

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

**Submission Title:** [PHY proposal for supporting up to 2.4 Mb/s data rates and long range in 15.4]

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**Source:** [Kunal Shah] Company [Itron]  
[] Company []

**Address** [San Jose, CA]

**Voice:** [], E-Mail:[kunal.shah@itron.com]

**Re:** []

**Abstract:** [PHY proposal for supporting up to 2.4 Mb/s data rates and long range in 15.4]

**Purpose:** [To be considered in the PHY amendment as part of 802.15.4x]

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# Background

- **Scope of the project:**

“This amendment defines enhancements to the IEEE Std 802.15.4 SUN Orthogonal Frequency-Division Multiplexing (OFDM) PHYs enabling the support for data rates up to 2.4Mb/s. This amendment also defines additional channel plans, as needed, to support emerging applications.”

# Purpose and Objective

- Higher data rate support
  - OFDM 800 kbps, 1.2 Mbps, 2.4 Mbps
  - Builds on what is working now
- Longer range modes support
  - SUN-OQPSK rate modes 0-3 at 100 k/chips per second
  - Channel plan is not defined for most market regions including North America
- Specify operational PHY parameters for existing 15.4 regions

# Suggested Updates to SUN OFDM PHY

- 21.3 Data rates for SUN OFDM

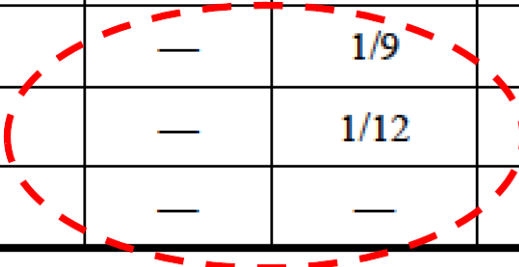
Table 21-9—Data Rates for SUN OFDM PHY

Parameter	OFDM Option 1	OFDM Option 2	OFDM Option 3	OFDM Option 4
Nominal bandwidth (kHz)	1094	552	281	156
Channel spacing (kHz)	1200	800	400	200
DFT size	128	64	32	16
Active tones	104	52	26	14
# Pilot tones	8	4	2	2
# Data tones	96	48	24	12
MCS0 (kb/s) (BPSK rate 1/2 with 4x frequency repetition)	100	50	—	—
MCS1 (kb/s) (BPSK rate 1/2 with 2x frequency repetition)	200	100	50	—
MCS2 (kb/s) (QPSK rate 1/2 and 2x frequency repetition)	400	200	100	50
MCS3 (kb/s) (QPSK rate 1/2)	800	400	200	100
MCS4 (kb/s) (QPSK rate 3/4)	—	600	300	150
MCS5 (kb/s) (16-QAM rate 1/2)	—	800	400	200
MCS6 (kb/s) (16-QAM rate 3/4)	—	—	600	300

# PHY symbol per octet

**Table 21-11—*phySymbolsPerOctet* values for SUN OFDM PHY**

MCS level	OFDM Option			
	1	2	3	4
MCS0 (BPSK 1/2 rate coded and 4x frequency repetition)	2/3	4/3	—	—
MCS1 (BPSK 1/2 rate coded and 2x frequency repetition)	1/3	2/3	4/3	—
MCS2 (QPSK 1/2 rate coded and 2x frequency repetition)	1/6	1/3	2/3	4/3
MCS3 (QPSK 1/2 rate coded)	1/12	1/6	1/3	2/3
MCS4 (QPSK 3/4 rate coded)	—	1/9	2/9	4/9
MCS5 (16-QAM 1/2 rate coded)	—	1/12	1/6	1/3
MCS6 (16-QAM 3/4 rate coded)	—	—	1/9	2/9



# PHY Interleaver

- 21.4.5 Interleaver

**Table 21-12— $N_{cbps}$  for SUN OFDM with *phyOfdmInterleaving* = 0**

MCS level	OFDM Option 1	OFDM Option 2	OFDM Option 3	OFDM Option 4
MCS0	24	12	—	—
MCS1	48	24	12	—
MCS2	96	48	24	12
MCS3	192	96	48	24
MCS4	—	96	48	24
MCS5	—	192	96	48
MCS6	—	—	96	48

# Receiver sensitivity

- 21.5.3 Receiver sensitivity

**Table 21-20—Sensitivity requirements for OFDM options and MCS levels**

	Option 1	Option 2	Option 3	Option 4
MCS0 (BPSK $\frac{1}{2}$ rate coded and 4x frequency repetition)	-103 dBm	-105 dBm	—	—
MCS1 (BPSK $\frac{1}{2}$ rate coded and 2x frequency repetition)	-100 dBm	-103 dBm	-105 dBm	—
MCS2 (QPSK $\frac{1}{2}$ rate coded and 2x frequency repetition)	-97 dBm	-100 dBm	-103 dBm	-105 dBm
MCS3 (QPSK $\frac{1}{2}$ rate coded)	-94 dBm	-97 dBm	-100 dBm	-103 dBm
MCS4 (QPSK $\frac{3}{4}$ rate coded)	—	-94 dBm	-97 dBm	-100 dBm
MCS5 (16-QAM $\frac{1}{2}$ rate coded)	—	-91 dBm	-94 dBm	-97 dBm
MCS6 (16-QAM $\frac{3}{4}$ rate coded)	—	—	-91 dBm	-94 dBm

# Suggested Updates to SUN O-QPSK PHY

- Addition of SUN-OQPSK rate modes 0-3 at 100 k/chips per second
- 22.3.2 SHR coding and spreading
- 22.3.3 PHR coding and spreading
- 22.3.4 PSDU coding and spreading for DSSS
- 22.3.5 PSDU coding and spreading for MDSSS

902-928	1000	0	yes	(16,1) <sub>0/1</sub> -DSSS	yes	31.25
		1	no	(16,4)-DSSS	yes	125
		2	no	(8,4)-DSSS	yes	250
		3	no	none	yes	500



# Suggested Updates to SUN O-QPSK PHY

- 22.3.12 Pilot insertion
- 22.5.3 Receiver sensitivity

**Table 22-21—Required receiver sensitivity for spreading mode DSSS [dBm]**

Frequency band (MHz)	Rate mode			
	0	1	2	3
470–510	–110	–105	–100	–95
779–787	–105	–100	–95	–90
868–870	–110	–105	–100	–95
902–928	–105	–100	–95	–90
917–923.5	–105	–100	–95	–90
920–928	–110	–105	–100	–95
2400–2483.5	–105	–100	–95	–90

# Channel Numbering for SUN OQPSK PHY

- Channel number for 100 kchips/sec need to be included in the table below

902-928	SUN FSK operating mode #1	0.2	129	902.2
	SUN FSK operating mode #2 & #3	0.4	64	902.4
	OFDM Option4	0.2	129	902.2
	OFDM Option3	0.4	64	902.4
	OFDM Option2	0.8	31	902.8
	OFDM Option1	1.2	20	903.2
	O-QPSK	2	12	904