**IEEE P802.15**

**Wireless Personal Area Networks**

|  |  |  |
| --- | --- | --- |
| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | **Channel paging for 4g Generic PHY** | |
| Date Submitted | [21 January 2010] | |
| Source | [] [ITRON] [France] | Voice: [ ] Fax: [ ] E-mail: [ larry.taylor@discretetime.com] |
| Re: | Draft text contribution for 15.4g | |
| Abstract | Channel paging provides a logical and coherent way to structure the standard defined PHY modes. | |
| Purpose | Draft text contribution | |
| 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. | |

# Text changes to 802.15.4:

**3 Definitions**

Add the following :

**3.x channel band**: A set of communication channels in standard specified range of frequencies using one or several particular PHY mode.

**3.y PHY Mode**: A set of PHY parameters uniquely defining the communication channel.

# Text changes to Clause 6\_fsk\_122409:

**6.1.2 Channel assignments**

Replace the existing contents of 6.1.2 Channel assignments with:

*Change the last paragraph as follows:*

The upper 5 most significant bits (MSBs) of the 32-bit channel bitmaps in *phyChannelsSupported* shall be

used as an integer value to specify 32 possible channel pages. The lower 27 bits of the channel bit map shall

be used as a bit mask to specify channel numbers within a channel page, except for channel pages 7 and 8, where the number of channels may exceed 27; the channel assignments for pages 7 are described in **6.1.2.5a**.

**6.1.2.1 Channel numbering**

Replace the existing contents of 6.1.2.1 Channel numbering with:

*Change first line as follows:*

A total of 27 channels numbered 0 to 26 are available per channel page, except for the channel page 7 and 8, where the number of channels per page is implementation dependent. The channel assignments for channel pages 7 and 8 are described in **6.1.2.5a**.

*Change last line in this clause to:*

An exception to this is the UWB PHY where specific mandatory and optional behaviors are as defined in

6.12.11.1 and the MRFSK, OFDM and MR-OQPSK PHYs, where specific mandatory and optional behaviors are as defined in ***[insert correct subclauses for each SUN PHY]***.

Replace the existing contents of 6.1.2.5a Channel numbering for MRFSK PHY with:

*Add to section inserted after “Channel numbering for the UWB PHY” (after clause 6.1.2.5 and before 6.1.2.6 in 802.15.4-2009 draft, before clause 6.2.2.2 in P802.15.4-2006)*

**6.1.2.5a Channel numbering for the MRFSK, OFDM and** MR-OQPSK **PHYs**

Channel page 7 describes standard channel bands and channel page 8 describes extended channel bands. The interpretation of the 27 bit positions is different for channel page 7 and channel page 8. Channel pages 7 and 8 are allocated to the PHY operating modes defined by the MRFSK, OFDM and MR-OQPSK PHYs.

Figure 1: The use of the 27 lowest bits for the channel page 7 and 8.

The PHY PIB attribute *phyChannelsSupported* shall indicate that channel page 7 is supported for MRFSK, OFDM and MR-OQPSK PHYs. Support for channel page 8 is optional, but when supported in an implementation, shall be so indicated in *phyChannelsSupported* .

When the upper 5 bits of an element in the PIB attribute *phyChannelsSupported* is equal to 7 or 8, the lower 27 bits shall be used as follows (see Figure 1):

* The first 5 bits shall be used as an integer value to indicate (1-32) channel bands defined in 4g.
* The following 2 bits shall be used as an integer value to indicate the 3 PHYs (FSK, OFDM, MR-OQPSK) defined in 4g; One value is reserved for further use
* The remaining 20 bits shall be used as a bitmap to indicate the Modulation Modes (PHY modes) defined in 4g for each of the 3 PHYs (FSK, OFDM, MR-OQPSK) and for each channel bands.

For channel page 7, a set of standard frequency bands is defined and each value coded by the first 5 bits of the lowest 27 bits corresponds to a standard frequency band. The PHY PIB attribute *phyChannelBandsSupported* is an array of Channel Band Descriptors, with a number of elements equal to the number of channel bands defined in 4g as described by the PHY PIB attribute *phyNumberChannelBandsSupported*.

Figure x1: Channel Page 7 Structure

When the Channel Page sub-field is set to 7, the Channel Band sub-field is an index into the standard table of frequency bands (Table x1a) and the Modulation Type sub-field is an index into the standard table of modulation types (Table x1b).

When the Channel Page sub-field is set to 7, the PHY Mode sub-field is a bitmap and each bit position indicates which of 4g standard defined PHY modes (Table x1b1.x, Table x1b2.x, Table x1b3.x) is supported for each of the Modulation Types defined in 4g.

