**IEEE P802.15**

**Wireless Personal Area Networks**

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| Title | **Kookmin PHY 6 PPDU frame formats** |
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| Re: |  |
| Abstract | Details of Resolutions regarding to the submitted Comments on D0 are suggested.PHY 6 modes: PPDU frame formats are presented.  |
| Purpose | D0 Comments Resolutions and Editorial Revision. |
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# PHY 5 PPDU formats

**9.6.8.1 2D-sequential color code PPDU format**

|  |  |  |  |
| --- | --- | --- | --- |
| **Preamble**(see **9.6.8.1.1**) | **PHY header**(see **9.6.8.1.2**) | **HCS**(see **9.6.8.1.3**) | **PSDU**(see **9.6.8.1.4**) |
| SHR | PHR | PHY payload |

The 2D-sequential color code PPDU frame structure consists of the preamble field, PHR sub-fields, and the PSDU PHY payload.

**9.6.8.1.1** **Preamble field**

The preamble field for 2D-sequential color PHY mode is four data-block times long. Each block time is for a specific preamble matrix as follows.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Duration | one block time | one block time | one block time | one block time |
| Preamble | A | A’ | A | A’ |

A and A’ are two inverse forms of the 2D-code.

$$A\_{M×M}=\left(\begin{matrix}1 0&\cdots &1 0\\\vdots &\ddots &\vdots \\0 1&\cdots &0 1\end{matrix}\right); A'\_{M×M}=\left(\begin{matrix}0 1&\cdots &0 1\\\vdots &\ddots &\vdots \\1 0&\cdots &1 0\end{matrix}\right); $$

By comparing a pair of preambles A and A’, the receiver is able to distinguish individual-LEDs on the transmitter.

**9.6.8.1.2** **PHY header**

The PHY header will support the related communication modes those are specified by MAC frame, at least bidirectional communications mode, and D2D mode will be supported. The PHY header is TBD, will be clarified along with MAC frame when D1 comes out.

PHY header is sent at the lowest data rate among available PHY modes of 2D-sequential code.

**9.6.8.1.3** **HSC field**

TBD along with PHY header.

**9.6.8.1**.**4** **PSDU PHY payload**

The count of payload blocks in PSDU (N) is read from the PHY header.

**Table – (2D-sequential PHY mode) PSDU frame format**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Data block 1 | Data block 2 | … | Data block N |
| Data bits | $$3(M×M-4)$$ | $$3(M×M-4)$$ |  | $$3(M×M-4)$$ |

where MxM is the number of LEDs in the transmitter. Three color channels are used.

The block interval is specified at longer than the maximum interframe interval of camera sampling to make sure that every symbol is sampled at least once. Normally, the block rate is specified at 10Hz to support 30fps camera receiver that has time-variant frame rate.

**Table – (2D-sequential PHY mode) data block format**

|  |  |  |  |
| --- | --- | --- | --- |
|  | Data block (i-1) | Data block i | Data block (i+1) |
| LEDs matrix |  |  |  |
| Clock information atreference LEDs | $$R\_{red\\_channel}=\left[\begin{matrix}1&1\\1&1\end{matrix}\right]$$ | $$R\_{red\\_channel}=\left[\begin{matrix}0&0\\0&0\end{matrix}\right]$$ | $$R\_{red\\_channel}=\left[\begin{matrix}1&1\\1&1\end{matrix}\right]$$ |
| Rotation information atreference LEDs | $$R\_{blue\\_channel}=\left[\begin{matrix}1&1\\1&0\end{matrix}\right]$$ | $$R\_{blue\\_channel}=\left[\begin{matrix}0&0\\0&1\end{matrix}\right]$$ | $$R\_{blue\\_channel}=\left[\begin{matrix}1&1\\1&0\end{matrix}\right]$$ |
| Data bits | $$3(M×M-4)$$ | $$3(M×M-4)$$ | $$3(M×M-4)$$ |

where MxM is the number of LEDs in the transmitter. Three color channels are used.

The clock information transmitted by four reference LEDs via red channel is to support the receiver decoding under the presence frame rate variation. Also, the detection and removal of rolling effected image is supported by the clock information.

The rotation information transmitted by four reference LEDs via blue channel is to support the receiver decoding under the presence of camera rotation.

**9.6.8.5 Kookmin invisible code PPDU format**

|  |  |  |  |
| --- | --- | --- | --- |
| **Preamble**(see **9.6.8.5.1**) | **PHY header**(see **9.6.8.5.2**) | **HCS**(see **9.6.8.5.3**) | **PSDU**(see **9.6.8.5.4**) |
| SHR | PHR | PHY payload |

The Kookmin invisible code PPDU frame structure consists of the preamble field, PHR sub-fields, and the PSDU PHY payload.

**9.6.8.1.1** **Preamble field**

The preamble field for invisible code PHY mode is four data-block times long. Each block time is for a specific preamble matrix as follows.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Duration | one block time | one block time | one block time | one block time |
| Preamble | A | A’ | A | A’ |

A and A’ are two inverse forms of the 2D-code.

$$A\_{m×m}=\left(\begin{matrix}1 0&\cdots &1 0\\\vdots &\ddots &\vdots \\0 1&\cdots &0 1\end{matrix}\right); A'\_{m×m}=\left(\begin{matrix}0 1&\cdots &0 1\\\vdots &\ddots &\vdots \\1 0&\cdots &1 0\end{matrix}\right); $$

The preamble is also helpful in helping the receiver to distinguish individual invisible-cells on the transmitter.

**9.6.8.1.2** **PHY header**

The PHY header will support the related communication modes those are specified by MAC frame, at least bidirectional communications mode, and D2D mode will be supported. The PHY header is TBD, will be clarified along with MAC frame when D1 comes out.

PHY header is sent at the lowest data rate among available PHY modes of invisible code.

**9.6.8.1.3** **HSC field**

TBD along with PHY header.

**9.6.8.1**.4 **PSDU PHY payload**

The count of payload blocks in PSDU (N) is read from the PHY header.

**Table – (Invisible code PHY mode) PSDU frame format**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Data block 1 | Data block 2 | … | Data block N |
| Data bits | $$(m×m-4)$$ | $$(m×m-4)$$ |  | $$(m×m-4)$$ |

where mxm is the number of invisible-cells in the transmitter.

The block interval is specified at longer than the maximum interframe interval of camera sampling to make sure that every symbol is sampled at least once.

Also, the data block utilizes 1/2-rate line coding. The optical clock rate is usually specified at 10Hz and therefore, the block rate is at 5Hz to support 30fps camera receiver that has time-variant frame rate.

**Table – (Invisible code PHY mode) data block format**

|  |  |  |
| --- | --- | --- |
|  | Data block (i) | Data block (i+1) |
|  |  |  |  |  |
| Clock-and-rotation information atreference LEDs | $$R\_{invisible\\_chl.}=\left[\begin{matrix}1&1\\1&0\end{matrix}\right]$$ | $$R\_{invisible\\_chl.}=\left[\begin{matrix}0&0\\0&1\end{matrix}\right]$$ | $$R\_{invisible\\_chl.}=\left[\begin{matrix}1&1\\1&0\end{matrix}\right]$$ | $$R\_{invisible\\_chl.}=\left[\begin{matrix}0&0\\0&1\end{matrix}\right]$$ |
| Data bits | $$m×m-4$$ | $$m×m-4$$ |

where mxm is the number of invisible-cells in the transmitter.

The clock-and-rotation information transmitted by four reference LEDs is to support the receiver decoding under the presence frame rate variation and the rotation of receiver.