

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

Submission Title: [Tensorcom's PHY Proposal]

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Re: [TG6 call for proposals, IEEE P802.15-08-0829-01-0006, December 3, 2008]

Abstract: [Low complexity low power GMSK based dual-mode PHY]

Purpose: [This document is intended as a proposal for addressing the requirements of TG6 standard]

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Narrowband Summary

■ Modulation

➤ 2-GMSK (BT = 0.5, h = 0.5)

- FEC
 - Outer RS(15,13) in $GF(2^4)$
 - Inner CC code, with constraint length 3, rate $\frac{1}{2}$ [5 7]
- Mandatory mode: Payload is spread with Barker code of length 5
- Data is differentially encoded
- Optional Mode: no spreading

➤ Optional 4-GMSK (BT = 0.5, h = 0.25)

- No spreading

➤ Common preamble

- Overall length ~ 896 chips

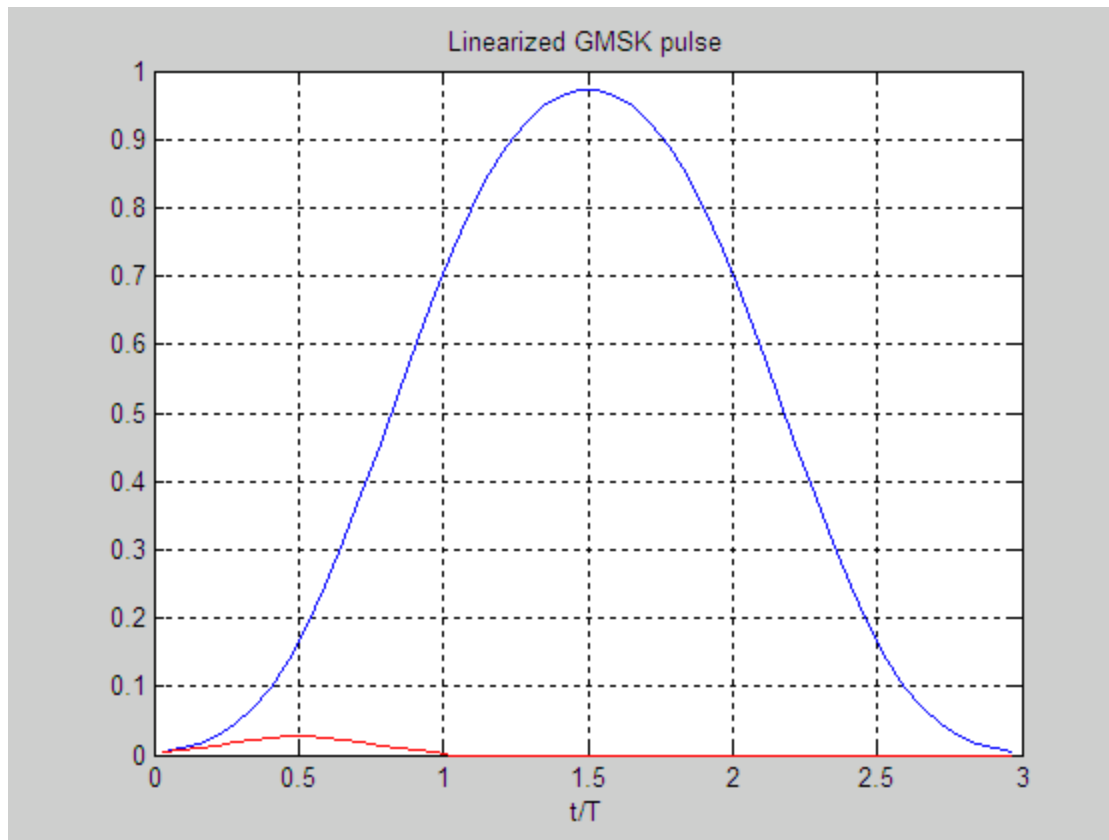
Available Bands

Band	Freq.	Bandwidth	Max. EIRP
MedRadio	401-402 MHz, 405-406 MHz	≤ 100 KHz	-6 dBm
MICS (LBT)*	402-405 MHz	≤ 300 KHz	-10 dBm
ISM	433.5-434.5 MHz	NA	-14.4 dBm
	868-928 MHz	≥ 500 KHz	+30 dBm
	902-928 MHz	≥ 500 KHz	+30 dBm
	2400-2483.5	≥ 500 KHz	+30 dBm
WMTS	608-614 MHz	≥ 1.5 MHz	10.8 dBm
	1395-1400 MHz	NA	22.2 dBm
	1427-1432 MHz	NA	22.2 dBm

