IEEE P802.15
Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)	
Title	**Spectral mask for FSK**	
Date Submitted	[May, 2010	
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Re:	[d1P802-15-4g_Draft_Standard.pdf]	
Abstract	[This document describes changes to add an FSK mask to the draft.]	
Purpose	[To resolve comments in LB51.]	
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1. 802.15.1/Bluetooth

802.15.1 uses the following modulation

- GFSK (but no filter specified or tested in compliance)
- BT = 0.5
- 0.28 < modulation index < 0.35, min deviation 115 kHz
- Zero crossing error less than ±1/8 of a symbol period.

The modulation is illustrated in Figure 1.

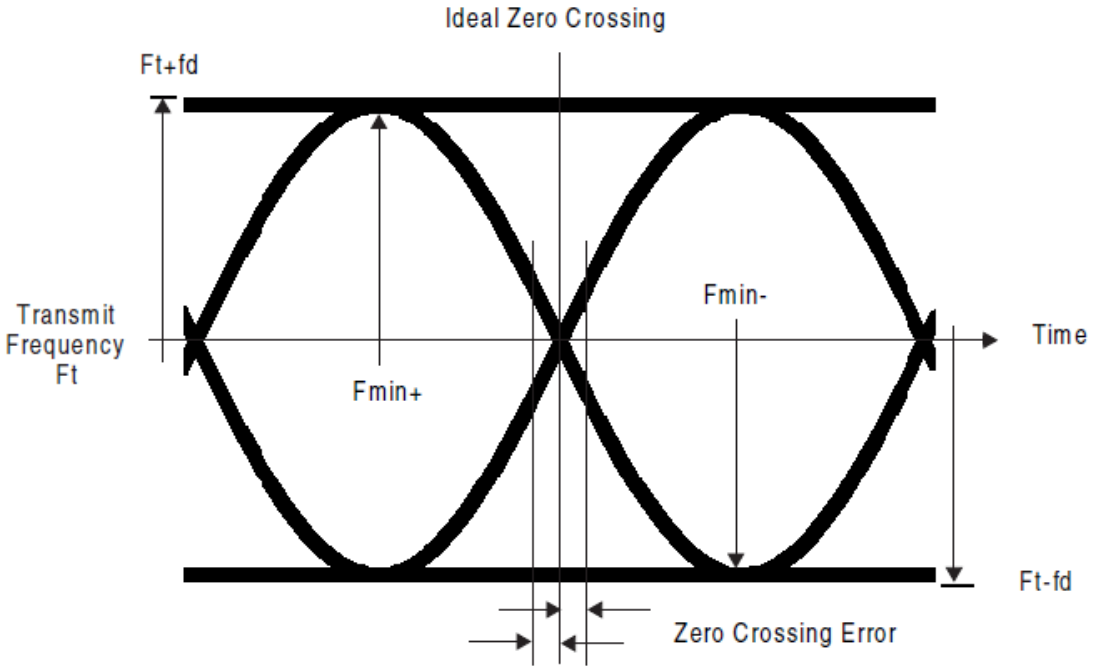

Figure 1—Modulation figure for 802.15.1

The requirement for accuracy is:

"For each transmission, the minimum frequency deviation, F_{min} = min{|F_{min}+|, Fmin–}, which corresponds to 1010 sequence, shall be no smaller than ± 80% of the frequency deviation fd with respect to the transmit frequency Ft, which corresponds to a 00001111 sequence."

The TX mask is defined as follow:

- Adjacent channel power on adjacent channels with a difference in RF channel number of two or greater.
- This adjacent channel power is defined as the sum of the measured power in a 1 MHz RF channel in a 100 kHz bandwidth using maximum hold.
- Device transmits on RF channel M, and the adjacent channel power is measured on RF channel number N.
- The transmitter shall transmit a pseudo-random data pattern in the payload

The requirements are given in Table 1.

Table 1—802.15.1 transmit spectrum mask

Frequency offset	Transmit power
± 500 kHz	–20 dBc (FCC requirement)
2 MHz (|M –N| = 2)	–20 dBm
3 MHz or greater (|M –N| ≥ 3)	–40 dBm
NOTE–If the output power is less than 0 dBm, then, wherever appropriate, the FCC's 20 dB relative requirement overrules the absolute adjacent channel power requirement stated in this table.	

Note that there is no requirement for power in the channel directly adjacent to the RF channel (|M – N| = 1).

2. Suggested text for 802.15.4g

New subclause, add before 6.12a.4 for spectral mask:

6.12a.4 Transmit spectral mask

The transmit power measurement shall use a 1 kHz resolution bandwidth and integrate the power over bandwidth, BW, given in Table 2 centered on the adjacent channel center frequency.

Table 2—Integration bandwidh for channel power measurement

Data rate	Integration BW	Channel spacing
50 kb/s	100 kHz	200 kHz
150 kb/s	225 kHz	400 kHz
200 kb/s	300 kHz	400 kHz

For a given RF transmit channel, M, and an adjacent channel, N, in the regulatory bandwidth, the power in the adjacent channel relative to the power in the RF transmit channel shall be less than the value given in Table 3.

