Project: IEEE P802.15 Interest Group for Wireless Personal Area Networks (WPANs)

Submission Title: PHY requirement considerations for high rate FSK
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Re:

Abstract: Technical considerations for high rate FSK extension to the SUN-FSK PHY

Purpose: To discuss PHY requirements for high rate FSK.

Considerations on rate extension for SUN-FSK PHY

Introduction

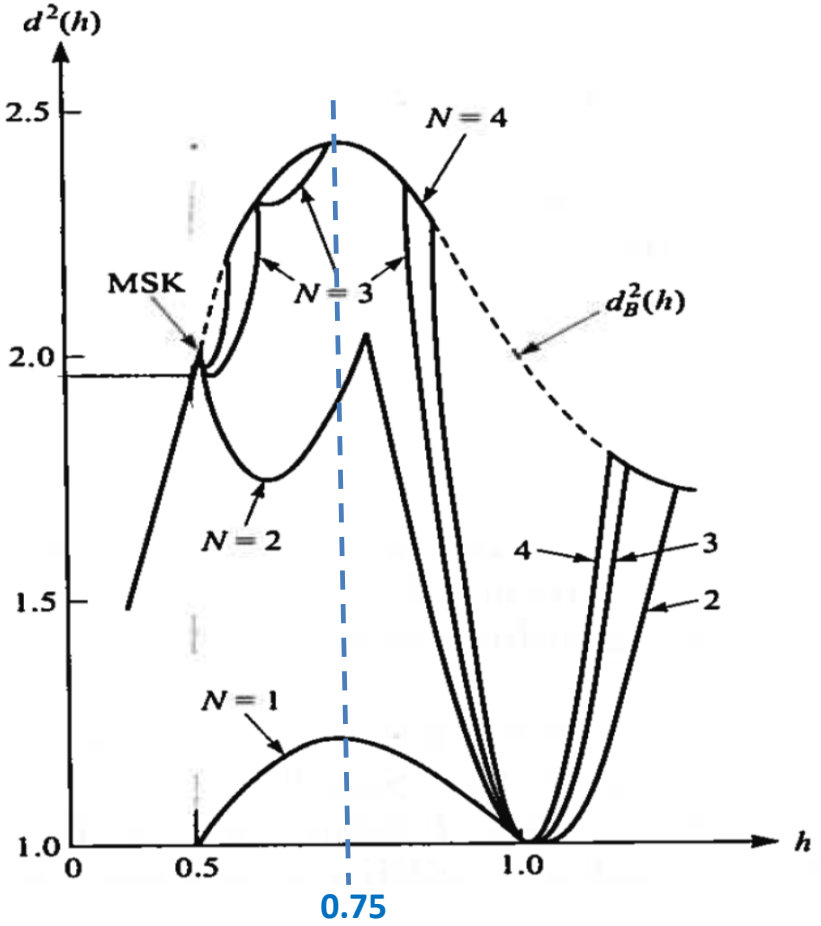
- Higher data rates raises two concerns:

1. The need for small modulation index to comply with bandwidth requirements. This may reduce the receive sensitivity.
2. The higher data rates will also reduce receive sensitivity

- This contribution addresses these concerns.