* LBT: Listen Before-talk

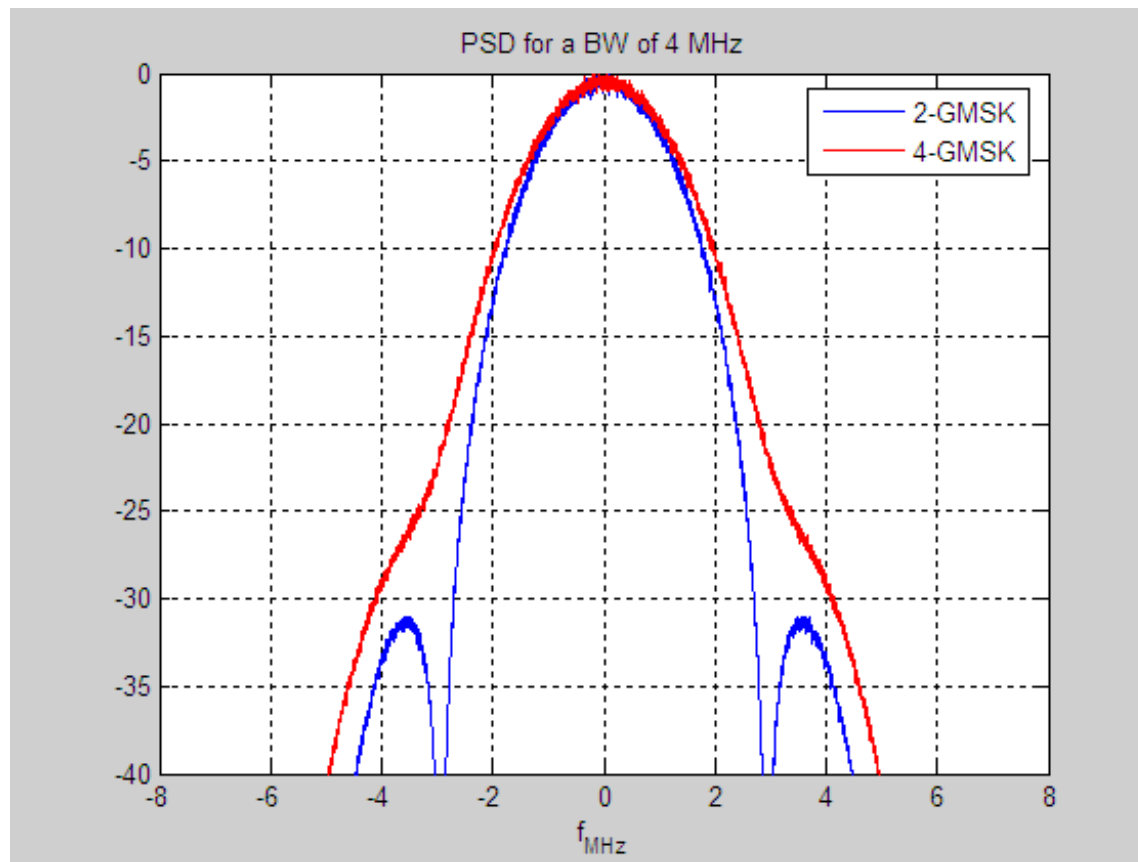
2-GMSK

- 2-GMSK, $BT = 0.5$, modulation index $h = \frac{1}{2}$
↔ $\pi/2$ -BPSK with linearized GMSK pulse



