,600, low = 115 K or firmware setting) | Input to RN41 with weak pulldown |
| 5   | RESET    | Active-low reset                                                    | Input to RN41 with 1K pullup     |
| 6   | SPI_CLK  | Programming only                                                    | No Connect                       |
| 7   | PCM_CLK  | PCM interface                                                       | No Connect                       |
| 8   | PCM_SYNC | PCM interface                                                       | No Connect                       |
| 9   | PCM_IN   | PCM interface                                                       | No Connect                       |
| 10  | PCM_OUT  | PCM interface                                                       | No Connect                       |
| 11  | VDD      | 3.3-V regulated power input                                         | –                                |
| 12  | GND      | Ground                                                              | –                                |
| 13  | UART_RX  | UART receive input                                                  | Input to RN41                    |
| 14  | UART_TX  | UART transmit output                                                | High level output from RN41      |
| 15  | UART_RTS | UART RTS, goes high to disable host transmitter                     | Low level output from RN41       |
| 16  | UART_CTS | UART CTS, if set high, it disables transmitter                      | Low level input to RN41          |

| Pin     | Name     | Description                                    | Default                                                             |
|---------|----------|------------------------------------------------|---------------------------------------------------------------------|
| 17      | USB_D+   | USB port                                       | 1.5 K pullup activated when USB port is ready (~500 ms after reset) |
| 18      | USB_D-   | USB port                                       | –                                                                   |
| 19      | GPIO2    | Status, high when connected, low otherwise     | Output from RN41                                                    |
| 20      | GPIO3    | Auto discovery = high                          | Input to RN41 with weak pulldown                                    |
| 21      | GPIO5    | Status, toggles based on state, low on connect | Output from RN41                                                    |
| 22      | GPIO4    | Set factory defaults                           | Input to RN41 with weak pulldown                                    |
| 23      | SPI_CSB  | Programming only                               | No connect                                                          |
| 24      | SPI_MISO | Programming only                               | No connect                                                          |
| 25 - 27 | NC       | RF pad, keep all traces and planes clear       | –                                                                   |
| 28 - 29 | GND      | Ground                                         | –                                                                   |
| 30      | AIO0     | Optional analog input                          | Not used                                                            |
| 31      | GPIO8    | Status (RF data RX/TX)                         | Output from RN41                                                    |
| 32      | GPIO9    | I/O                                            | Input to RN41 with weak pulldown                                    |
| 33      | GPIO10   | I/O (remote DTR signal)                        | Input to RN41 with weak pulldown                                    |
| 34      | GPIO11   | I/O (remote RTS signal)                        | Input to RN41 with weak pulldown                                    |
| 35      | AIO1     | Optional analog input                          | Not Used                                                            |

Figure 3 shows the module's physical dimensions.

**Figure 3. RN41/RN41N Physical Dimensions**

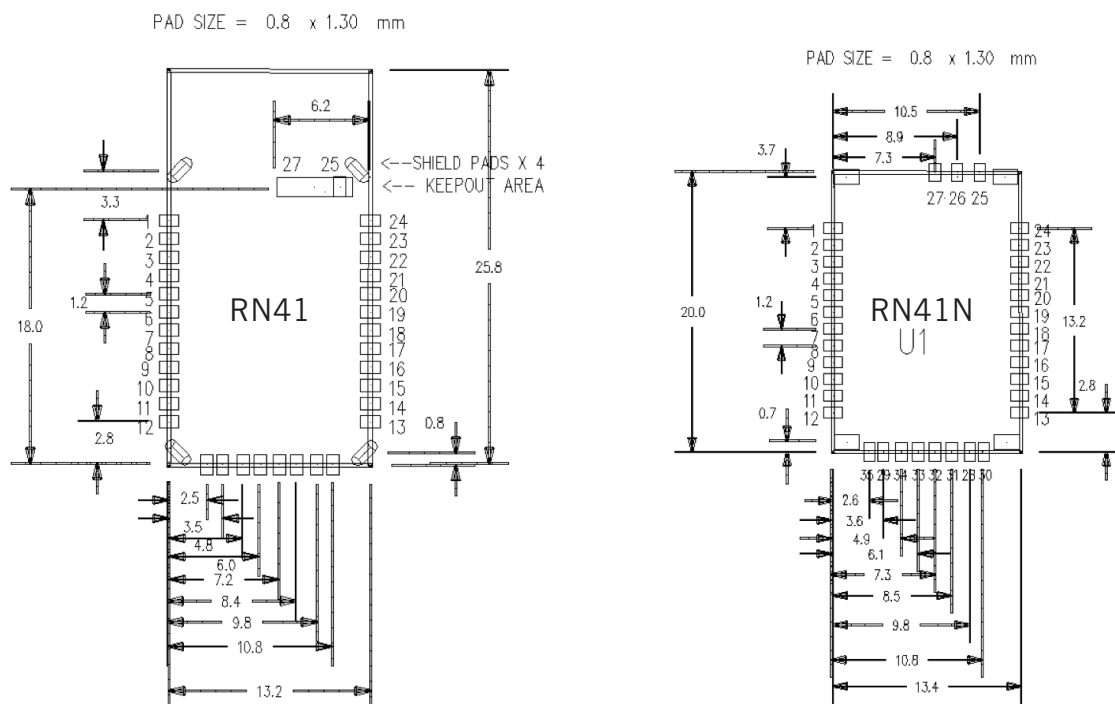


Figure 4 shows a typical application schematic.

