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

Submission Title: Clarification on sensitivity definitions in SUN PHYs

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Abstract: Clarification on sensitivity for SG Next Gen SUN PHYs

Purpose: Discussion

Introduction:

- SG Next Gen SUN PHYs is considering to reuse the sensitivity conditions as per other SUN PHYs already specified. This contribution is attempting to clarify the current conditions.

802.15.4-2020 – Sensitivity conditions (10.1.8):

Table 10-24—Receiver sensitivity conditions

Term	Definition of term	Conditions
Packet error rate (PER)	Average fraction of transmitted packets that are not correctly received.	Average measured over random PSDU data.
Receiver sensitivity	Lowest input power for which the PER conditions are met.	PSDU length = 250 octets for SUN PHYs with data rates 50 kb/s and greater, 20 octets for all other PHYs. PER < 10% for SUN PHYs. PER < 1% for all other PHYs. Power measured at antenna terminals with interference not present.

802.15.4-2020 – SUN FSK (1):

19.6.7 Receiver sensitivity

The SUN FSK receiver sensitivity shall be better than S, where S, for binary modulation, is defined as follows:

$$S = \left(S_0 + 10\log\left[\frac{R}{R_0}\right]\right) \text{dBm}$$

where

S_0	is –91 without FEC and –97 with FEC
R_0	is 50 kb/s
R	is the bit rate, in kb/s

See 10.1.8 for additional information on receiver sensitivity.

802.15.4-2020 – SUN FSK (2):

Table 19-7—SUN FSK modulation and channel parameters[a] *(continued)*

Band designation (MHz)	Parameter	Operating mode #1	Operating mode #2	Operating mode #3
901	Data rate (kb/s)	10	20	40
	Modulation	2-FSK	2-FSK	2-FSK
	Modulation index	0.5	0.5	0.5
	Channel spacing (kHz)	12.5	12.5	12.5
915	Data rate (kb/s)	50	150	200
	Modulation	2-FSK	2-FSK	2-FSK
	Modulation index	1.0	0.5	0.5
	Channel spacing (kHz)	200	400	400
917	Data rate (kb/s)	50	150	200
	Modulation	2-FSK	2-FSK	2-FSK
	Modulation index	1.0	0.5	0.5
	Channel spacing (kHz)	200	400	400
928[b]	Data rate (kb/s)	10	20	40
	Modulation	2-FSK	2-FSK	2-FSK
	Modulation index	0.5	0.5	0.5
	Channel spacing (kHz)	25	25	25
1427[b]	Data rate (kb/s)	10	20	40
	Modulation	2-FSK	2-FSK	2-FSK
	Modulation index	0.5	0.5	0.5
	Channel spacing (kHz)	25	25	25
2450	Data rate (kb/s)	50	150	200
	Modulation	2-FSK	2-FSK	2-FSK
	Modulation index	1.0	0.5	0.5
	Channel spacing (kHz)	200	400	400

[a]Data rates shown are over-the-air data rates (the data rate transmitted over the air regardless of whether the FEC is enabled).
[b]Noncontiguous.

Data rates are specified at: over-the-air rate

Change in new revision:

- A comment in 4me was submitted to address the ambiguity in the sensitivity definition for SUN FSK (r2-66):

Comment	Proposed resolution
"bit rate" is not defined in clause 20.	Change "bit rate" to "data rate". This would make it consistent with Table 20-8 and to the footnote under Table 20-8, where is says "Data rates shown are over-the-air data rates (the data rate transmitted over the air regardless of wether FEC is enabled).

Comment was accepted by TG4me

Change in draft revision (4me):

- See P802-15-04meCMPD02D03:

20.6.7 Receiver sensitivity

The SUN FSK receiver sensitivity shall be better than S, where S, for binary modulation, is defined as follows:

~~$S = \left(S_0 + 10\log\left[\frac{R}{R_0}\right]\right)$~~ $S = \left(S_0 + 10\log\left[\frac{R}{R_0}\right]\right)$ dBm

where

S_0	is –91 without FEC and –97 with FEC
R_0	is 50 kb/s
R	is the ~~bit~~ data rate, in kb/s

See 11.1.8 for additional information on receiver sensitivity.

802.15.4-2020 – SUN OFDM (1):

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

MCS Level	Description	Option 1	Option 2	Option 3	Option 4
0	BPSK ½ rate coded and 4x frequency repetition	–103 dBm	–105 dBm	–108 dBm	–111 dBm
1	BPSK ½ rate coded and 2x frequency repetition	–100 dBm	–103 dBm	–105 dBm	–108 dBm
2	QPSK ½ rate coded and 2x frequency repetition	–97 dBm	–100 dBm	–103 dBm	–105 dBm
3	QPSK ½ rate coded	–94 dBm	–97 dBm	–100 dBm	–103 dBm
4	QPSK ¾ rate coded	–91 dBm	–94 dBm	–97 dBm	–100 dBm
5	16-QAM ½ rate coded	–88 dBm	–91 dBm	–94 dBm	–97 dBm
6	16-QAM ¾ rate coded	–85 dBm	–88 dBm	–91 dBm	–94 dBm

802.15.4-2020 – SUN OFDM (2):

Table 21-10—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	25	12.5
MCS1 (kb/s) (BPSK rate 1/2 with 2x frequency repetition)	200	100	50	25
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)	1200	600	300	150
MCS5 (kb/s) (16-QAM rate 1/2)	1600	800	400	200
MCS6 (kb/s) (16-QAM rate 3/4)	2400	1200	600	300

Data rates are specified at:
PHY in/PHY out

802.15.4-2020 – SUN O-QPSK (1):

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

Band designation (MHz)	Chip rate (kchip/s)	Rate mode			
		0	1	2	3
866	100	–110	–105	–100	–95
867	100	–110	–105	–100	–95
868	100	–110	–105	–100	–95
870	100	–110	–105	–100	–95
915	100	–110	–105	–100	–95
	1000	–105	–100	–95	–90
915-a	100	–110	–105	–100	–95
	1000	–105	–100	–95	–90
915-b	100	–110	–105	–100	–95
	1000	–105	–100	–95	–90
915-c	100	–110	–105	–100	–95
	1000	–105	–100	–95	–90
915-d	100	–110	–105	–100	–95
915-e	100	–110	–105	–100	–95
917	100	–110	–105	–100	–95
	1000	–105	–100	–95	–90
919	100	–110	–105	–100	–95
920	100	–110	–105	–100	–95
920-a	100	–110	–105	–100	–95
920-b	100	–110	–105	–100	–95
2450	2000	–105	–100	–95	–90

802.15.4-2020 – SUN O-QPSK (2):

Table 22-4—PSDU parameters for spreading mode DSSS

Band designation (MHz)	Chip rate (kchip/s)	Rate mode	BDE	Spreading mode	rate ½ FEC + interleaver	Data rate (kb/s)
470	100	0	yes	$(8,1)_{0/1}$-DSSS	yes	6.25
		1	yes	(4,1)-DSSS	yes	12.5
		2	yes	(2,1)-DSSS	yes	25
		3	no	none	yes	50
779	100	0	yes	$(8,1)_{0/1}$-DSSS	yes	6.25
		1	yes	(4,1)-DSSS	yes	12.5
		2	yes	(2,1)-DSSS	yes	25
		3	no	none	yes	50
	1000	0	yes	$(16,1)_{0/1}$-DSSS	yes	31.25
		1	no	(16,4)-DSSS	yes	125
		2	no	(8,4)-DSSS	yes	250
		3	no	none	yes	500

Data rates are specified at:
PHY in/PHY out