**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |
| --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **Text Input by Panasonic** | |
| Date Submitted | Mar. 2017 | |
| Source | [Hideki Aoyama] [] [address] | Voice: [ ] Fax: [ ] E-mail: [aoyama.hideki@jp.panasonic.com] |
| Re: | [If this is a proposed revision, cite the original document.]  [If this is a response to a Call for Contributions, cite the name and date of the Call for Contributions to which this document responds, as well as the relevant item number in the Call for Contributions.]  [Note: Contributions that are not responsive to this section of the template, and contributions which do not address the topic under which they are submitted, may be refused or consigned to the “General Contributions” area.] | |
| Abstract | [Description of document contents.] | |
| Purpose | [Description of what the author wants P802.15 to do with the information in the document.] | |
| Notice | This document has been prepared to assist the IEEE P802.15. It is offered as a basis for discussion and is not binding on the contributing individual(s) or organization(s). The material in this document is subject to change in form and content after further study. The contributor(s) reserve(s) the right to add, amend or withdraw material contained herein. | |
| Release | The contributor acknowledges and accepts that this contribution becomes the property of IEEE and may be made publicly available by P802.15. | |

## 3.2 Acronyms and abbreviations

(Addition to the list)

MPM Mirror Pulse Modulation

PLCP Physical Layer Conversion Protocol

(Replacement for the whole 5.2.5)

## 5.2.5 MPM MAC frame format

MPM MAC frame format is composed of a MHR and a MSDU. The MHR field contains the sequence number subfield. The bit-length of the MPDU is set as *macMpmMpduLength*.

|  |  |
| --- | --- |
| Bits:  0-5 | variable |
| Sequence Number | Frame Payload |
| MHR | MSDU |

Figure 5.2.5 – MPM general MAC frame format

### 5.2.5.1 Sequence Number subfield

The Sequence Number subfield contains a frame sequence number. The bit-length of the Sequence Number subfield is set as *macMpmSnLength*. In the case that bit-length of the Sequence Number subfield is set as variable length, the first bit of the Sequence Number subfield is used as the Last Frame Flag, which is set as 1 for the last frame and 0 for the other frame. Figure 5.2.5.1 shows how to determine the bit-length of the Sequence Number subfield.