4-GMSK

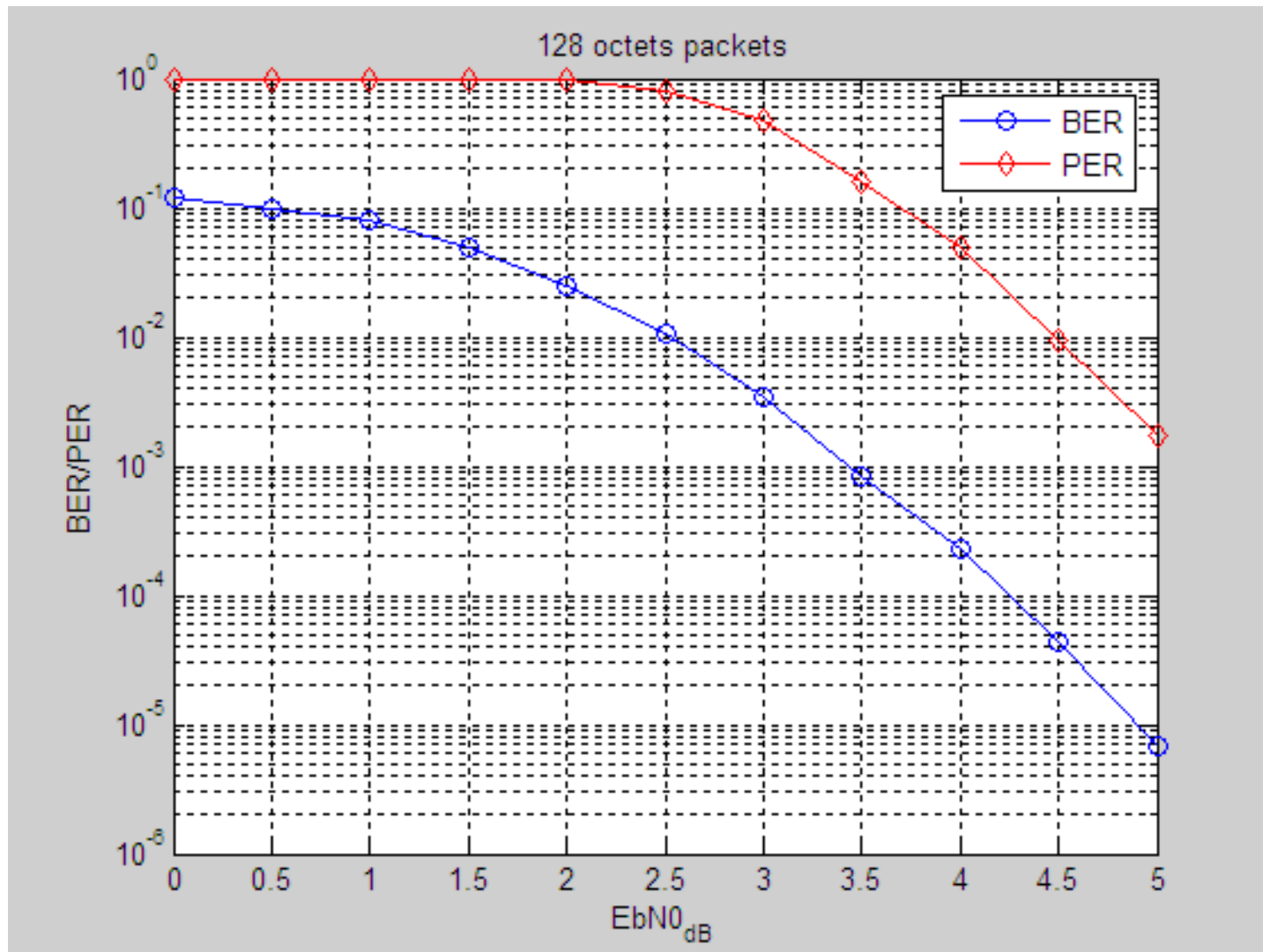
- 4-GMSK, $BT = 0.5$, modulation index $h = 1/4$
↔ $\pi/4$ -PAM with linearized GMSK pulses



GMSK Rx Options

- High performance, fully coherent
- Semi-coherent , symbol differential
- Chip differential
- Support for crystal-less radio in some bands

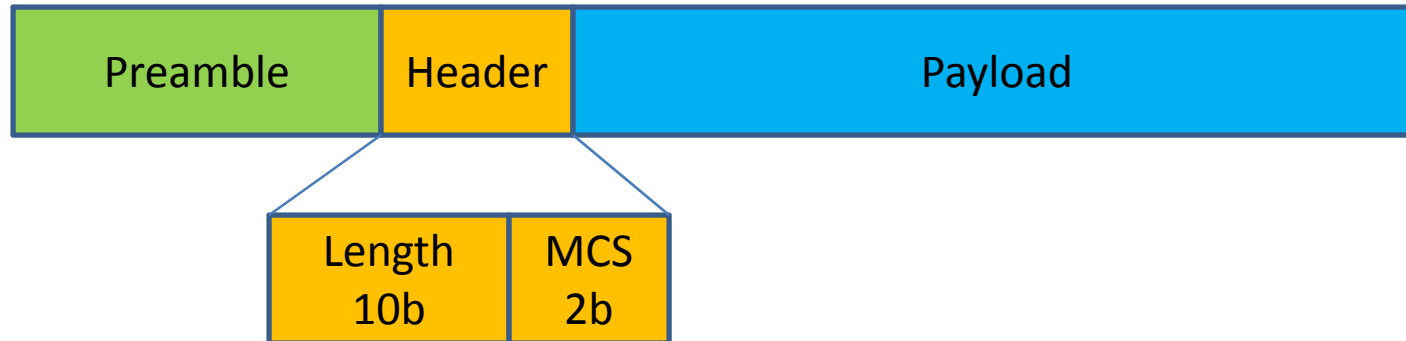
Performance Evaluation (Coherent Demod.)



