**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | **Discussion on Flicker Mitigation and Dimming methods** |
| Date Submitted | [July 2017] |
| Source | Trang Nguyen, and Yeong Min Jang (Kookmin University) |
| Re: | D3 comments and resolutions |
| Abstract | Dimming methods for OCC, Revision of 8.5.2.4 Dimming during data transmission. |
| Purpose | D3 comments and resolution |
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# **B. (Informative) Summary of Dimming methods**

The dimming methods are applied to individual PHY operating modes as descried as follows:

1. **Dimming method 1** (Compensation symbol insertion) shall be applied for PHY-I OOK and PHY-V MPM.
2. **Dimming method 2** (Pulse width modulation) shall be applied for PHY-II VPPM; PHY-IV UFSOOK, Twinkle VPPM, and HS-PSK; PHY-V MPM, RS-FSK, and CM-FSK.
3. **Dimming method 3** (Amplitude modulation) shall be applied for PHY-III CSK; PHY-IV S2-PSK, Twinkle VPPM, and HS-PSK; PHY-V C-OOK.

Table 1 summaries the selection of dimming methods for PHY operating modes.

**Table 1- Choice of Dimming methods for PHY operating modes**

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| **Mode** | **Selection of dimming method** | **Remark** |
| **PHY I, II, III** | | |
| OOK | Compensation insertion dimming | Method 1 |
| VPPM | PWM dimming | Method 2 |
| CSK | AM dimming | Method 3 |
| **PHY IV** | | |
| UFSOOK | PWM dimming | Method 2 |
| S2-PSK | AM dimming | Method 3 |
| Twinkle VPPM | PWM dimming/ AM dimming | Method 2/ hybrid method |
| HS-PSK | PWM dimming/ AM dimming |
| Offset-VPPM | Not supported | Flicker mode |
| **PHY V** | | |
| RS-FSK | PWM dimming | Method 2 |
| CM-FSK | PWM dimming |
| C-OOK | AM dimming | Method 3 |
| MPM | PWM dimming/  Compensation insertion dimming  AM dimming | Method 2/  Method 1/  Method 3 |
| **PHY VI** | | |
| A-QL | Not supported | Screen modulation modes operate at optical clock rates below the flicker-limit. |
| HA-QL | Not supported |
| VTASC | Not supported |
| Invisible data embedded display | Not supported |

# **C. Proposed changes on 8.5.2.4**

**8.5.2.4 PHY IV dimming**

**8.5.2.4.1 UFSOOK dimming (no change)**

**8.5.2.4.2 Offset VPWM dimming**

Offset VPWM is flicker, and dimming is not supported.

**8.5.2.4.3 S2-PSK dimming**

S2-PSK dimming is achieved by amplitude modulation as described in the sub-clause **“4.4.3.2.3 dimming by controlling pulse amplitude (AM)”**

The configuration of dimming level for S2-PSK shall be implemented over the PHY PIB attribute *phyOccDim*.

**8.5.2.4.4 HS-PSK dimming**

HS-PSK is a hybrid modulation method, it may implement both PWM dimming and AM dimming as a hybrid dimming.

The selection of the low dimming level and the high dimming level for DS8-PSK shall output the desired

dimming level as following:

Output dimming level = ½ (low dimmed level + high dimmed level)

Thus, both low dimming level and high dimming level can control the desired output level of dimming. The configuration of desired dimming level is performed over either the low dimming level (via the PHY PIB attribute *phyHSpskLowDim*) or the high dimming level (via the PHY PIB attribute *phyHSpskHighDim*) or

both.

**8.5.2.5 PHY V dimming**

**8.5.2.5.1 Twinkle VPPM (no change)**

**8.5.2.5.2 RS-FSK dimming**

RS-FSK dimming is achieved by controlling the pulse width as described in the sub-clause **“4.4.3.2.2 dimming by controlling pulse width (PWM)”.**

The configuration of RS-FSK dimming level shall be implemented via the PHY PIB*phyOccDim.*

**8.5.2.5.2 CM-FSK dimming**

CM-FSK and RS-FSK both implement the FSK waveform, thus CM-FSK dimming is achieved by the same manner as RS-FSK.

**8.5.2.5.3 C-OOK dimming**

The preamble symbol and data symbols are all symmetric symbols, and the average brightness of those is constant at 50%. The optical clock rate is also constant at a considerable low frequency, 2.2kHz or 4.4kHz.

C-OOK PHY modes achieve dimming by controlling the amplitude of either ones or zeros or both in OOK signal. The configuration of ones' amplitude generates the average brightness output at the dimmed level (<50%). Meanwhile, the configuration of zeros' amplitude achieves the average brightness output at the bright level (>50%). The achieved dimming level is the average brightness of one and zero.

**8.5.2.6 PHY VI dimming**

PHY VI modes operates with flicker, and dimming is not supported.