**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **SNUST - Offset-VPWM PHY Layer Operating Modes and Specifications Revision** | |
| Date Submitted | January, 2017 | |
| Source | Jaesang Cha, Kim Chan (SNUST), Chunseop Kim (QUBER Co., Ltd), Kirhyong Kim (Seil Technologies), Vinayagam Mariappan (SNUST) | Voice: [ ] Fax: [ ] E-mail: [chajs@seoultech.ac.kr] |
| Re: | Draft D1 Comment Resolution based Offset-VPWM PHY Layer Operating Modes and Specifications Revision | |
| Abstract | Details of Resolutions regarding to the submitted Comments on D1 are suggested for Offset-VPWM PHY Layer Operating Modes and PHY Specifications. The Flash Light designed to support LBS, Authentication, IoT/IoL, etc. | |
| Purpose | D1 Comments Resolutions and Editorial Revision. | |
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# **1. PHY LAYER OPERATING MODES FOR OFFSET-VPWM**

# **Operating Modes**

The Offset Variable Pulse Width Modulation for Smart Device Flash Light uses the PHY IV – Singular Point Source /Surface Light Source.

The PHY IV Operating Modes system specifications are given in Table 79. The additional PHY Operating Modes by Offset Variable Pulse Width Modulation for Smart Device Flash Light is presented the Table 79 – PHY IV Operating Modes (continued).

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| --- | --- | --- | --- | --- | --- |
| **PHY Operating Modes** | | | | | |
| **Modulation** | **RLL Code** | **Optical Clock Rate** | **FEC** | | **Data Rate** |
| **Outer Code (RS)** | **Inner Code (CC)** |
| OffsetVPWM | None | 25Hz | None | None | 18 bps |
| OffsetVPWM | None | 25Hz | RS(15,2) | CC(1/4) /CC(1/3) /CC(2/3) | 12 bps |
| OffsetVPWM | None | 25Hz | RS(15,4) | CC(1/4) / CC(1/3)/CC(2/3) | 10 bps |

**Table 79 – PHY IV Operating Modes (continued for offset-VPWM)**

# **2. PHY SPECIFICATIONS FOR OFFSET-VPWM**

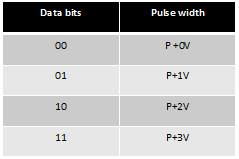
# **13.5 Offset-VPWM**

The Offset-VPWM PHY supported data rates and operating conditions is shown in Table 79 – PHY IV Operating Modes (continued) for Offset Variable Pulse Width Modulation for Smart Device Flash Light data transmission.

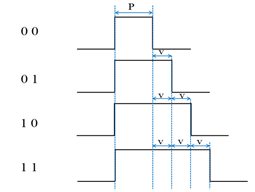
The proposed Offset-VPWM (Variable Pulse Width Modulation) designed with following characteristics,

* Modulation methods includes line coding
* Defining the sum (P + nV) of the unit to be added to the minimum pulse (P) which is a reference pulse width (V) as a Symbol ( P>>V, V>time error(jitter) )
* Can specify a 2bit data symbol, 4bit data symbol according to number of added pulse
* Data is expressed with offset pulse width, 2bits data(for example) were mapped into 4 Offset-VPWM symbols

The data symbol map for two bits symbol with pulse width and respective symbol blinking waveform are shown in Table 2-1 and Figure 2-1 respectively.

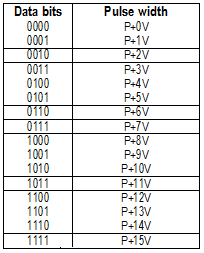


**Table 2-1 – Two Bits Symbol Mapping Truth Table**

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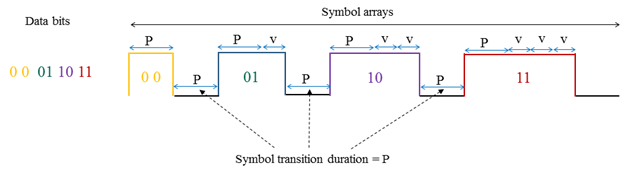
**Figure 2-1 – Two Bit Symbol Data Diagram**

In offset-VPWM, the data is expressed with offset pulse width, 4bits data (for example) were mapped into 16 Offset-VPWM symbols. The 4 bits symbol mapping truth table is shown in Table 2-2.



**Table 2-2 – Four Bits Symbol Mapping Truth Table**

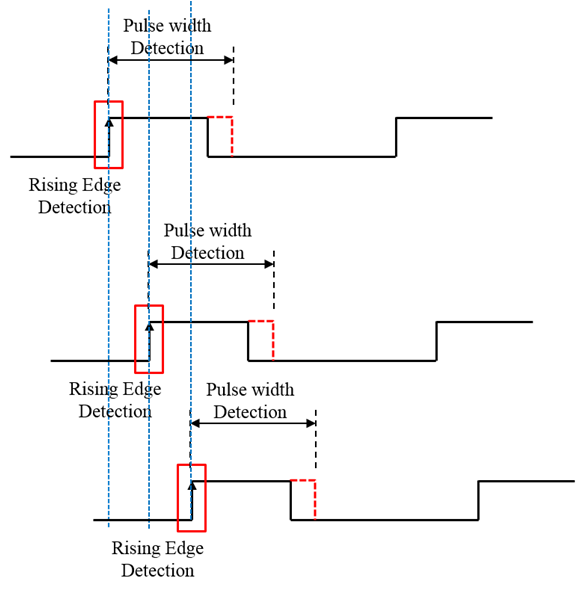
The symbol arrays mapping is described in waveform pattern as shown in Figure 2-2.



**Figure 2-2 – Symbol Array Mapping Timing Diagram**

Note: [Receiver Detection Method]

Receiver can synchronize rising edge and check pulse width length using Rolling-shutter method. The receiver detection process in the wave formatted approach is show in Figure 2-3.



**Figure 2-3 – Receiver Detection Process**