IEEE P802.15

Wireless Personal Area Networks

Project	IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)
Title	**Channel Page/Numbering & Generic PHY Text**
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Re:	Text submission for 15.4g draft
Abstract	This draft text summarizes the Channel Page/Number architecture presented in document 15-10-0140-01-004g. Document 15-10-0140-01-004g was a modification of Channel Page/Number proposals from Larry Taylor and Daniel Popa.
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 Clause 6:

6.1.2 Channel assignments

Insert the following paragraph after the last paragraph:

The introduction of the "400/470/863/915/950/2450 MHz FSK/GFSK/4-GFSK PHY specifications" results in the total number of channel assignments exceeding the channel numbering capability of the 32 channel pages that were defined in the 2006 edition of this standard. To be consistent with existing channel page/channel number structures, channel page 7 and channel page 8 have been allocated for SUN applications with different definitions as described in 6.1.2.5a.

6.1.2.1 Channel numbering

Change the first paragraph of 6.1.2.1 as indicated:

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

6.1.2.5a Channel numbering for SUN PHYs

Channel pages 0-6 allow up to 27 channels per page, where each bit in the channel page corresponds to a specific PHY mode channel. Each channel is for a specific PHY mode, where the frequency band, modulation scheme, and number of channels are defined and the channel bit in the channel page corresponds to a specific channel for the defined PHY mode.

To support the expanded number of channels required, the channel pages to support the 802.15.4g defined PHY modes will utilize a new definition. For 802.15.4g defined PHY modes, the channel page is used to define the PHY mode, where the PHY mode definition is for a specific frequency band and modulation scheme. Channel page 7 will be used for standard defined PHY modes added with the 802.15.4g amendment. The 802.15.4g amendment also provides a mechanism where additional PHY modes can be defined with a Generic PHY mechanism. Channel page 8 will be used for Generic PHY defined PHY modes.

The page 7 and page 8 channel page structures are shown in Figure 1Figure 1. The contents of Channel Page 7 and Channel Page 8 are described in 6.1.2.5a.1 and 6.1.2.5a.2 respectively.

31 30 29 28 27	26 25 24 23 22	21 20	19 18 17 16	15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Page 0	2450 MHz. O-QPSK, 16 Channels			915 MHz. BPSK, 10 Channels / *
⋮			⋮	⋮
⋮			⋮	⋮
Page 6	Reserved	950 MHz. GFSK, 12 Channels		950 MHz, BPSK, 11 Channels
Page 7	Freq Band	Modulation Scheme	Reserved	**Standard Defined PHY Modes** Bit map, where each bit corresponds to a particular PHY mode. PHY modes are defined for each Freq Band and Modulation Scheme
Page 8	Reserved	Reserved	Reserved	**Generic PHY Defined PHY Modes** Bit map, where a set bit indicates a Generic PHY mode supported by the device. Each set bit position corresponds to an element in phyGenericPHYDescriptors
Pages 9-31	Reserved			

Figure 1: Channel Page Structure for Pages 7 and 8

6.1.2.5a.1 Channel page structure for standard defined PHY modes

Channel page 7 is allocated to the standard defined SUN PHY operating modes. As shown in Figure 1Figure 1, Page 7 consists of three fields to specify the SUN operating modes. The three fields are:

- Frequency Band: 5 bits (bit 26 to bit 22) to define up to 32 possible frequency bands

- Modulation Scheme: 2 bits (bit 21 to bit 20) to define up to 4 modulation schemes

- PHY Mode: 2016 bits (bit 159 to bit 0) to define up to 1620 modes for each frequency band and modulation scheme.

The integer values used to define the frequency bands are shown in Table 1Table 1. The integer values used to define the modulation scheme are shown in Table 2Table 2. The PHY mode definition is specific to the frequency band and modulation scheme. Each bit in the PHY mode field corresponds to a standard defined PHY mode for the particular frequency band and modulation scheme. Section 6.1.2.5a.1.1 enumerates the standard defined PHY modes.