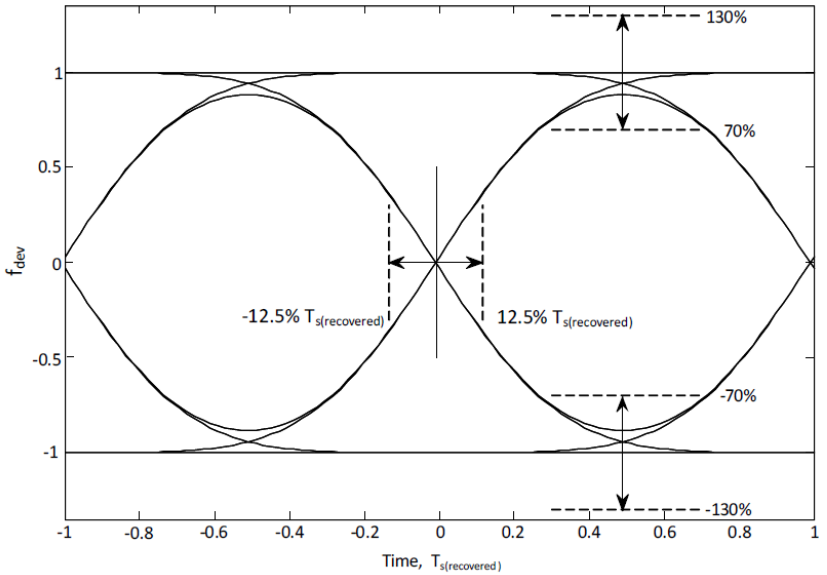
Euclidian distance vs mod-index

- Squared Euclidian distance drops down below h = 0.75 [1]
- This will reduce the RX sensitivity
- Proposed mod index is 0.4 and 0.5 [2]



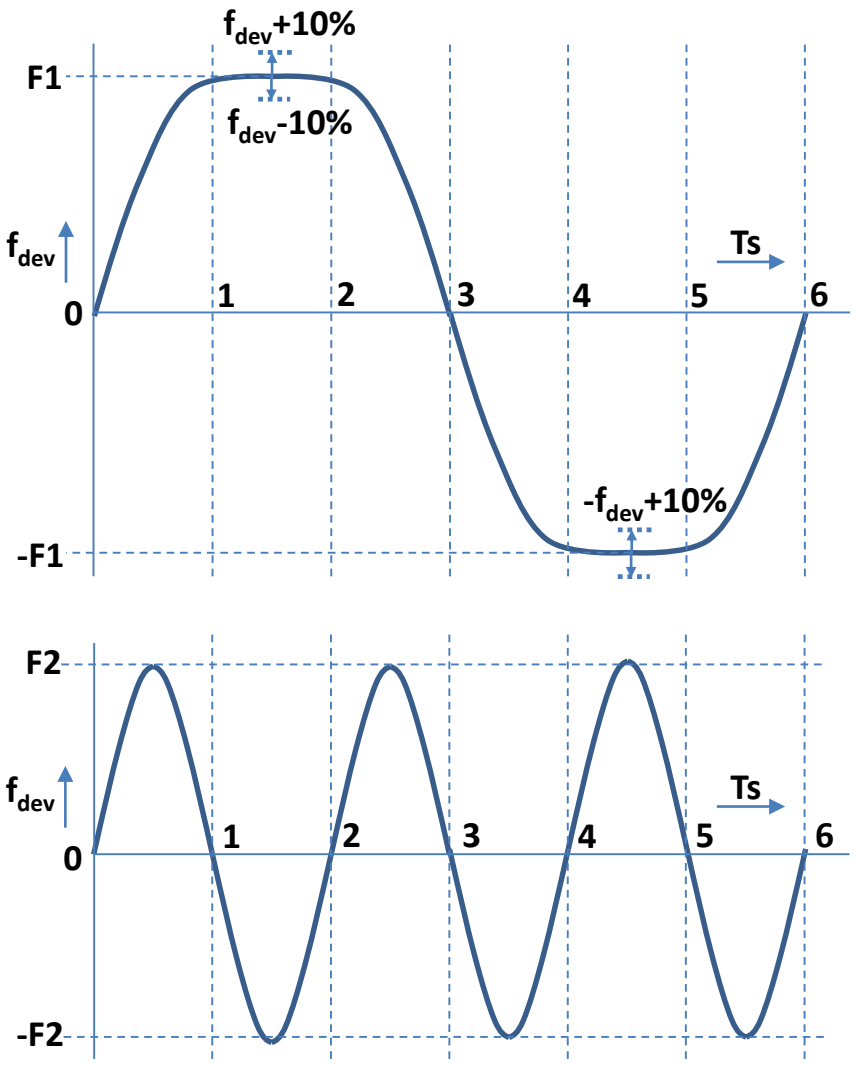
Frequency deviation tolerance

- In 802.15.4-2015 [3] the frequency deviation tolerance spec for 2-FSK is shown here.
- With the current frequency deviation tolerance spec the mod-index can be as low as 0.7 x 0.4 = 0.28. This would lead to a severe sensitivity impact.
- The receiver bandwidth needs to accommodate the 30% over-modulation which also impacts the receive sensitivity.
- A tighter modulation definition would benefit the worst case receive sensitivity.