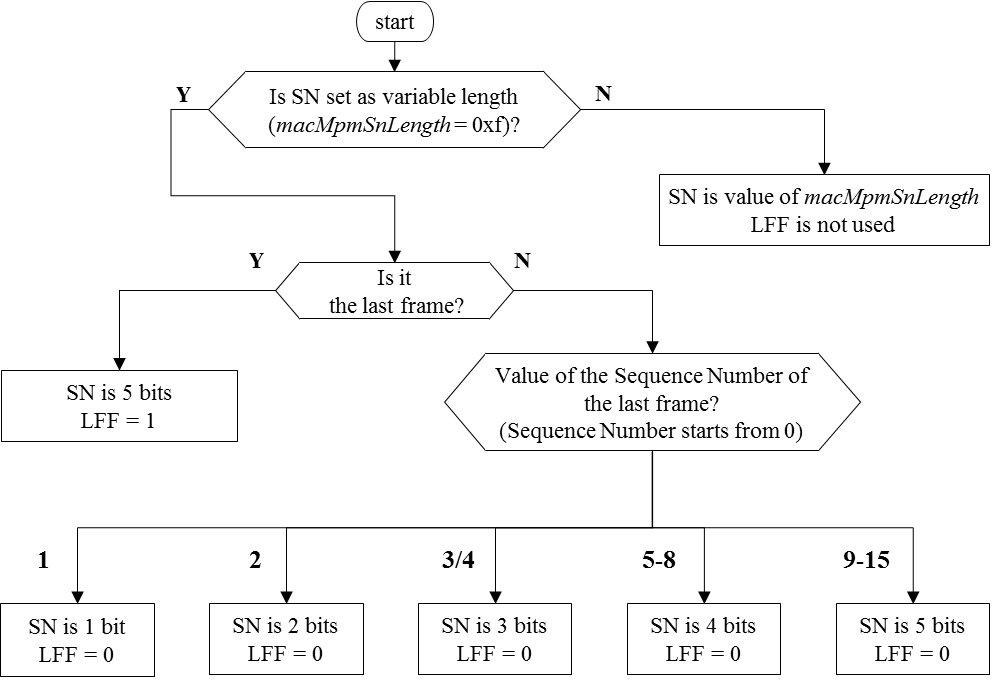


Figure 5.2.5.1 --- How to determine the bit-length of the Sequence Number subfield

SN: Bit-length of the Sequence Number subfield

LFF: the Last Frame Flag (the first bit of the Sequence Number subfield)

### 5.2.5.2 MSDU

The MSDU contains the frame payload.

## 6.4.2 MAC PIB attributes

(Addition to) Table 100 --- MAC PIB attribute

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Attribute** | **Identifier** | **Type** | **Range** | **Description** | **Default** |
| *macMpmSnLength* |  | Integer | 0x0-0xf | Indicates the bit-length of the Sequence Number subfield. Values from 0x0 to 0xe indicate the (fixed) bit-lengths. Value 0xf indicates that the bit-length is variable. | 0xf |
| *macMpmMpduLength* |  | Integer | 0x00-0xff | Indicates the bit-length of MPDU. | 12 |

(Replacement for the whole 8.5.2.5.4)

#### 8.5.2.5.4 MPM dimming

MPM supports dimming by (a) analog dimming, (b) PWM dimming, (c) VPPM dimming (for only MPM PHY PPM mode), and/or (d) inserting dimming fields as shown in Figure 8.5.2.5.4.

The width of inserted pulse of PWM dimming shall be less than one third of the original pulse and less than 50 micro second.

