



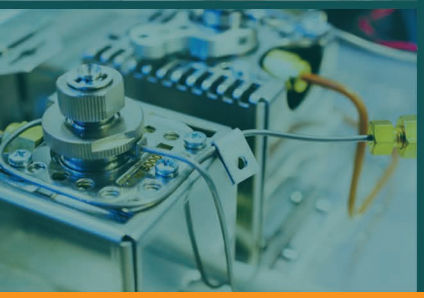


Radiocrafts

Embedded Wireless Solutions

AN020: RF MODULE TROUBLE SHOOTING GUIDE

APPLICATION NOTE

We Make Embedded Wireless
Easy to Use

RF Module Trouble Shooting Guide

Introduction

The purpose of this document is to list some of the most common issues that customers report when using Radiocrafts modules, and the solution to these issues.

The issues covered are:

- "I am not able to get UART communication / module not working"
  - Corrupted configuration memory
  - Module soldering
- "I am experiencing shorter range then expected"
  - Antenna gain transmitter/receiver
  - The environment
  - Noise at the receiver

"I am not able to get UART communication / module not working"

All Radiocrafts modules are verified for UART communication in the final factory test, before shipment to customer. Therefore, even if the issue can often be perceived as the module is failing, this is not normally the case.

Based on experience through our support there are two common failures causing this issue:

- Module configuration memory has been corrupted.
- Module soldering issue on main PCB

To get the best starting point for failure analyses, one important question is this: Did the system work after assembly or not? If it worked after assembly, and stopped working later during the product lifetime, it is most likely the configuration memory that has been mis-configured.

Corrupted configuration memory

The Radiocrafts modules have configuration parameters stored in flash. These parameters are used to configure and set up the module correctly. Among other things, these parameters control the UART setup (baud rate, flow control etc.) and the radio setup (channel, output power etc.).

In configuration mode, these configuration parameters can be changed and this includes writing them to flash memory. Writing to a flash memory page is a process consisting of first erasing and then writing.

- If the module is powered down or loses power during a flash write cycle, the entire page might be just erased and set to 0xFF.
- The RF modules are half-duplex and it is deaf on UART when transmitting on RF.
- If the application processor does not wait for the module to be ready before sending next UART telegram, the UART parsing inside the module might start in the middle of a UART telegram.
- If the first character received on UART is '0x00' the module will enter configuration mode un-intentionally.
- The module will issue '>' on UART, but the application processor might not read this as there was no intention to enter configuration mode.
- UART packets for RF transmission will then be received and interpret at commands in configuration mode. This might end up in changes in configuration memory.

To prevent problems:

- Avoid writing to flash regularly (using 'M' command). Only do this at production test/ first time start-up. Only write when necessary, read and check the values first.
- When writing to flash, be careful not to lose power during this process.
- In operation, be sure to not to write to UART when the module is not ready. This can be achieved through HW UART flow control and following the timing restriction in the Data Sheet / User Manual.
- Monitor the UART data coming from the module (TXD), and if a single '>' is received at a time it is not expected appropriate steps can be taken to get out of configuration mode.

To fix a problem when it has occurred:

- Try to connect to the UART on different data rates. For each different data rate try to connect, reset and try to enter config mode. If '>' is received, then the connection is established.
- When in configuration mode, it is possible to send the @RC command that reset configuration memory to factory default values (check the Used Manual for the specific module type weather @RC command is available).
- When in configuration mode, each memory location can be reset with the 'M' command

Module soldering

LGA packages like the Radiocrafts modules are a commonly used packet type for system-in-package modules that contains many components inside.

But some EMS needs to tune their process in order to get a low yield loss with LGA components. Specifically for hand soldering first prototype series customers sometimes get no connection to some module pins. This can happen also for reflow soldering. In that case, the issue is often related to the footprint, solder paste or silkscreen (area and thickness).

There are several guides for soldering LGA packages that can be used by EMS.

http://www.psemi.com/pdf/app_notes/an61.pdf
http://www.nxp.com/assets/documents/data/en/package-information/AN2920.pdf

To analyse if there is no-connection on a specific pin, one trick is to measure the diode voltage toward ground/VCC with a multimeter. N.B.; the board must have power turned off before doing this test.

If there is connection to the specific module pin, the multimeter will measure the diode voltage drop of the protection diode on a given pin. If there is no connection to this module pin, the multimeter will show "open connection". Note that other components using the same signal line can influence the measurement.

"I am experiencing shorter range then expected"

Range is parameter that is difficult to specify, but sometimes customers are getting significant lower range that should be expected.

The range of a wireless link is given by the following set of parameters

- **Output power at transmitter**
- Antenna gain a transmitter
- The environment between the transmitter and the receiver
- Antenna gain at receiver
- **Sensitivity at receiver**

- Noise at receiver

The **bold** parameters are determined by the RF module, but the other four are controlled by the final application and product design. For simplicity, trouble with the antenna gain of transmitter and receiver is treated as one common issue.

Antenna gain transmitter/receiver

Antenna gain is one of the critical parameters to achieve good range. If there are concerns with the performance of the antenna, the following things can be tested.

- Solder in/connect an external dipole antenna and see if range improve significantly
- If using PCB/wire antenna, try to adjust length up/down and check for improvement Improvement can be monitored by checking RSSI of incoming packets
- If you use a commercial off-the-shelf antenna, verify that you follow the reference design 100%
- If possible, test your EIRP in an anechoic chamber
- In our White Paper WP008 there are more information on optimizing antenna performance

The environment

The physical environment is not something that can be changed. However it is important understand how the environment affects the range and what the expected range will be.

The communication range of RF modules are typically given as line-of-sight (LOS). This means outdoor tests with no objects between the transmitter and receiver. These are the ideal condition for any radio link.

However, for a real world application the physical environment is often indoors, or with obstacles between the transmitter and receiver. This will significantly reduce the range.

- To verify your products communication range, try them outdoors in open field. If the LOS range is good outdoor, that means your product/antenna design is good.

Noise at the receiver

One parameter that is sometimes forgotten is the noise picked up by the receiver. Sensitivity is characterized by only thermal noise at the receiver (as given by the Noise figure), but it real applications the limiting noise might come from other sources. There are two different noise sources that should be considered:

- External noise (environmental noise)
- Internal noise

External noise can be background noise as estimated by ITU (ITU-R P.372-6) or it can be local noise like radiation from your Wi-Fi or PC monitor. To verify if this is an issue, test in different locations can give an answer.

Internal noise is noise generated inside the same product as the module is being used. It can be noise generated by DC/DC converters or noise from the main CPU.

- To check if noise is present, you can measure the noise by measuring the signal level when not receiving a packet. This is normally done with the 'S' command for Radiocrafts modules. To get a good understanding the reading must be done repeatedly to catch burst noise
- Remove the antenna (and ideally terminate the input with a 50 Ohm termination) and measure the RSSI again. If the RSSI value drops, this indicate there is external (or even internal) noise that is picked up by the antenna

- To check for external noise, try measuring range outdoors
- For 2.4 GHz the external noise is less outdoors, while the background noise for 169 MHz might be at the same level as indoors
- To verify if internal noise is present, try to power off the rest of the product and only power on the RF module, connecting the UART to an external development board, and check packet reception

Document Revision History

Document Revision	Changes
1.0	First release
1.1	Design Update

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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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