**IEEE P802.15**

**Wireless Personal Area Networks**

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| Title | **Kookmin suggested PPDU frame formats for Merged RS-FSK modes** |
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| Abstract | Suggested PPDU frame formats for Merged RS-FSK modes between Kookmin and NTU. |
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**--------------------------- PHY 5 RS-FSK PPDU formats -----------------------------------**

# **9.6.7.2 RS-FSK PPDU format**

|  |  |  |  |
| --- | --- | --- | --- |
| **Preamble**  (see 9.6.7.2.1) | **PHY header**  (see 9.6.7.2.2) | **HCS**  (see 9.6.7.2.3) | **PSDU**  (see 9.6.7.2.4) |
| SHR | PHR | | PHY payload |

The RS-FSK PPDU frame structure consists of the preamble field, PHR sub-fields, and the PSDU payload.

## **9.6.7.2.1** **RS-FSK Preamble field**

The preamble is a frequency domain sequence and does not have any channel coding or line coding. The preamble shall be defined to be distinguishable among all the PHR and PSDU of all supported operating modes.

**Preamble type 1 (Kookmin):**

If the preamble type 1 is sent, all PHR and PSDU field shall be sent using RS32-FSK or RS64-FSK.

The preamble field for RS-FSK is two symbol times long. Each symbol time is for a specific preamble frequency as follows.

|  |  |  |
| --- | --- | --- |
| Duration | one symbol time | one symbol time |
| Preamble | fSF\_1 | f'SF |

* The first preamble : fSF\_1 = 200Hz is fixed frequency.
* The second preamble : f’SF\_1 = fSF\_1 + 33.∆f is variable as a function of ∆f.

**Preamble type 2 (NTU)**

If the preamble type 2 is sent, all PHR and PSDU field shall be sent using RS8-FSK or RS16-FSK.

The preamble field for RS-FSK is one symbol time.

|  |  |  |
| --- | --- | --- |
| Duration | one symbol time | one symbol time |
| Preamble | fSF\_2=2.232 kHz | Gap symbol |

## **9.6.7.2.2** **RS-FSK PHY header**

The PHY header, as shown in table ABC1, shall be transmitted with RS-FSK modulation.

The MAC shall select the optical clock rate for communication during the clock-rate selection process, as defined in 6.5 (modified). The PHY header shall be sent at the lowest data rate for the chosen optical clock rate (i.e. RS32-FSK for 10Hz optical clock rate of Kookmin RS32-FSK and RS64-SK modes; and RS8-FSK for 30Hz optical clock rate of NTU RS8-SK and RS16-FSK modes). The clock rate does not change throughout the frame between the preamble, header, and payload.

**Table ABC1– PHY header**

|  |  |  |
| --- | --- | --- |
| **PHY header field** | **Bit-width** | **Explanation on usage** |
| Burst mode | 1 | Enable IFS – Interframe spacing/ splitter symbol |
| Channel number | 0 (disabled) |  |
| MCS ID | 6 | Provide information about PHY type and data rate |
| Length of PSDU field | 0 (disabled) |  |
| reserved | 1 | For future use |

### x.1 Burst mode enable

The burst mode bit indicates that the next frame following the current frame is part of the burst mode. Refer to following PSDU formats for more detailed information.

### x.2 MCS ID

The modulation and coding scheme (MCS) ID shall be indicated in the PHY header based on Table 83(cont).

The MCS ID utilizes 6 bits for MCS indication.

**Table 83 (cont) MCS ID**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **MCS indication** | **PHY** | **Data rate** | **Unit** |
| TBD | TBD (RS32-FSK) | V | 40 | bps |
| TBD | TBD (RS64-FSK/2-PSK) | 60 |
| TBD | TBD (RS8-FSK) | 90 x 2/3=60 |
| TBD | TBD (RS16-FSK) | 120 x2/3=90 |
|  |  |  |
|  |  |  |
|  | OOK modes |  |
|  |  |  |
|  | PWM/PPM modes |  |
|  |  |  |
|  |  |  |  |  |

### x.3 Reserved sub-field

RS32-FSK is able to transmit 4 data bits plus one Ab per frequency. Hence 8 bit-width equivalent to two symbol times is used for PHY header and one bit is reserved for future use.

## **9.6.7.2.3 RS-FSK HSC**

TBD along with PHY header.