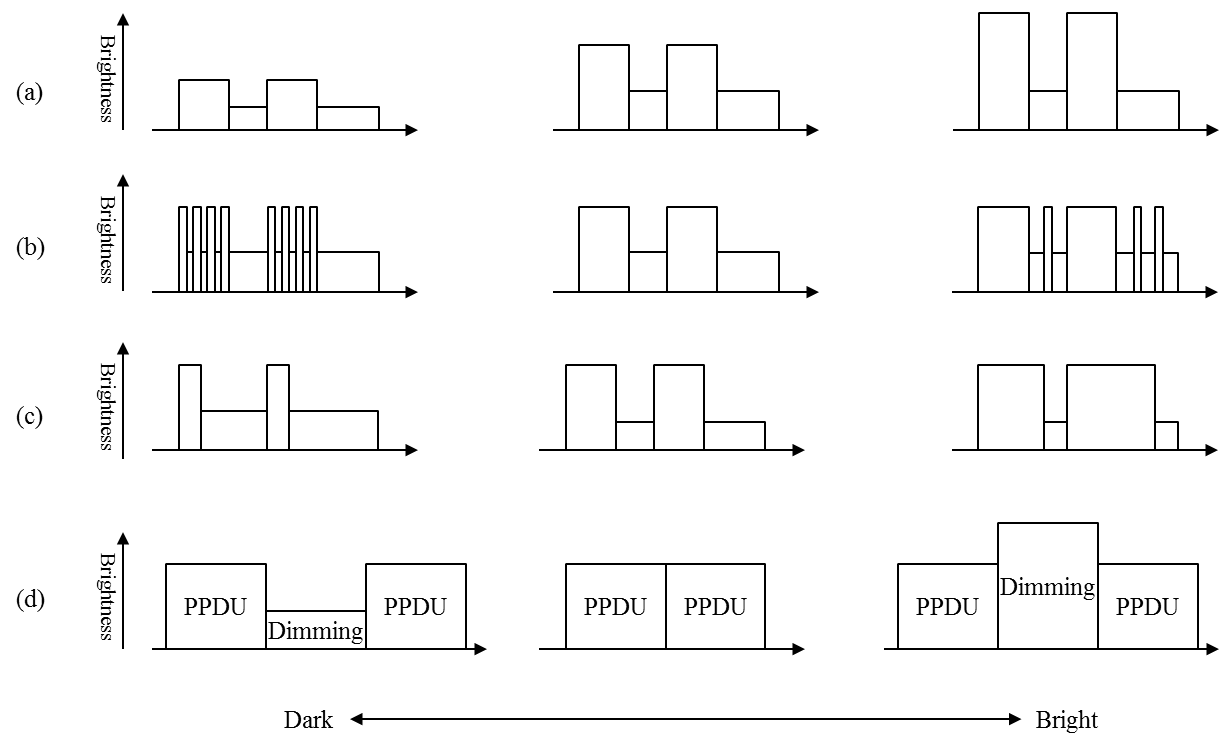


Figure 8.5.2.5.4 --- MPM dimming

(Replacement for the whole 8.6.7.4)

### 8.6.7.4 MPM PPDU format

MPM consists of the PSDU field only.

### 8.6.7.4.1 MPM PSDU field

The PSDU field contains MPDU that is converted by MPM PLCP.

### 9.5.2 PHY PIB attributes

(Addition to) Table 188 --- PHY PIB attributes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Attribute** | **Identifier** | **PLCP Center** | **Range** | **Description** |
| *phyMpmMode* |  | Integer | 0-1 | Indicates the MPM PHY mode.  0: PWM mode  1: PPM mode |
| *phyMpmPlcpHeaderMode* |  | Integer | 0x0-0xf | Indicates the PLCP Header subfield mode and the PLCP Footer subfield. See 14.4.2 and 14.4.5. |
| *phyMpmPlcpCenterMode* |  | Integer | 0x0-0xf | Indicates the PLCP Center subfield mode. See 14.4.4. |
| *phyMpmSymbolSize* |  | Integer | 0x0-0xf | Indicates the number of symbols of the Payload subfield. 0x0 indicates variable. It is referred as *N*. |
| *phyMpmOddSymbolBit* |  | Integer | 0x0-0xf | Indicates the bit-length that is contained in each odd-numbered symbol of the Payload subfield. It is referred as *Modd*. |
| *phyMpmEvenSymbolBit* |  | Integer | 0x0-0xf | Indicates the bit-length that is contained in each even-numbered symbol of the Payload subfield. It is referred as *Meven*. |
| *phyMpmSymbolOffset* |  | Integer | 0x00-0xff | Indicates the offset value of symbols of the Payload subfield. It is referred as *W1*. |
| *phyMpmSymbolUnit* |  | Integer | 0x00-0xff | Indicates the unit value of symbols of the Payload subfield. It is referred as *W2*. |
|  |  |  |  |  |

(Replacement for the whole 14.4)

## 14.4 MPM

MPM PLCP converts MPDU to the PLCP Header subfield, the Front Payload subfield, the PLCP Center subfield, the Back Payload subfield, and the PLCP Footer subfield as shown in Figure 14.4. MPM PHY mode is set as *phyMpmMode*.

