Bluetooth radio and baseband operation: a summary

Bluetooth operates using frequency hopping spread spectrum techniques (FHSS) with Gaussian frequency shift keying (GFSK). The parameters of these techniques are described in more detail below.

For more information please refer to the Radio and Baseband specification chapters of the Bluetooth Core specification at
http://www.bluetooth.com/developer/specification/Bluetooth_11_Specifications_Book.pdf

Bluetooth channel definition

The Bluetooth channel is represented by a pseudo-random hopping sequence hopping through 79 RF channels. The hopping sequence is unique for each piconet (a group of units comprising a master and up to 7 slaves all sharing the same channel) and is determined by the Bluetooth device address of the master; the phase in the hopping sequence is determined by the Bluetooth clock of the master. The channel is divided into time slots where each slot corresponds to an RF hop frequency. Consecutive hops correspond to different RF hop frequencies.

The nominal hop rate is 1600 hops/s. All Bluetooth units participating in the piconet are time- and hop-synchronized to the channel.

Time slots

The channel is divided into time slots, each 625 ms in length. The time slots are numbered according to the Bluetooth clock of the piconet master. The slot numbering ranges from 0 to 2^{27} -1 and is cyclic with a cycle length of 2^{27}.

In the time slots, master and slave can transmit packets.

A time division duplex scheme is used where master and slave alternatively transmit. The master shall start its transmission in even-numbered time slots only, and the slave shall start its transmission in odd-numbered time slots only. The packet start shall be aligned with the slot start.

Packets transmitted by the master or the slave may extend over up to five time slots.

The RF hop frequency shall remain fixed for the duration of the packet. For a single packet, the RF hop frequency to be used is derived from the current Bluetooth clock value. For a multi-slot packet, the RF hop frequency to be used for the entire packet is derived from the Bluetooth clock value in the first slot of the packet. The RF hop frequency in the first slot after a multi-slot packet shall use the frequency as determined by the current Bluetooth clock value. If a packet occupies more than one time slot, the hop frequency applied shall be the hop frequency as applied in the time slot where the packet transmission was started.

Modulation and bit rate

The data transmitted has a symbol rate of 1 Ms/s. A Gaussian-shaped, binary FSK modulation is applied with a BT product of 0.5. A binary one is represented by a positive frequency deviation, a binary zero by a negative frequency deviation. The maximum frequency deviation shall be between 140 kHz and 175 kHz.

Modulation and characteristics

The Modulation is GFSK (Gaussian Frequency Shift Keying) with a BT=0.5. The Modulation index must be between 0.28 and 0.35. A binary one is represented by a positive frequency deviation, and a binary zero is represented by a negative frequency deviation. The symbol timing shall be better than ±20 ppm.

For each transmit channel, the minimum frequency deviation (Fmin = the lesser of {Fmin+, Fmin-}) which corresponds to 1010 sequence shall be no smaller than ±80% of the frequency deviation (fd) which corresponds to a 00001111 sequence.

In addition, the minimum deviation shall never be smaller than 115 kHz.

The zero crossing error is the time difference between the ideal symbol period

and the measured crossing time. This shall be less than ± 1/8 of a symbol period.