Table 1 - Frequency Band Definitions

Decimal	binary $(b_{26}, b_{25}, b_{24}, b_{23}, b_{22})$	Description
0	(0, 0, 0, 0, 0)	950MHz (Japan)
1	(0, 0, 0, 0, 1)	400-430 MHz (Japan)
2	(0, 0, 0, 1, 0)	863–870 MHz
3	(0, 0, 0, 1, 1)	915 MHz
4	(0, 0, 1, 0, 0)	2400-2483.5 MHz
5	(0, 0, 1, 0, 1)	220-222, US and Canada, 12.5kHz BW channels
6	(0, 0, 1, 1, 0)	450-470 MHz (US FCC Part 90)
7	(0, 0, 1, 1, 1)	470-510 MHz (China)
8	(0, 1, 0, 0, 0)	896-901 MHz (US FCC Part 90)
9	(0, 1, 0, 0, 1)	901-902 MHz (US FCC Part 24)
10	(0, 1, 0, 1, 0)	928-960 MHz (US, Non-contiguous)
11	(0, 1, 0, 1, 1)	1427-1452 MHz (US and Canada, non-contiguous)
12	(0, 1, 1, 0, 0)	1492-1518 MHz (US and Canada, non-contiguous)
13	(0, 1, 1, 0, 1)	1605-1625 MHz (US, Non-contiguous)
14	(0, 1, 1, 1, 0)	1800-1830 MHz (US and Canada, Non-contiguous)
15	(0, 1, 1, 1, 1)	779-787 MHz (China)
16	(1, 0, 0, 0, 0)	922 MHz (Korea)
17	(1, 0, 0, 0, 1)	TV white spaces
18-31		Reserved

Table 2 Modulation scheme representation

Decimal	Binary (b_{21}, b_{20})	Description
0	(0, 0)	FSK/GFSK
1	(0, 1)	OFDM
2	(1, 0)	O-QPSK
3	(1, 1)	Reserved

6.1.2.5a.1.1 Standard Defined PHY Modes

6.1.2.5a.1.1.1 *Frequency Band = 0, 950 MHz (Japan)*

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	0	0	0	0	0	Reserved																	1	1	1
Page 7					0 = 950 MHz					0=(G)FSK		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = 50 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 200/400 kHz (mandatory mode)
Bit Position 1 = 100 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 400 kHz
Bit Position 2 = 200/400 kbps, GFSK/4-GFSK, Mod Index = 1.0/0.33, Channel Spacing = 600 kHz
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.2 *Frequency Band = 1, 400-430 MHz (Japan)*

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	0	0	1	0	0	Reserved																	1	1	1
Page 7					1=400-430MHz					0=(G)FSK		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = 50 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 200/400 kHz (mandatory mode)
Bit Position 1 = 100 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 400 kHz
Bit Position 2 = 200/400 kbps, GFSK/4-GFSK, Mod Index = 1.0/0.33, Channel Spacing = 600 kHz
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.3 *Frequency Band = 2, 863-870 MHz*

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	0	1	0	0	0	Reserved																	1	1	1
Page 7					2 = 863-870					0=(G)FSK		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = 50 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 200 kHz (mandatory mode)
Bit Position 1 = 100 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 400 kHz
Bit Position 2 = 200 kbps, 4-GFSK, Mod Index = 1/3, Channel Spacing = 400 kHz
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.4 *Frequency Band = 3, 915 MHz*

6.1.2.5a.1.1.4.1 FSK Modulation

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	0	1	1	0	0	Reserved																	1	1	1
Page 7					3 = 915 MHz					0=(G)FSK		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = 50 kbps, FSK, Mod Index = 1.0, Channel Spacing = 200 kHz (mandatory mode)
Bit Position 1 = 150 kbps, FSK, Mod Index = 0.5, Channel Spacing = 400 kHz
Bit Position 2 = 200 kbps, GFSK, Mod Index = 0.5, Channel Spacing = 400 kHz
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.4.2 OFDM Modulation

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page 7					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	0	1	1	0	1	Reserved																	1	1	1
Page 7					3 = 915 MHz					1 = OFDM		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 =
Bit Position 1 =
Bit Position 2 =
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.4.3 O-QPSK Modulation