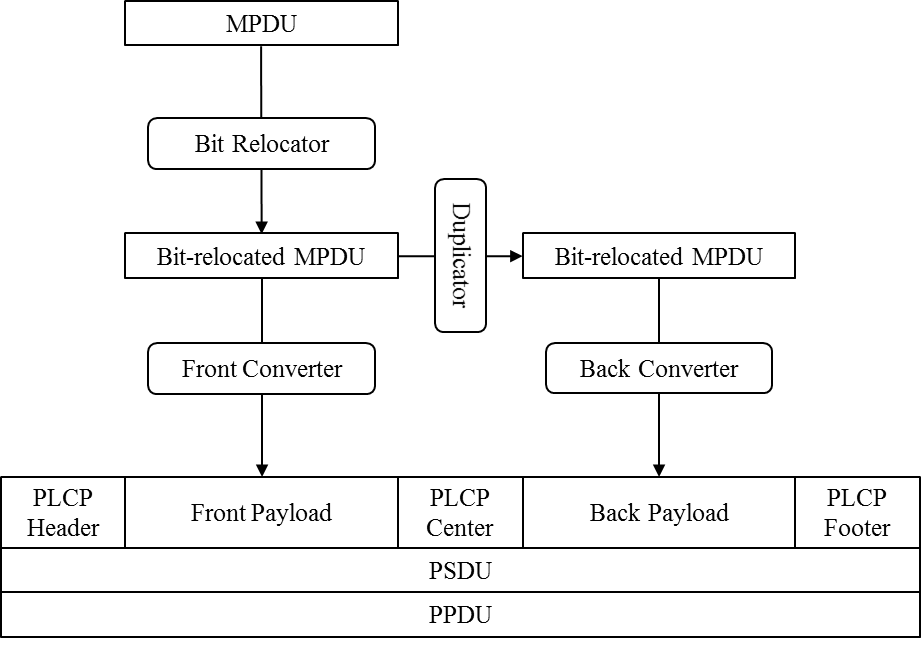


Figure 14.4 --- MPM PHY and PLCP

### 14.4.1 Bit Relocation

Let (*x0, x1, x2, …*) be bits of MPDU, *LSN* be the bit-length of the Sequential Number subfield, and *N* be the number of symbols of each Payload subfield. Relocated bits (*y0, y1, y2, …*) are indicated as

### 14.4.2 PLCP Header subfield

The PLCP Header subfield consists of four symbols for PWM mode and three symbols for PPM mode that are defined in Table 14.4.2.

Table 14.4.2 --- PLCP Header subfield modes

|  |  |  |
| --- | --- | --- |
| *phyMpmPlcpHeaderMode* | PLCP Header subfield symbols | |
| PWM mode | PPM mode |
| 0 | 0, 0, 0, 0 | 0, 0, 0 |
| 1 | 20, 10, 20, 20 | 90, 80, 80 |
| 2 | 30, 20, 30, 30 | 100, 90, 90 |
| 3 | 40, 30, 40, 40 | 110, 100, 100 |
| 4 | 50, 40, 50, 50 | 120, 110, 110 |
| 5 | 60, 50, 60, 60 | 130, 120, 120 |
| 6 | 70, 60, 70, 70 | 140, 130, 130 |
| 7 | 80, 70, 80, 80 | 150, 140, 140 |
| 8 | 90, 80, 90, 90 | 160, 150, 150 |
| 9 | 100, 90, 100, 100 | 170, 160, 160 |
| 10 | 110, 100, 110, 110 | 180, 170, 170 |
| 11 | 120, 110, 120, 120 | 190, 180, 180 |
| 12 | 130, 120, 130, 130 | 200, 190, 190 |

### 14.4.3 Front Payload subfield and Back Payload subfield

Each of the Front Payload subfield and the Back Payload subfield consist of *N* symbols. Let *Modd* be a bit-length contained in an odd-numbered symbol, *Meven* be a bit-length contained in an even-numbered symbol, *W1* be a symbol value offset, and *W2* be a symbol value unit. *N, Modd, Meven, W1,* and *W2* are set in the PHY PIB in Table 188.

Relocated MPDU Payload Bits (*y0, y1, y2, …*) are converted as follows. Let *zi* be calculated as

where

then the *i*th Symbol of the Front Payload subfield is calculated as

and the *i*th Symbol of the Back Payload subfield is calculated as

### 14.4.4 PLCP Center subfield

The PLCP Center subfield consists of four symbols for PWM mode and three symbols for PPM mode that are defined in Table 14.4.4.