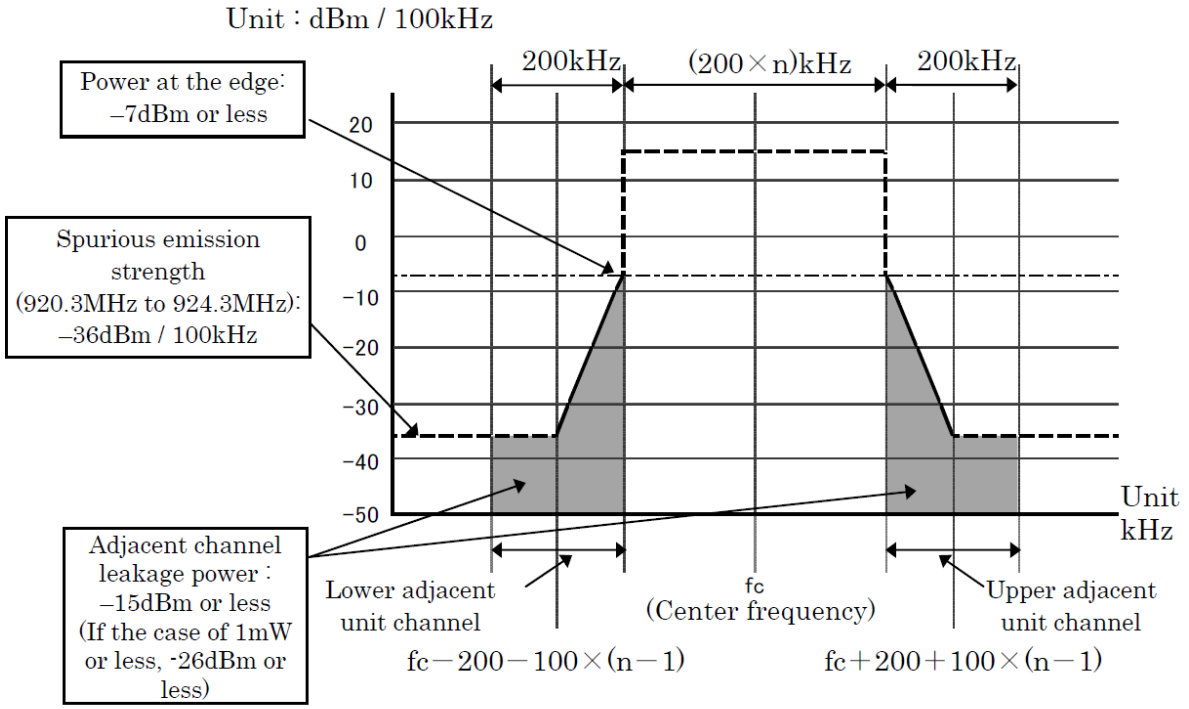
Proposal for modulation quality spec

- Gaussian shaping, BT = 0.5
- Measurement:
- Modulate with 111000111…
- Measure F1 at the center of the 111 and 000 sequence
- Spec:
  - F1 = f_{dev} +/-10%
- Modulate with 101010…
- Measure F2 at the center of a 1 and 0 symbol
- Spec:
  - F2 = (0.88 x F1) +/-10%



Adjacent channel emission requirements

- ARIB STD-T108 [4]
- Wi-SUN specifies 920 to 928 MHz
- Part 2 of STD-T108
- Max power for Part 2 = 20 mW = 13 dBm
- Spurious: “Except for |f-fc| <=(200+100×n) kHz if bandwidth of unit radio channel is 200kHz
- Most stringent channel mask in Part 2 shown



(Note: Center frequency is one of frequencies shown in Table 3.11 to Table 3.15 of 3.2.3 Radio channel and n is a number of unit radio channels constructing a radio channel.)