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	0	1	1	1	0	Reserved																1	1	1	1
Page 7					3 = 915 MHz					2 = O-QPSK		Four standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = Chip rate =1000 kchip/s, 16,1 spreading, Data Rate = 31.25 kbps
Bit Position 1 = Chip rate =1000 kchip/s, 16,4 spreading, Data Rate = 125 kbps
Bit Position 2 = Chip rate = 1000 kchip/s, 8,4 spreading, Data Rate = 250 kbps
Bit Position 3 = Chip rate =1000 kchip/s, no spreading, Data Rate = 500 kbps
Bit Positions 4-19 = Reserved

6.1.2.5a.1.1.5 *Frequency Band = 4, 2400-2483.5 MHz*

6.1.2.5a.1.1.5.1 FSK Modulation

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page 7					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	1	0	0	0	0	Reserved																	1	1	1
Page 7					4 = 2400 MHz					0=(G)FSK		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = 50 kbps, FSK, Mod Index = 1.0, Channel Spacing = 200 kHz (mandatory mode)
Bit Position 1 = 150 kbps, FSK, Mod Index = 0.5, Channel Spacing = 400 kHz
Bit Position 2 = 200 kbps, GFSK, Mod Index = 0.5, Channel Spacing = 400 kHz
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.6 *Frequency Band = 5, 220-222, US and Canada, 12.5 kHz BW channels*

Details to be filled in

6.1.2.5a.1.1.7 *Frequency Band = 6, 450-470 MHz (US FCC Part 90)*

Details to be filled in

6.1.2.5a.1.1.8 *Frequency Band = 7, 470-510 MHz (China)*

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Page					Freq Band					Modulation		Standard Defined PHY Modes																			
0	0	1	1	1	0	0	1	1	1	0	0	Reserved																	1	1	1
Page 7					7 = 470-510					0=(G)FSK		Three standard defined PHY modes (bit positions 0-2)																			

Bit Position 0 = 50 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 200 kHz (mandatory mode)
Bit Position 1 = 100 kbps, GFSK, Mod Index = 1.0, Channel Spacing = 400 kHz
Bit Position 2 = 200 kbps, 4-GFSK, Mod Index = 1/3, Channel Spacing = 400 kHz
Bit Positions 3-19 = Reserved

6.1.2.5a.1.1.9 Frequency Band = 8, 896-901 MHz (US FCC Part 90)

Details to be filled in

6.1.2.5a.1.1.10 Frequency Band = 9, 901-902 MHz (US FCC Part 24)

Details to be filled in

6.1.2.5a.1.1.11 Frequency Band = 10, 928-960 MHz (US, Non-contiguous)

Details to be filled in

6.1.2.5a.1.1.12 Frequency Band = 11, 1427-1452 MHz (US and Canada, non-contiguous)

Details to be filled in

6.1.2.5a.1.1.13 Frequency Band = 12, 1492-1518 MHz (US and Canada, non-contiguous)

Details to be filled in

6.1.2.5a.1.1.14 Frequency Band = 13, 1605-1625 MHz (US, Non-contiguous)

Details to be filled in

6.1.2.5a.1.1.15 Frequency Band = 14, 1800-1830 MHz (US and Canada, Non-contiguous)

Details to be filled in

6.1.2.5a.1.1.16 Frequency Band = 15, 779-787 MHz (China)

Details to be filled in

6.1.2.5a.1.1.17 Frequency Band = 16, 922 MHz (Korea)

Details to be filled in

6.1.2.5a.1.1.17 Frequency Band = 17, TV white spaces

Details to be filled in

6.1.2.5a.2 Channel page structure for Generic PHY Defined PHY Modes
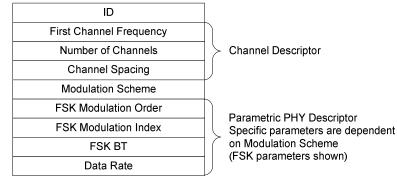
Channel Page 8 is used to list Generic PHY operating modes. As shown in Figure 1Figure 1, the channel page 8 structure uses the least significant 2016 bits to represent the

available Generic PHY descriptors. Each bit corresponds to the Generic PHY Id (0-1~~5~~9) and the Id is the index (0-1~~5~~9) in the *phyGenericPHYDescriptors* array. In Channel Page 8, the bit fields used to represent frequency band and modulation scheme are reserved and the frequency band and modulation scheme are defined by the Generic PHY descriptor.