When the Channel Page sub-field is set to 8, the Channel Band sub-field, the Modulation Type sub-field and PHY Modes sub-field have the same interpretation and shall be used as when the Channel Page sub-field is set to 7.

When the Channel Page sub-field is set to 8 the Channel Band sub-field is an index position into a table of frequency bands with the same structure as the standard table of frequency bands, and the Modulation Type sub-field is an index into a table of modulation types with the same structure as the standard table of modulation types.

When the Channel Page sub-field is set to 8, the PHY Mode sub-field is a bitmap and each bit position indicates all vendor defined PHY modes for each type of modulation FSK, OFDM and MR-QPSK (Table x1c.1, Table x1c.2, Table x1c.3).

A table of standard frequency bands is given in (new table Table x1a) and standard Modulation Types is given in [*new table Table xb1*]. The standard PHY Mode table is given in [new table Table xxx].

The centre frequency of each channel in the frequency band is given by Equation (1) where Band Edge is the lowest frequency of the first channel, Channel Separation is the difference between two adjacent channel centre frequencies and Channel is a number in the range 0 to the number of contiguous channels – 1 in the frequency band.

Centre Frequency = Band Edge + ((2 x Channel + 1) x Channel Separation)/2 (1)

When the *phyCurrentPage* PHY PIB attribute is set to channel page 7 or 8, the PHY PIB attribute *phyCurrentChannelBandName* shall contain the Channel Band Name of the element of *phyChannelBandsSupported* that describes the frequency band and the PHY operating mode currently used, and the PHY PIB attribute *phyCurrentSubChannel* shall indicate the channel within the channel band currently used. A compliant device shall support all channels in each channel band supported.

Replace the existing contents of 6.1.2.6 Channel pages with:

**6.1.2.6 Channel pages**

*Add to Table 4:*

|  |  |  |  |
| --- | --- | --- | --- |
| **Channel page**  **(decimal)** | **Channel page**  **(binary)**  **(b31, b30, b29, b28, b27)** | **Channel**  **number(s)**  **(decimal)** | **Channel number description** |
| 7 | 0 0 1 1 1 | Variable | Standard defined channel bands for the MRFSK, OFDM and MR-OQPSK PHYs. See section [*insert subclause reference*] |
| 8 | 0 1 0 0 0 | Variable | Vendor defined channel bands for the MRFSK, OFDM and MR-OQPSK PHYs. See section [*insert subclause reference*] |
| 9-31 | 0 1 0 0 1 – 1 1 1 1 1 | *Reserved* | *Reserved* |

Table xa: Standard Frequency Bands [*new table*]

|  |  |  |
| --- | --- | --- |
| **Channel Band Index**  **(Decimal)** | **Applicable PHY Descriptors** | **Description** |
| 1 |  | 950MHz (Japan) |
| 2 |  | 400 MHz (1MHz BW, exact frequencies yet to be allocated) |
| 3 |  | 863–870 MHz |
| 4 |  | 915 MHz |
| 5 |  | 2400 MHz |
| 6 |  | 220-222, US and Canada, 12.5kHz BW channels |
| 7 |  | 450-470 MHz (US FCC Part 90) |
| 8 |  | 470-510 MHz (China) |
| 9 |  | 896-901 MHz (US FCC Part 90) |
| 10 |  | 901-902 MHz (US FCC Part 24) |
| 11 |  | 928-960 MHz (US, Non-contiguous) |
| 12 |  | 1427-1452 MHz (US and Canada, non-contiguous) |
| 13 |  | 1492-1518 MHz (US and Canada, non-contiguous) |
| 14 |  | 1605-1625 MHz (US, Non-contiguous) |
| 15 |  | 1800-1830 MHz (US and Canada, Non-contiguous) |
| 16 |  | 783 MHz (China) |
| 17 |  | 922 MHz (Korea) |
| 18 |  | TV white spaces |
| 19 |  | 778-787 MHz (China) |
| 20-31 |  | Reserved |

Table xb: Standard Modulation Types [*new table*]

|  |  |
| --- | --- |
| Modulation Type  Descriptor  ID (decimal) | Comments |
| 0 | Reserved |
| 1 | FSK |
| 2 | OFDM |
| 3 | DSSS |

**Modulation Type SUN FSK:**

Table x1b1.1 FSK Modulation Type: PHY Modes for the Channel Band number 1

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FSK Mode**  **(bitmap)** | **Mod Order** | **Mod** | **Mod Index (h)** | **Channel Spacing kHz** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 |  |  |  |  |  |  |  |  |
| b02 |  |  |  |  |  |  |  |  |
| b03 |  |  |  |  |  |  |  |  |
| b04 |  |  |  |  |  |  |  |  |
| b05 |  |  |  |  |  |  |  |  |
| … |  |  |  |  |  |  |  |  |
| b19 |  |  |  |  |  |  |  |  |