**Figure 4. Application Schematic**



## DESIGN CONCERNS

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The following sections provide information on designing with the RN41 module, including radio interference, factory reset, solder reflow profile, connection status, etc.

### Reset Circuit

The RN41 contains a 1k pullup to VCC, and the reset polarity is active low. The module's reset pin has an optional power-on-reset circuit with a delay, which should only be required if the input power supply has a very slow ramp or tends to bounce or have instability on power up. Often a microcontroller or embedded CPU I/O is available to generate the reset once power is stable. If not, designers can use one of the many low-cost power supervisor chips currently available, such as the MCP809, MCP102/121, and Torex XC61F.

### Factory Reset Using GPIO4

Roving Networks recommends that designers connect the GPIO4 pin to a switch, jumper, or resistor so it can be accessed. This pin can be used to reset the module to its factory default settings, which is critical in situations where the module has been misconfigured. To reset the module to the factory defaults, GPIO4 should be high on power-up and then toggle low, high, low, high with a 1 second wait between the transitions.

### Connection Status

GPIO5 is available to drive an LED, and it blinks at various speeds to indicate status (see Table 7). GPIO2 is an output that directly reflects the connection state as shown in Table 8.

**Table 7. GPIO5 Status**

| GPIO5 Status    | Description                                               |
|-----------------|-----------------------------------------------------------|
| Toggle at 1 Hz  | The module is discoverable and waiting for a connection.  |
| Toggle at 10 Hz | The module is in command mode.                            |
| Low             | The module is connected to another device over Bluetooth. |

**Table 8. GPIO2 Status**

| GPIO2 Status | Description                                               |
|--------------|-----------------------------------------------------------|
| High         | The module is connected to another device over Bluetooth. |
| Low          | The module is not connected over Bluetooth.               |

### HCI Mode

Roving Networks offers the Host Controller Interface (HCI) mode in addition to the standard operational mode of its Bluetooth modules (standard mode refers to the on-board stack running on the module).

In HCI mode, the on-board stack is bypassed and the module is put in a state that runs the Bluetooth baseband. The HCI provides a command reference interface to the baseband controller and the link manager, and provides access to the hardware status and control registers. This interface provides a uniform method for accessing the Bluetooth baseband capabilities.

In this mode, the Bluetooth stack is no longer on-board the module. It is offloaded to the interfacing host processor. The Bluetooth module is used as a radio, performing the lower level MAC functionalities, while the application stack runs on the host processor.

Using the module in HCI mode allows designers to implement profiles that are not natively supported on the Bluetooth module.

**NOTE:** HCI mode requires a separate firmware build that must be loaded into the module's flash at the factory. Is not upgradeable in the field.

Roving Networks offers HCI mode in two hardware interfaces:

- HCI over UART (RN41HCI-I/RM)
- HCI over USB (RN41U-I/RM)

### *HCI over UART*

In this mode, the hardware interface between the host processor and the Bluetooth module is the UART. You must interface the flow control signals between the host processor and the Bluetooth module for the HCI interface to work. Failure to do so can cause the host processor and the Bluetooth module to become out of sync and break the Bluetooth link.

### *HCI over USB*

In this mode, the hardware interface between the host processor and the Bluetooth module is the USB. In this architecture, the Bluetooth module is the USB slave and the host processor is the USB host.

Using the USB interface offers the advantage of a faster data link between the Bluetooth module and the host processor. With this architecture, it is possible to achieve Bluetooth's theoretical maximum throughput of 3 Mbps.

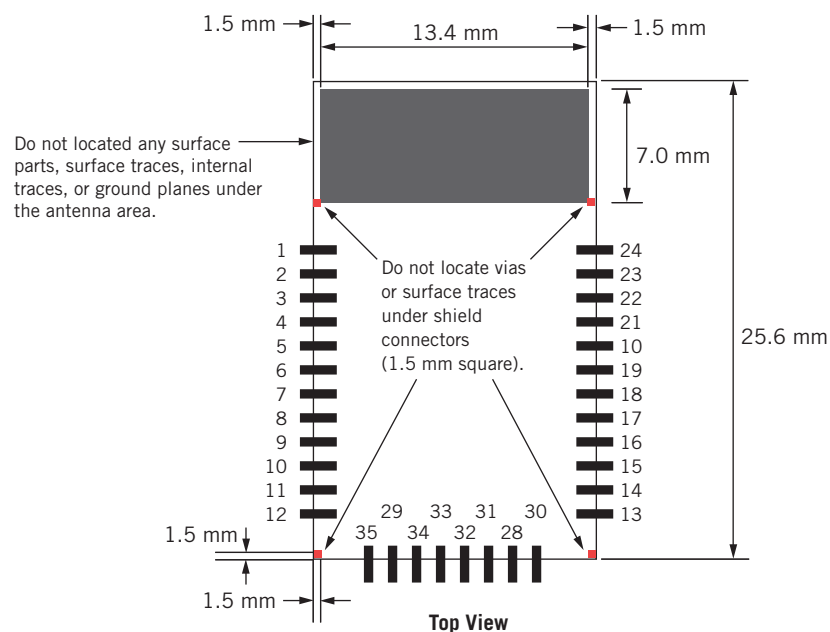
## **Using the SPI Bus to Upgrade the Flash Memory**

