

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

**Submission Title:** Impact of power spectral density limit in TVWS

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**Re:** Call for Contribution (IEEE802.15.4m)

**Abstract:** This contribution discusses an impact of power spectral density limit in TV white space for consideration of the technical guidance document.

**Purpose:** Technical Contribution for discussion in IEEE802.15.4m

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# Introduction

- This contribution discusses the issue on power spectral density (PSD) limits in TV whitespace (TVWS).
- Some numerical examples and observations are provided for different signaling potentially considered in TG4m for further discussion.

# PSD limit in TVWS (FCC Second MO&O [1])

- Paragraph 70:
  - The Commission did not specify minimum bandwidth limits for transmissions by TV bands devices or power spectral density (PSD) limits in the *Second Report and Order*.
- Paragraph 83 (summary):
  - PSD limit on the maximum permissible conducted output power spread across a transmit bandwidth of the full bandwidth of a TV channel.
  - The resulting PSD limits per 100 kHz bandwidth:
    - 16.7 mW (12.2 dBm) for fixed devices
    - **1.67 mW (2.2 dBm) for personal/portable devices**
    - 0.83 mW (-0.8 dBm) for sensing-only personal/portable devices
    - 0.7 mW (-1.8 dBm) for personal/portable devices operating adjacent to occupied channels.

# Ofcom Draft regulatory requirements for White Space Devices (WSD)

- Paragraphs 3.19.1 – 3.19.3 (summary)
  - Maximum permitted EIRP spectral density is specified in units of dBm/(0.2MHz), both for master and slave WSDs.
  - The number of EIRP spectral density limit has not been specified yet.

## Numerical Examples (FSK)

- Available power for transmission per user is calculated based on PSD limit in the FCC 2<sup>nd</sup> MO&O.
- Modulation parameter of the FSK is the same as in Table 120 of Ref. [4],.
- Table 1 shows an approximate power limit per user of different FSK signals.

Table 1 Approximate power limit of FSK signals

Parameters	Case 1	Case 2	Case 3
Data rate [kbps]	50	200	400
Modulation	2FSK	2FSK	4FSK
Modulation Index	1.0	1.0	<b>0.33</b>
Channel spacing[kHz]	200	600	600
Power limit (EIRP) (Portable)	<0.835mW (< -0.78dBm)	<3.3mW (5.23dBm)	<3.3mW (5.23dBm)

# Numerical Examples (OFDM)

- Available power for transmission per user is calculated based on PSD limit in the FCC 2nd MO&O.
- Modulation parameters of the OFDM signals are the same as in Ref. [5].
- Table 2 shows an approximate power limit per user of different FSK signals.

Table 2 Approximate power limit of OFDM signals

Parameters	Option1	Option2	Option3	Option4
Bandwidth[kHz]	1094	552	281	156
Channel spacing[kHz]	1200	800	400	200
FFT size( $N_{FFT}$ )	128	64	32	16
# of active tones	104	52	26	14
Power limit(EIRP) (Portable)	18.2mW (12.62dBm)	9.2mW (9.64dBm)	4.6mW (6.71dBm)	2.6mW (4.15dBm)

# Observations

- PSD limit makes a significant impact to the signal power in the use of TVWS, therefore careful design of system parameters is recommended.
- Available transmission power of FSK signal is limited though it is easier to comply with the out-of-band emission limit.
- OFDM signals seem easier to have more transmission power, however, out-of-band emission limit may become the problem in the case of small FFT size.
- Since different signaling choices are available in TG4m according to different use cases, it is necessary to take care of both PSD limit and out-of-band emission limit in TVWS.

## References

1. TG4m Technical Guidance Document, Doc. IEEE 802.15-11-0684-09-004m, Mar. 2012
2. FCC Second MO&O, FCC-10-174, Sep. 2010.
3. Ofcom, Draft regulatory requirements for white space devices in the UHF TV band, Feb. 2012
4. IEEE draft std. 802.15.4g/D7, 2011
5. S. Sasaki, T. Inoko, and Y. Fukaishi, Doc. IEEE 802.15-12-0061-01-004m, Jan. 2012