RF connection with the RFM12B

Get the most from your RFM12b

Summary

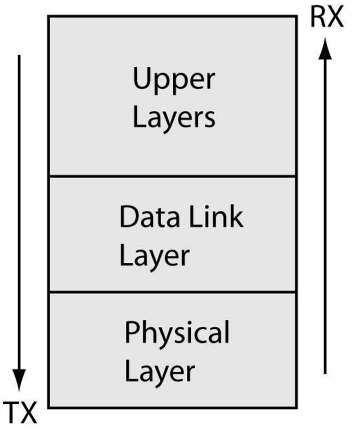
To get the most out of your RF connection with the RFM12b you need to follow some simple guidelines. This document helps you to understand the basics of these modules to get the best results for your RF connection.

The proposed solution herein needs to be read as an example and is in no way a complete guide, nor is it intended to give a definitive solution for every RF connection or system.

Communication model

Start your design with a drawing of your communication model.

The model shows you how to write different parts of the firmware to obtain the best results. In this document we look at two essential parts of the model and show you how to maximize the communication distance and reliability of the RF connection.



Example of a communication model (stack).

Physical layer

The bottom part of our model is mostly made up by the RFM12B module and this is called the physical layer. The register settings in the module determine the basic RF setting for the connection:

- RF frequency
- Data rate
- Bandwidth of the transmitter
- Bandwidth of the receiver
- Transmitter power
- Receiver sensitivity

The most common mistake is to set the data rate and bandwidth too high. This is mainly due to the many examples that are available on the Internet.

The best connection however should be made with a data rate as low as possible and a receiver bandwidth as narrow as possible.

To set this up correctly, you need to know the system requirements. If the requirements are relatively low, or if the payload contains only a few bits, the data rate can be as low as 600 bit/s.

The transmitter bandwidth has a relationship to the chosen data rate. A data rate of 600 bit/s can be send with the lowest transmitter bandwidth possible; 15 kHz.

The TX bandwidth sets the frequency distance between the carrier frequency when sending a ‘1’ and the carrier frequency when sending a ‘0’.

Remember, the modulation of these modules is FSK; Frequency Shift Keying.

The TX bandwidth should only be increased under two conditions:

- When the data rate exceeds half of the transmitter bandwidth.
- When the RF channel is very noisy.

As a rule of thumb you can set the transmitter bandwidth to the first setting above the data rate x2.

The bandwidth of the receiver should be set to a value close to the transmitter bandwidth plus the data rate x2.

Example:

Data rate = 16 kbit/s
TX Bw = 135 kHz.
RX Bw = 200 kHz.

The big advantage of a narrow receiver bandwidth is a good signal to noise ratio from the receiver. A lower receiver bandwidth results in a lower noise floor and thus higher receiver sensitivity.

The example above can be enhanced by lowering the transmitter bandwidth to 45 or 30 kHz and the receiver bandwidth set to 134 or even 67 kHz. You can also use a slightly lower the data rate to optimize even further.

You should allow some time in your project to experiment with these settings to obtain the best results. You should also allow some room for the tolerances between RFM modules.

Data Link Layer

The Data Link Layer is a term used for the first part of the stack that is all in firmware. In this part of the stack you determine how the module should react to data being send and data being received. In this part you switch from technical parameters to more behavioral settings of your RF system.

This is also the part where you transfer the raw data into a payload and subsequently into the RF data packet or frame. For the receiver the layer does the exact opposite to extract (recreate) the raw data.

The reason for making a packet can be found in the behavior of an RF signal in general. An electromagnetic signal contains only 1 channel. There is no easy way to construct a separate channel for the clock. To be able to communicate, you will have to construct the data so the receiver can synchronize with this data (stream) and extract the clock from the data.

The reception of the data depends on the synchronization to the FSK signal by the RF chip. To determine what it needs, we need to look at how the receiver works. In the RF12 chip data sheet (page 1) you can see a functional block diagram.

In the lower left part you can see the connection to the clock oscillator. You can see the output of the oscillator is connected to every other block in the diagram, except the controller. This means the whole system is synchronized by a clock oscillator.

The RF packet should minimal contain the following elements:

- A preamble containing only changes between ‘1’ and ‘0’.
- A SFD (Start Frame Delimiter). For the RFM12B this is fixed to 0x2DD4 or 0xD4 only.
- A payload containing the data with as much transitions between ‘1’ and ‘0’ as possible.

The receiver needs the preamble to synchronize to the data rate of the transmitter. The receivers AGC is set and everything is prepared for the upcoming SFD. We call this bit-synchronization.

The SFD is necessary for the receiver to know when the payload starts. We call this byte-synchronization.

After byte-synchronization the payload is received.

You can add a CRC to the end of the packet to obtain information about the quality of the data. If in the receiver a bit is changed from ‘1’ to ‘0’ or vice-versa during reconstruction by the receiver, the CRC should indicate a faulty payload. With this indication the firmware can act by requesting a new packet or it can discard the packet.

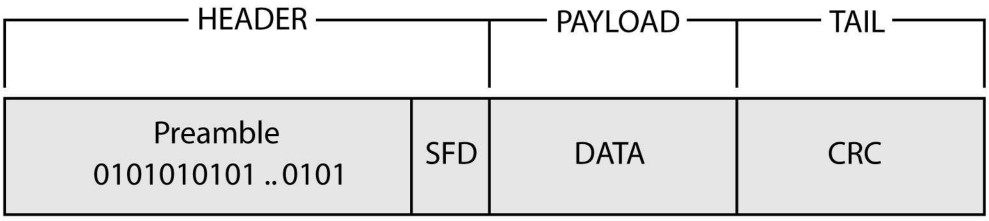
The length of a packet is a trade-off between the length of the payload and the length of the preamble in relation to the chance for disrupting noise on the RF channel.

The longer the preamble, the better the receiver should be able to synchronize. However, the chance of noise or some other signal disrupting the signal also increases. Thus the preamble should be as short as possible, but long enough to do the job. Also the length of the payload should be a short as possible due to the same factor.

To protect the bits in the payload you should consider to encode the data and preferably by a FEC (Foreward Error Correction).

Please refer to our RF optimized Hamming code found on our website for further information about the FEC:

http://www.ideetron.nl/Teasers/3-2_Hamming.pdf



Construction of a data packet.

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