…

Table x1b1.5 FSK Modulation Type: PHY Modes for the Channel Band number 5

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FSK Mode**  **(bitmap)** | **Mod Order** | **Mod** | **Mod Index (h)** | **Channel Spacing kHz** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 | 2 | FSK | 1.0 | 200 | 50 | 1 | 50 | Mandatory |
| b01 | 2 | FSK | 1.0 | 400 | 150 | 1 | 150 | Optional |
| b02 | 2 | GFSK | 1.0 | 400 | 200 | 1 | 200 | Optional |
| b03 | N/A |  |  |  |  |  |  |  |
| b04 | N/A |  |  |  |  |  |  |  |
| … |  |  |  |  |  |  |  |  |
| b19 | N/A |  |  |  |  |  |  |  |

…

Table x1b1.11 FSK Modulation Type: PHY Modes for Channel Band number 11

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FSK Mode**  **(bitmaps)** | **Mod Order** | **Mod** | **Mod Index (h)** | **Channel Spacing kHz** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 | 2 | FSK | 1.0 | 200 | 50 | 1 | 50 | Mandatory |
| b01 | 2 | FSK | 1.0 | 400 | 100 | 1 | 150 | Optional |
| b02 | 2 | GFSK | 1.0 | 400 | 50 | 1 | 200 | Optional |
| b03 | N/A |  |  |  |  |  |  |  |
| b04 | N/A |  |  |  |  |  |  |  |
| … |  |  |  |  |  |  |  |  |
| b19 | N/A |  |  |  |  |  |  |  |

and so on.

**Modulation Type MR-OQPSK:**

Content of following tables will be completely filled up once the MR-OQPSK sub-group work is done.

Table x1b2.1 MR-OQPSK PHY Types: PHY Types for Channel Band number 1

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PHY Descriptor**  **Id**  **(Decimal)** | **Chip Rate kchip/sec** | **Modulation** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 |  |  |  |  |  |  |
| b01 |  |  |  |  |  |  |
| b02 |  |  |  |  |  |  |
| b03 |  |  |  |  |  |  |
| b04 |  |  |  |  |  |  |
| … |  |  |  |  |  |  |
| b19 |  |  |  |  |  |  |

and so on…

**Modulation Type SUN OFDM:**

Content of tables will be completely filled up once the SUN-DSSS sub-group work is done.

Table x1b3.1 PHY Types: tPHY Types for Channel Band number 1.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **PHY Descriptor**  **Id**  **(Decimal)** | **Chip Rate kchip/sec** | **Modulation** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 |  |  |  |  |  |  |
| b01 |  |  |  |  |  |  |
| b02 |  |  |  |  |  |  |
| b03 |  |  |  |  |  |  |
| b04 |  |  |  |  |  |  |
| … |  |  |  |  |  |  |
| b19 |  |  |  |  |  |  |

and so on.

**Vendor defined PHY Modes**

*FSK Modulation type*

Table x1c.1: PHY Modes for FSK modulation type

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FSK Mode**  **(bitmap)** | **Mod Order** | **Mod** | **Mod Index (h)** | **Channel Spacing kHz** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 |  |  |  |  |  |  |  |  |
| b02 |  |  |  |  |  |  |  |  |
| b03 |  |  |  |  |  |  |  |  |
| b04 |  |  |  |  |  |  |  |  |
| b05 |  |  |  |  |  |  |  |  |
| … |  |  |  |  |  |  |  |  |
| b19 |  |  |  |  |  |  |  |  |

*OFDM Modulation type*

Table x1c.2: PHY Modes for OFDM modulation type

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FSK Mode**  **(bitmap)** | **Mod Order** | **Mod** | **Mod Index (h)** | **Channel Spacing kHz** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 |  |  |  |  |  |  |  |  |
| b02 |  |  |  |  |  |  |  |  |
| b03 |  |  |  |  |  |  |  |  |
| b04 |  |  |  |  |  |  |  |  |
| b05 | N/A |  |  |  |  |  |  |  |
| … |  |  |  |  |  |  |  |  |
| b19 | N/A |  |  |  |  |  |  |  |