## 9.6.7.2.4 **RS-FSK PSDU PHY payload**

The PSDU shall support the following normal data transmission modes

1. Packed mode
2. Burst mode

The packed mode contains multiple PPDUs per frame and is used to send multiple consecutive PPDUs to the same destination within the frame for high throughput. Thus, the overhead of sending multiple MAC and PHY headers to the same destination is eliminated in this mode, providing higher MAC efficiency. This can be used in most modes as the preferred means of data communication.

The burst data mode does not use the clock information embedding or bandwidth division to support the varying frame rate camera Rx. Instead, the spacing symbol is used between frames to support varying frame rate camera Rx. The cost of spacing is the waste of symbol time, however, the spacing symbol time can be utilized for low-rate PD communication.

### X.1 Packed data mode

**X.1.1 Kookmin packed mode**

For packed mode, the PSDU consists of multiple data sub-frames (noted as DS). Each DS consists of multiple data bits and is mapped into a frequency symbol. The amount of bits carried by a frequency symbol depends on the number of frequencies used in modulation. By using 32 frequencies for modulation, 4 data bits along with an asynchronous bit (Ab) are transmitted each frequency symbol time. Likewise by using 64 frequencies for modulation, 5 data bits along with an asynchronous bit (Ab) is transmitted by a frequency symbol each time.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **PSDU payloads** | | | |
|  | **DS 1** | **DS 2** | **…** | **DS N** |
| Mode 1:  RS32-FSK | (1 Ab + 4 data bits) | (1 Ab + 4 data bits) |  | (1 Ab + 4 data bits) |
| Mode 2:  RS62-FSK | (1 Ab + 5 data bits) | (1 Ab + 5 data bits) |  | (1 Ab + 5 data bits) |
| Mode 3:  RS62-FSK/ 2-PSK | (1 Ab + 6 data bits) | (1 Ab + 6 data bits) |  | (1 Ab + 6 data bits) |

**X.1.2 NTU packed mode**

For packed mode, the PSDU consists of multiple data sub-frames. The number of sub-frames per packet is the multiples of three. The bandwidth is divided into three equal sub bands (sub-BW) for sequentially data mapping. The first sub-BW shall be used to map data sub-frame #3i, the second sub-BW shall be used to map data sub-frame #(3i+1), and the last sub-BW shall be used to map data sub-frame #(3i+2).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **PSDU payloads** | | | | |
|  | **DS 1** | **DS 2** | **DS 3** | **…** | **DS 3N+2** |
| Mode 1:  RS8-FSK | 3 data bits  (sub-BW #1) | 3 data bits  (sub-BW #2) | 3 data bits  (sub-BW #3) | **…** | 3 data bits  (sub-BW #3) |
| Mode 2:  RS16-FSK | 4 data bits  (sub-BW #1) | 4 data bits  (sub-BW #2) | 4 data bits  (sub-BW #3) | **…** | 4 data bits  (sub-BW #3) |

### X.2 Burst mode

**X.1.1 NTU burst mode**

When burst mode is enabled, the splitter symbol (SS) is required as the sub-frames spacing. The SS is inserted in between PHR and PSDU field, and between data sub-frames (see Figure ABC1).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PHR** | **PSDU** | | | | | | | |
|  | **SS** | **DS 1** | **SS** | **DS 2** | **SS** | **…** | **DS N** | **SS** |
|  | 868Hz | RS8-FSK or  RS16-FSK | 868Hz | RS8-FSK or  RS16-FSK | 868Hz |  | RS8-FSK or  RS16-FSK | 868Hz |

Figure ABC1 - PSDU format for NTU burst mode

The frequency for splitter symbol is constant at 7aPF/18 (868Hz) where aPF is the selected frequency for preamble.

The SS is at TBD symbol time in length.

**X.1.2 Kookmin burst mode**

The spacing between sub-frames DS is inserted to support the time-variant frame rate Rx decoder. When the burst mode is enable, it gains benefit in the amount of data bits per DS because the clock information embedding into DS is disable to reduce overhead. In contrast, the spacing is symbol time wasted.

The spacing is transmitted at the high frequency that is imperceptible by the camera Rx. The spacing symbol is at one symbol time in length.

The spacing can be a constant frequency that does not carry any data. Also, the spacing can be sent via OOK modulation to support low-rate PD communication.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **PSDU payloads** | | | | | |
| **DS 1** | **Spacing** | **DS 2** | **Spacing** | **…** | **DS N** |
| data bits | > 10kHz | data bits | > 10kHz |  | data bits |

Figure ABC2 - PSDU format for Kookmin burst mode