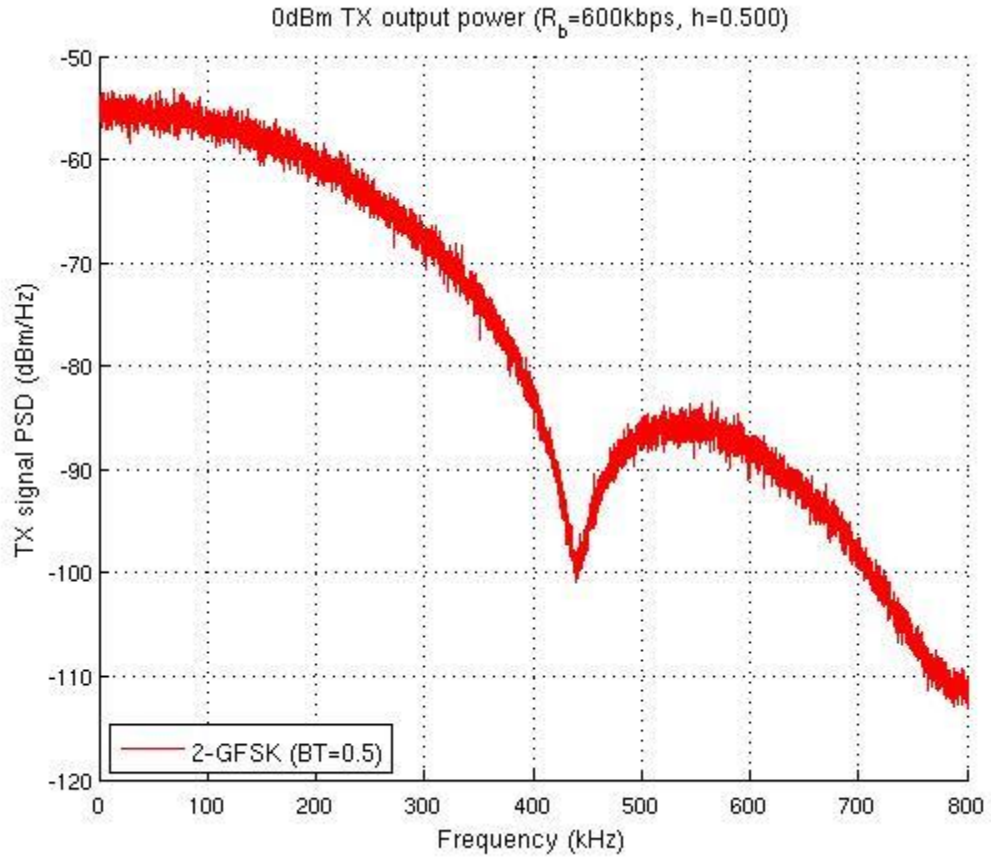
Adjacent Channel Leakage Power (ACLP) and spurious emission strength (SES)

Rb	h	BT	N	ACLP band	ACLP	SES band	SES	ACP@13	SES@13	Pmax
[kbps]				[kHz]	[dB]	[kHz]	[dB]	[dBm]	[dBm]	[dBm]
600	0.4	0.5	3	300-500	-24.64	500-600	-40.24	-11.64	-27.24	4.24
600	0.4	0.5	4	400-600	-36.64	600-700	-44.54	-23.64	-31.54	8.54
600	0.4	0.5	5	500-700	-38.85	700-800	-60.43	-25.85	-47.43	13
600	0.5	0.5	5	500-700	-35.15	700-800	-53.75	-22.15	-40.75	13
							limits	-15	-36	

Notes:

- Above numbers are simulated. Need verification using TELEC-T245 measurement method.
- Higher modulation index is preferred.

PSD for mod-index 0.5



References

[1] Digital Communications by John G. Proakis.

[2] IEEE 802.1-20-0009-02-wng by Harada, Okumura, Kashiwagi, Ikuta, Fukui, Jeng-Shiann and Kuramochi.

[3] IEEE 802.15.4-2015

[4] ARIB STD-T108 “920MHz-Band Telemeter, Telecontrol and Data Transmission Radio Equipment”