A generic PHY descriptor consists of fields to define a specific frequency band (Channel Descriptor), a particular modulation scheme, and parametric descriptors that are specific to the modulation scheme. A generic PHY descriptor is shown in Table 3~~Table 3~~. The *phyGenericPHYDescriptors* array consists of up to 16~~20~~ generic PHY descriptors. For an example of the use of the generic PHY mechanism, refer to Annex P.

Table 3: Generic PHY Descriptor

ID
First Channel Frequency
Number of Channels	Channel Descriptor
Channel Spacing
Modulation Scheme
FSK Modulation Order
FSK Modulation Index	Parametric PHY Descriptor Specific parameters are dependent on Modulation Scheme (FSK parameters shown)
FSK BT
Data Rate

6.1.2.5a.2.1 Generic PHY Channel Descriptor

The channels available in the Generic PHY Descriptor mode are defined by the following fields:

- First channel frequency – the center frequency of the first channel

- Number of channels – The number of contiguous channels starting at the first channel frequency

- Channel spacing – The spacing between adjacent channels

6.1.2.5a.2.2 Generic PHY Modulation Scheme and Modulation Scheme Specific Parameters

The generic PHY mode is described by a modulation scheme, and then by parameters or descriptors that are specific to the modulation scheme. FSK is the only modulation scheme with defined parameters. A generic PHY FSK modulation scheme is defined by the following parameters:

- FSK Modulation Order – enumerated as 2-level or 4-level FSK

- FSK Modulation Index

- FSK BT – defines if the mode is FSK or GFSK by specifying a value for BT

6.1.2.5a.2.3 Generic PHY Data Rate

Regardless of modulation scheme, the data rate defines the raw over-the-air bit rate for the generic PHY mode.

6.1.2.6 Channel pages

Change Table 4(the entire table is not shown) as indicated:

Channel page (decimal)	Channel page (binary) (b31, b30, b29, b28, b27)	Channel number(s) (decimal)	Channel number description
7	0 0 1 1 1	Not Applicable	Enumerates the standard defined PHY modes added with the 802.15.4g amendment. See section 6.1.2.5a.1. The channel page is used to define the frequency band, modulation scheme, and PHY mode. The channels are defined by *phySunChannelsSupported*.
8	0 1 0 0 0	Not applicable	Enumerates the SUN PHY modes defined using the Generic PHY mechanism. See section 6.1.2.5a.2. The channel page is used to define the frequency band, modulation scheme, and PHY mode. The channels are defined by *phySunChannelsSupported*.
9-31	0 1 0 0 1 – 1 1 1 1 1	*Reserved*	*Reserved*

6.4.2 PHY PIB attributes

Change Table 31 (the entire table is not shown) as indicated:

The following fields in Table 31 of the current draft are to be removed:

- phyCapabilitiesTable
- phyMaxNumChannels
- phyMode
- phyNumSets
- phyScramblePHR
- phyScrambleSeed

Table 31

Attribute	Identifier	Type	Range	Description
phyCurrentChannel	0x00	Integer	(*Editor's note: modify the range to the following values*) 0-511	
phyNumSunPageEntriesSupported		Integer	0-63	Number of SUN page entries supported
phySunPageEntriesSupported		Array	An R x 32-bit array, where R ranges from 0 to *phyNumSunPageEntriesSupporte*	Each row is a 32-bit element defining a supported SUN page 7 or 8 entry. The 32-bits are per the page 7 and page 8 "channel page"

