

Simple BLE modem model

BabbleSim 2.4GHz Phy modem model

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Introduction

This [BabbleSim](#) component is a model of a 2.4GHz BLE modem.

It can be used together with the BabbleSim 2.4GHz physical layer (Phy).

Although a very simple model, it includes the typically dominant impairments that affect BLE receptions:

- Thermal noise
- Co-channel interference
- Adjacent channel interference

It also includes a simple RSSI measurement noise model.

Each of this is described below in its own section

This model does not intend to represent any particular receiver architecture, and due to its simplicity, its parameters may be easily adjusted to roughly match the performance of different real modems.

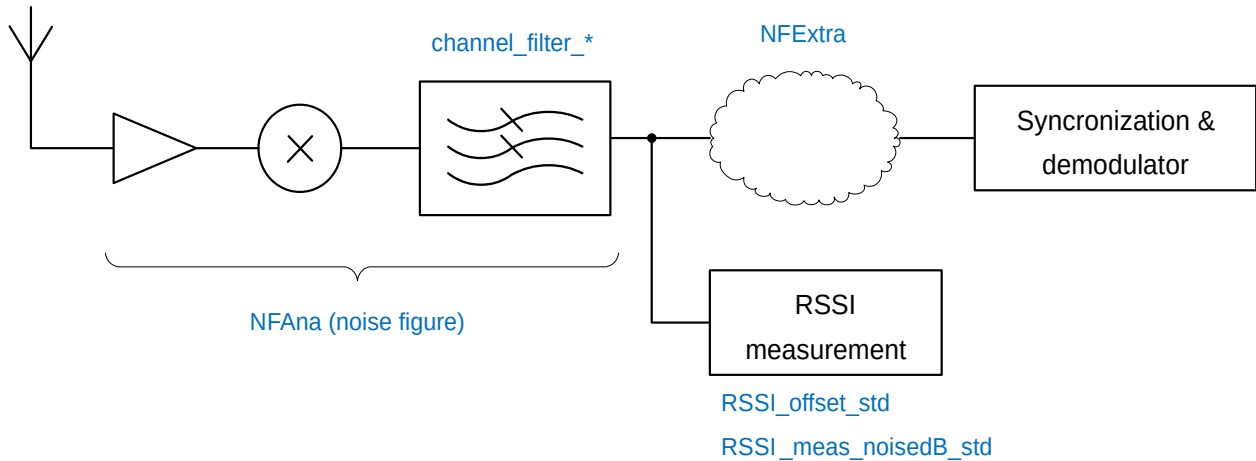


Illustration 1: Model assumed receiver pseudo-architecture and parameters

Thermal noise

The receiver noise performance is modeled with 2 parameters:

- Its noise figure (command line configurable)
- The channel filter noise BW

The noise figure is divided in two parts (NF_{Ana} and NF_{Extra}), to allow for affecting less the RSSI (Received Signal Strength Indication) measurements than the signal to be demodulated.

The channel filter noise bandwidth is dependent on the receiver modulation configuration.

Co-channel and adjacent channel interference

Any non desired signal present at the antenna will be filtered with the receiver channel filter according to its offset from the desired signal.

The total power from these signals will affect both the RSSI measurements and the SNR (Signal to Noise Ratio) in demodulation.

Demodulator

The demodulator will behave like an ideal 2FSK demodulator when receiving a signal with an SNR equal to $\{\text{desired signal power}\} / (\{\text{Thermal noise}\} + \{\text{interference power}\})$, but with a limit to the SNR imposed by the parameter `Nfloor_dig`.

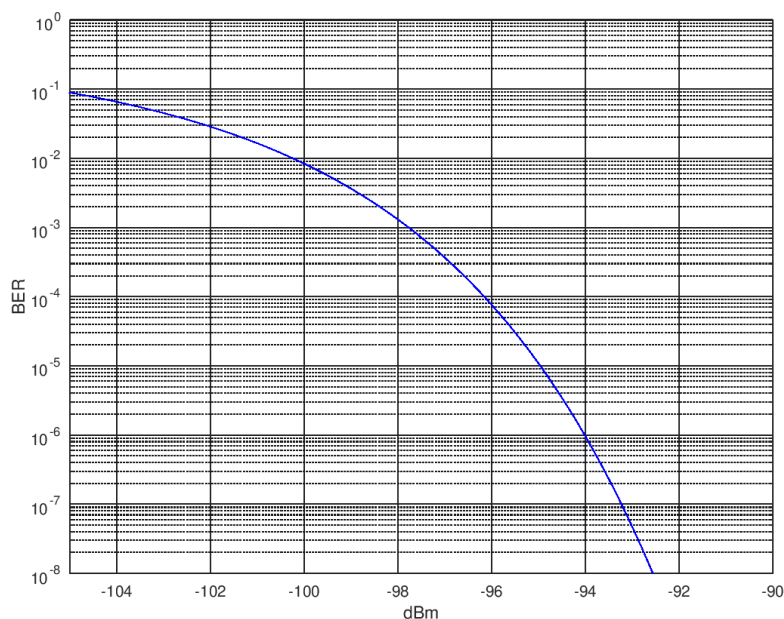


Illustration 2: 1Mbps BLE demodulation performance with the default NF_{Ana}=4dB, NF_{Extra}=2dB, Nfloor=-35dB

Synchronization

No model of synchronization effects is included. But a parameter is provided (PER) to adjust the excess packet error rate due to these effects.

RSSI measurements

A simple model of a device (calibration) power measurement offset is included. This offset is modeled as a normal distribution with average 0, and standard deviation configurable from command line with `RSSI_offset_std`. This offset is drawn for each device during initialization, and is constant during the whole execution and for the whole band.

Also a per-measurement error/noise component is modeled as another normal distribution with average 0 and standard deviation configurable with the command line parameter `RSSI_meas_noisedB_std`