*MR-QPSK Modulation type*

Table x1c.3: PHY Modes for MR-QPSK modulation type

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FSK Mode**  **(bitmap)** | **Mod Order** | **Mod** | **Mod Index (h)** | **Channel Spacing kHz** | **Symbol Rate kHz** | **Bits/**  **Sym** | **kbits/**  **sec** | **Comment** |
| b00 |  |  |  |  |  |  |  |  |
| b02 |  |  |  |  |  |  |  |  |
| b03 |  |  |  |  |  |  |  |  |
| b04 |  |  |  |  |  |  |  |  |
| b05 |  |  |  |  |  |  |  |  |
| … |  |  |  |  |  |  |  |  |
| b19 |  |  |  |  |  |  |  |  |

Replace the existing contents of 6.4.2 PHY PIB attributes with:

**6.4.2 PHY PIB attributes**

*Change Table 31 as follows:*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Attribute | Identifier | Type | Range | Description |
| *phyChannelsSupported* | 0x01 | Array | An R x 32  bit array,  where R  ranges from  1 to 32 | The array is composed of R rows,  each of which is a bit string with the  following properties: The 5 MSBs  (b27, …, b31) indicate the channel  page, and the 27 LSBs (b0, b1, …,  b26) indicate the status (1=available,  0=unavailable) for each of the up to  27 valid channels (b*k* shall indicate  the status of channel *k* as in 6.1.2)  supported by that channel page.  For channel pages 7 and 8, the 27 LSBs as defined in 6.4.2.x  The device only needs to add the rows  (channel pages) for the PHY(s) it supports. |
| *phyNumberChannelBandsSupported* |  | Integer | 0..65535 | The number of elements in *phyChannelBandsSupported* |
| *phyChannelBandsSupported* |  | Integer |  |  |
| *phyCurrentBand* |  | Integer | Current Band |  |
| *phyModulationType* |  | Integer | Modulation Type |  |
| *phyCurrentModulationType* |  | Integer | Current Modulation Type |  |
| *phyCurrentPHYMode* |  | Integer | Current PHY Mode | When the channel page is 7 or 8, The current PHY Mode is indexed by *phyCurrentChannelBand index , phyCurrentModulationType and a bit set to 1in the bitmap PHY Mode.* |

**6.4.2.x Complete PHY Mode Descriptor**

A PHY Mode descriptor shall be as defined in Table (PHY Mode Descriptor)

Table x - PHY Mode Descriptor

|  |  |  |  |
| --- | --- | --- | --- |
| **Attribute** | **Type** | **Valid Range** | **Description** |
| Channel Band Index | Integer | 0-31 | Unique Channel Band identifier |
| Modulation Type Index | Integer | 0-3 | Band agnostic Modulation Type identifier , as defined in 6.1.2.5a |
| PHY Mode | bitmap | .. | Parametric PHY Descriptor, as defined in Table (Parametric PHY Descriptor) |

The complete PHY Mode Descriptor shall be formed from Channel Page Index, The Channel Band Index, the Modulation Type Index and a value of 1 set for the appropriate bits into the PHY Mode bitmap field. The bits set to 1 from the PHY Mode bitmap field correspond to ones defined in Table x1b1.x, Table x1b2.x, Table x1b3.x.

For channel page 8, the PHY Mode descriptor shall be formed from Channel Page Index, The Channel Band Index, the Modulation Type Index and a value of 1 set for the appropriate bits into the PHY Mode bitmap field. The bits set to 1 from the PHY Mode bitmap field correspond to ones defined by each vendor in tables structures as Table x1b1.x, Table x1b2.x, Table x1b3.x..

Figure x – Frequency Band Descriptor

|  |  |  |  |
| --- | --- | --- | --- |
| **Attribute** | **Type** | **Valid Range** | **Description** |
| Band Edge | Integer | … | Starting frequency of channel band |
| Channel Spacing | Integer | … | Separation of adjacent channel centre frequencies – standard separations are 50, 100, 200, 400, 600 kHz |
| Number of Channels | Integer | 1.. | Number of channels in the band – defines the upper frequency limit of the channel band |

Figure x –PHY Mode Descriptor per Modulation Type

|  |  |  |  |
| --- | --- | --- | --- |
| **Attribute** | **Type** | **Valid Range** | **Description** |
| PHYType | Integer | 0-3 | 0 = reserved  1 = FSK  2 = OFDM  3 = DSSS |
| FSK PHY Descriptor variant (Content of following parameters may vary by PHY type. ) | | | |
| ModOrder | Enumeration | {2…n} | Modulation order; Defines bits/symbol  (bits/symbol = mod order/2) |
| FSKModIndex | Float | 0.25-2.5 | Modulation Index |
| GFSKBT | Enumeration | BT\_0.5  BT\_1.0  BT\_OFF | Gaussian transmit shaping filter used. If BT\_OFF no shaping filter (FSK). |
| SymbolRate | Integer | 1kHz - 1MHz | Integer 1Hz steps. . |
|  |  |  |  |