			d	definitions.
phyCurrentSunPageEntry		Bit Map	32 bits	Used to define the current frequency band, modulation scheme, and particular PHY mode when *phyCurrentPage* = 7 or 8. A 32-bit field per the page 7 or page 8 definitions, but only one bit in the ~~20~~16-bit PHY MODE field will be set to indicate the current mode. If it is a page 7 entry, the set bit indicates the particular standard defined PHY mode. If it is a page 8 entry, the set bit indicates the index or ID in the *phyGenericPHYDescriptors* array used to define the current PHY mode.
phyMaxSunChannelSupported		Integer	0-511	The page 7 or page 8 entry specified by *phyCurrentSunPageEntry* describes the total number of defined channels for the PHY mode, where there are either a standard defined number of channels (page 7) or a Generic PHY defined number of channels (page 8). *phyMaxSunChannelSupported* defines the highest channel number supported by the device and is used to size the *phySunChannelsSupported* array. *phyMaxSunChannelSupported* is only valid if *phyCurrentPage* equals 7 or 8.
phySunChannelsSupported		Bit Map	*phyMaxSunChannelSupported*/8 octets or *phyMaxSunChannelSupported*+1 bits	Channel bit map identifying which channels may be used when *phyCurrentPage* = 7 or 8. Bit zero in the first byte corresponds to channel zero and bit seven in the first byte corresponds to channel 7. Bit zero in the second byte corresponds to channel 8 and bit seven in the second byte corresponds to channel 15, etc. A bit is set (=1) to indicate the channel is available and the bit is clear (=0) to indicate the channel is unavailable.
phyNumGenericPHYDescriptors		Integer	0-16~~20~~	Number of Generic PHY Descriptors supported by the device.
phyGenericPHYDescriptors		Array	An array sized by *phyNumGenericPHYDescriptors.* The size of each element is per the *GenericPHYDescriptorsEntry*	A table of entries where each entry is used to define a page 8 PHY mode.

			defined in Table 31a.	

Table 31a – Elements of phyGenericPHYDescriptors

Id		Integer	0-15~~19~~	An identifier of the Generic PHY mode. This id corresponds to a bit position (0-15~~19~~) in the page 8 channel page definition.
FirstChannelFrequency		Integer	All bands	Specifies the center frequency, in Hertz, of the first channel in the list.
NumChannels		Integer	0-511	The number of channels defined for the particular PHY mode. The actual channels supported by the device are defined by *phySunChannelsSupported*
ChannelSpacing		Integer	1 – 1,000,000 Hz	The channel spacing (distance between adjacent center frequencies) in Hertz.
DataRate		Integer	1 – 1,000,000 bps	The data rate in bps
ModulationScheme		Enumeration	0 = FSK/GFSK 1 = OFDM 2 = O-QPSK 3 = reserved NOTE – if specific parameters are not defined for the other modulation schemes, values 1-3 will be left as reserved	The modulation scheme of the Generic PHY entry. The remaining Generic PHY parameters are determined based on the modulation scheme.
FSK.ModulationOrder		Enumeration	0 = 2-level FSK 1 = 4-level FSK	The FSK modulation order
FSK.ModulationIndex		Float	0.25 – 2.50	The FSK modulation index
FSK.BT		Enumeration	0 = 0.5 1 = 1.0	The FSK BT. 0.5 for GFSK or 1.0 for FSK

6.3.2a.1 Mode Switching subfield

Change TBD at the end of the first paragraph to be the Canonical Name:

Add the following text and figure to the end of the first paragraph:

The Canonical Name specifies the operating mode of the subsequent PPDU following the PPDU that contains the Mode Switch subfield. The Canonical Name is a page entry in Channel Page 7 or Channel Page 8 as shown in Figure 2Figure 2. As indicated in Figure 2Figure 2, a Canonical Name can be shortened from 32 bits to 87 bits to reduce overhead. The full representation is the same as the 32-bit Channel Page 7 or 8 definition. The 32-bits can be shorted as follows:

- Only page 7 or 8 needs to be selected; the 5-bit page can be shorted to one bit to select page 7 (0) or page 8 (1)

- The frequency band does not need to be specified, as mode switching is only supported within a given frequency band

- Mode switching from one modulation scheme (e.g. FSK) to another modulation scheme (e.g. OFDM) is supported and the 2-bit modulation scheme needs to be specified

- Mode is the integer value of the new mode, where the integer value of the mode corresponds to the standard defined bit position (page 7) or the Generic PHY ID (page 8). With 16 available bits, 16 modes are possible and the integer value for the specific mode can be specified by a 4-bit field

	Page	Freq Band	Mod Scheme	Mode
Full representation	5 bits	5 bits	2 bits	20 bits
Shortened form	1 bit *	0 bits	2 bits	4 bits
	* Only need to select page 7 or 8			

Figure 2: Structure of the Canonical Name