Table 14.4.4 --- PLCP Center subfield modes

|  |  |  |
| --- | --- | --- |
| *phyMpmPlcpCenterMode* | PLCP Center subfield symbols | |
| PWM mode | PPM mode |
| 0 | 0, 0, 0, 0 | 0, 0, 0 |
| 1 | 20, 10, 10, 20 | 80, 90, 80 |
| 2 | 30, 20, 20, 30 | 90, 100, 90 |
| 3 | 40, 30, 30, 40 | 100, 110, 100 |
| 4 | 50, 40, 40, 50 | 110, 120, 110 |
| 5 | 60, 50, 50, 60 | 120, 130, 120 |
| 6 | 70, 60, 60, 70 | 130, 140, 130 |
| 7 | 80, 70, 70, 80 | 140, 150, 140 |
| 8 | 90, 80, 80, 90 | 150, 160, 150 |
| 9 | 100, 90, 90, 100 | 160, 170, 160 |
| 10 | 110, 100, 100, 110 | 170, 180, 170 |
| 11 | 120, 110, 110, 120 | 180, 190, 180 |
| 12 | 130, 120, 120, 130 | 190, 200, 190 |

### 14.4.5 PLCP Footer subfield

The PLCP Header subfield consists of four symbols for PWM mode and three symbols for PPM mode that are defined in Table 14.4.5.

Table 14.4.5 --- PLCP Footer subfield modes

|  |  |  |
| --- | --- | --- |
| *phyMpmPlcpHeaderMode* | PLCP Footer subfield symbols | |
| PWM mode | PPM mode |
| 0 | 0, 0, 0, 0 | 0, 0, 0 |
| 1 | 20, 20, 10, 20 | 80, 80, 90 |
| 2 | 30, 30, 20, 30 | 90, 90, 100 |
| 3 | 40, 40, 30, 40 | 100, 100, 110 |
| 4 | 50, 50, 40, 50 | 110, 110, 120 |
| 5 | 60, 60, 50, 60 | 120, 120, 130 |
| 6 | 70, 70, 60, 70 | 130, 130, 140 |
| 7 | 80, 80, 70, 80 | 140, 140, 150 |
| 8 | 90, 90, 80, 90 | 150, 150, 160 |
| 9 | 100, 100, 90, 100 | 160, 160, 170 |
| 10 | 110, 110, 100, 110 | 170, 170, 180 |
| 11 | 120, 120, 110, 120 | 180, 180, 190 |
| 12 | 130, 130, 120, 130 | 190, 190, 200 |

### 14.4.6 Waveform

Symbols shall be transmitted as two states of light intensity, the bright state and the dark state.

In MPM PHY PWM mode, symbol value corresponds to continuous time of a state in micro second. For example, the first symbol value corresponds continuous time of the first bright state and the second symbol value corresponds continuous time of the following dark state as shown in Figure 14.4.6A. The first state can be dark state as well.