While not required, this bus is very useful for configuring the Bluetooth modules' advanced parameters. The bus is required when upgrading the module's firmware. The typical application schematic shown in Figure 4 shows a 6-pin header that can be implemented to gain access to this bus. A minimum-mode version might simply use the SPI signals (4 pins) and obtain ground and VCC from elsewhere in the design.

## **Minimizing Radio Interference**

When laying out the carrier board for the RN41 module, the areas under the antenna and shielding connections should not have surface traces, ground planes, or exposed vias (see Figure 5). For optimal radio performance, the RN41 module's antenna end should protrude at least 5 mm beyond any metal enclosure.

**Figure 5. Minimizing Radio Interference**



Because the RN41N does not contain an antenna, it does not carry regulatory approvals.

If designers use Roving Networks recommended design, they can file for a permissible antenna change and use Roving Networks' regulatory approvals. Roving Networks recommends the Yageo chip antenna for the RN41N module. For detailed information on this antenna, refer to the Yageo chip antenna data sheet on the Support page of the Roving Networks website at [http://www.rovingnetworks.com/Support\\_Overview](http://www.rovingnetworks.com/Support_Overview).

If designers choose to use another antenna, they must go through the regulatory approval process.

## Solder Reflow Profile

The lead-free solder reflow temperature and times are:

- *Temperature*—230° C, 30 - 40 seconds, peak 250° C maximum
- *Preheat temperature*—165° ± 15° C, 90 to 120 seconds
- *Time*—Single pass, one time

## COMPLIANCE INFORMATION

Table 9 describes the module's compliance information.

**Table 9. Compliance Information (RN41 Only)**

| Category      | Country                 | Standard                            |
|---------------|-------------------------|-------------------------------------|
| Radio         | USA<br>FCC ID:          | FCC CFR47 Part 15 C, para 15.247    |
|               |                         | T9J-R41-1                           |
|               | Europe                  | EN 300 328-1                        |
|               |                         | EN 300 328-2 2.4GHz                 |
|               | Canada<br>IC Canada ID: | IC RSS-210 low power comm. device   |
|               |                         | 6514A-RN411                         |
| EMC           | USA                     | FCC CFR47 Part 15 subclass B        |
|               | Europe                  | EN 55022 Class B radiated           |
|               |                         | EN61000-4-2 ESD immunity            |
|               |                         | EN61000-4-3 radiated field          |
|               |                         | EN61000-4-6 RF immunity             |
|               |                         | EN61000-4-8 power magnetic immunity |
| Bluetooth     | LISTED                  | B013180                             |
| Environmental | RoHS                    | RoHS compliant                      |

## ORDERING INFORMATION

Table 10 provides ordering information.

**Table 10. Ordering Information**

| Part Number                                                 | Description                                                          |
|-------------------------------------------------------------|----------------------------------------------------------------------|
| RN41-I/RM                                                   | Standard Application firmware (SPP/DUN Master and Slave).            |
| RN41HCI-I/RM                                                | HCI firmware (HCI over H4 UART).                                     |
| RN41U-I/RM                                                  | USB firmware (HCI over USB port, slave device at 12-Mbps rate).      |
| RN41HID-I/RM                                                | HID firmware supporting HID device and SPP profiles.                 |
| RN41N-I/RM                                                  | Standard application firmware (SPP and DUN) without antenna.         |
| RN41NHCI-I/RM                                               | HCI firmware (HCI over H4 UART) without antenna.                     |
| RN41NU-I/RM                                                 | USB firmware (HCI over USB port) without antenna.                    |
| RN41NHID-I/RM                                               | HID firmware supporting HID device and SPP profiles without antenna. |
| For other configurations, contact Roving Networks directly. |                                                                      |

Go to <http://www.rovingnetworks.com> for current pricing and a list of distributors carrying Roving Networks products.

## REVISION HISTORY

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### **Version 3.42r 4/11/2013**

- Updated the module part numbers.

### **Version 3.41r 10/15/2012**

- Updated the GPIO5 status table to correctly show that when GPIO5 is low, it indicates that the module is connected to another device over Bluetooth.

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