Example Link Budget

PARAMETERS	value			Unit
Transmitter				
Information Data Rate (Rb)	1.73	0.87	0.17	Mbps
Coding Rate	0.43	0.43	0.43	
Modulation Scheme	4-GMSK	2-GMSK	2-GMSK	
Spreading Gain	1	1	5	
Center Frequency	2.45	2.45	2.45	GHz
Effective Bandwidth (BW)	2.00	2.00	2.00	MHz
Tx Antenna Gain (GT)	0.00	0.00	0.00	dB
Tx Average Power (PT)	0.00	0.00	0.00	dBm
Receiver				
Noise Figure Referred to the Antenna Terminal (NF)	10.0	10.0	10.0	dB
Eb/NO (1% PER)	6.5	5.0	5.0	dB
Implementation Losses	1.5	1.5	1.5	dB
Rx Antenna Gain (GR)	0.0	0.0	0.0	dB
Sensitivity				
Propagation Loss Index	3	3	3	
Path Loss at 1m (L1)	40.23	40.23	40.23	dB
Minimum Rx Sensitivity Level (Smin)	-93.6	-98.1	-105.1	dBm
Shadow Margin + Link Margin (M)	40.0	44.0	52.0	dB
Rx Power Calculations				
Path Loss Ld = PR - (PT + GT + GR + M)	53.61	54.12	53.11	dB
Range d(m)	3	3	3	m

Packet Structure



- Preamble & Header : 2-GMSK
- Shortened RS(5,3) for header, CC is reset after header
- Payload
 - MCS0: 2-GMSK, SF = 7, data rate = $(BW/7) * (1/2) * (13/15)$
 - MCS1: 2-GMSK, SF = 1, data rate = $BW * (1/2) * (13/15)$
 - MCS2: 4-GMSK, SF = 1, data rate = $2 * BW * (1/2) * (13/15)$

Conclusion

- Simple low complexity 2-GSMK based PHY
- Optional 4-GMSK for HR
- Support for multiple transmit and receiver architectures
- Simple modification to current 802.15.4 header

UWB Summary

- BW ~ 1 GHz
- 2-GMSK (BT = 0.5, h = 0.5)
 - FEC: Reed Solomon RS(255,239) + Ham(12,8)
 - MCS0: spreading factor = 16
 - MCS1: spreading factor = 4
 - MCS2: spreading factor = 1
- Block transmission with block length of 256
- Cyclic Golay prefix of length 64

Link Budget

PARAMETERS	value			Unit
Transmitter				
Information Data Rate (Rb)	468.63	234.31	39.05	Mbps
Coding Rate	0.62	0.62	0.62	
Modulation Scheme	2-GMSK	2-GMSK	2-GMSK	
Spreading Gain	1	2	16	
Center Frequency	7.00	7.00	7.00	GHz
Effective Bandwidth (BW)	1000.00	1000.00	1000.00	MHz
Tx Antenna Gain (GT)	0.00	0.00	0.00	dB
Tx Average Power (PT)	-12.10	-12.10	-12.10	dBm
Receiver				
Noise Figure Referred to the Antenna Terminal (NF)	8.0	8.0	8.0	dB
Eb/NO (1% PER)	6.0	6.0	5.0	dB
Implementation Losses	1.5	1.5	1.5	dB
Rx Antenna Gain (GR)	0.0	0.0	0.0	dB
Sensitivity				
Propagation Loss Index	2.5	2.5	2.5	
Path Loss at 1m (L1)	49.34	49.34	49.34	dB
Minimum Rx Sensitivity Level (Smin)	-71.8	-74.8	-83.6	dBm
Shadow Margin + Link Margin (M)	3.0	4.5	10.2	dB
Rx Power Calculations				
Path Loss Ld = PR - (PT + GT + GR + M)	56.69	58.20	61.28	dB
Range d(m)	2.0	2.3	3.0	m