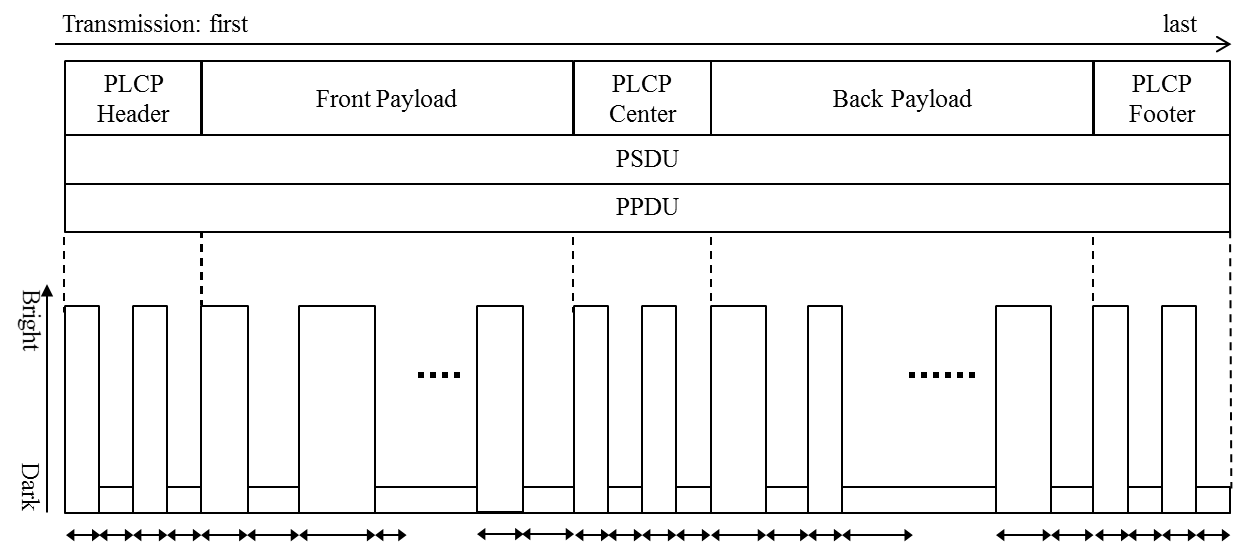


Figure 14.4.6A --- MPM PHY PWM mode waveform

In MPM PHY PPM mode, symbol value corresponds to duration time between the beginning of bright state and the beginning of the next bright state in micro second. The duration time of continuous bright state shall be shorter than 90% of the symbol value. Figure 14.4.6B shows an example waveform.

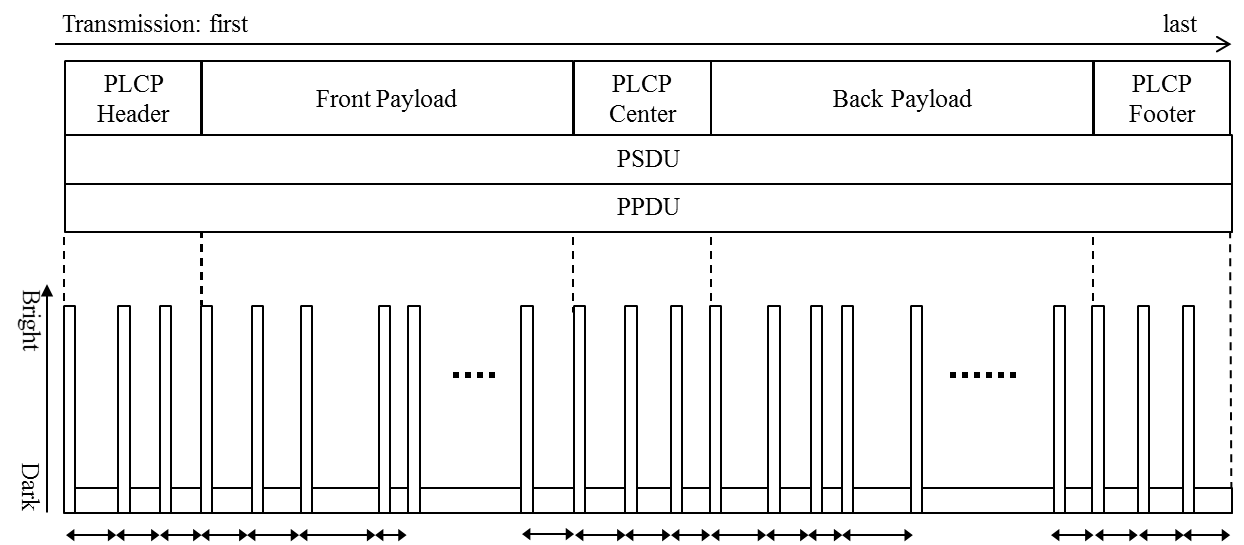


Figure 14.4.6B --- MPM PHY PPM mode waveform

For both modes, a transmitter can transmit only a part of the symbols, but all symbols of the PLCP Center subfield and at least *N* symbols from the Front Payload subfield and the Back Payload subfield must be transmitted.