Table 3—802.15.1 transmit spectrum mask

Frequency offset	Adjacent channel power relative to channel poer
|M –N| = 2	–20 dBc
|M –N| ≥ 3	–40 dBc

Combined with the transmit spectrum mask, a clear definition modulation accuracy and symbol timing takes the place of specifying the filter. Neither Guassian FSK or plain FSK is strictly accurate, so instead, use the term filtered FSK (FFSK).

Add a new subclause before 6.12a.4 as shown:

6.12a.5 Modulation

The modulatiion for MR-FSK is filtered frequency shift keying (FFSK) witheither 2 levels (2-FFSK) or 4 levels (4-FFSK). The modulation index for the MR-FSK modes is defined in Table 1a.

The symbols and terms for 2-FFSK signal is illustrated in Figure 2.

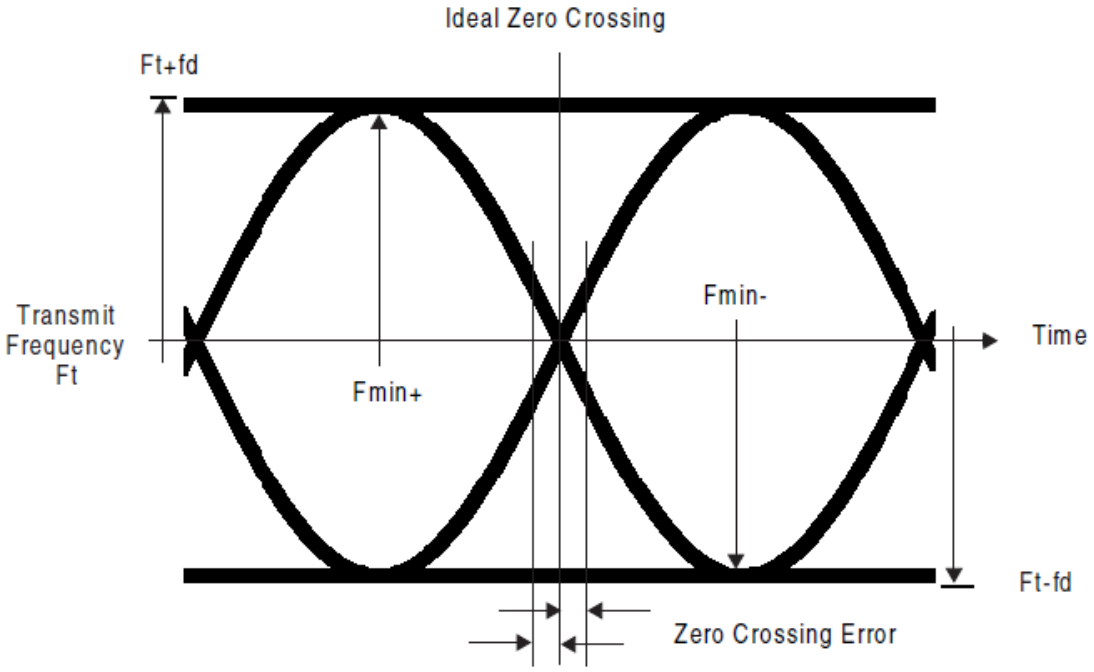

Figure 2—2-FFSK modulation

For 2-FFSK, the error in the modulation, fd, shall be less than ±0.1*(modulation index)*(symbol rate).

The zero crossing error shall be less than ±1/8 of a symbol period.

The symbols and terms for 4-FFSK are illustrated in Figure 3.

For 4-FFSK, the error in the modulation shall be less than ±0.1*(modulation index)*(symbol rate)

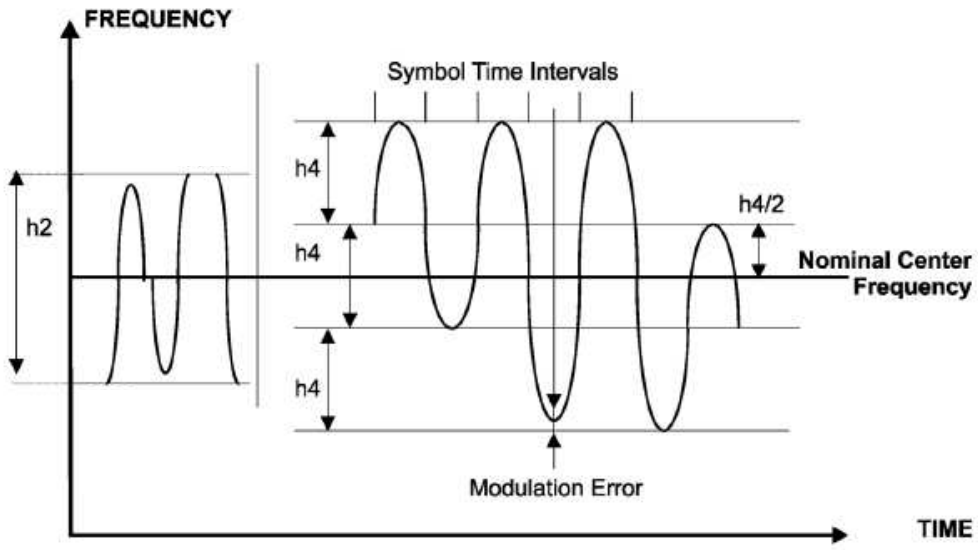

Figure 3—4-FFSK modulation