Title: **3 Mbit/s FH PHY PMD Text Proposal**

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Introduction

In document P802.11-96/52 the extension of the current FH PMD to support an optional 3 Mbit/sec rate was presented. Further, document P802.11-96/80 presented text replacements needed to incorporate 3 Mbit/s PMD into clause 14. Document P802.11-96/80 was written as a replacement to 2 Mbit/s PMD description which describes jointly the 2 and 3 Mbit/s PMDs. The FH group preferred to have the 3 Mbit/s PMD text to be encapsulated into separate subclause as to minimize changes to existing text. This submission reflects this trend.

Editorial Note

The text replacement shown below was produced as a modification of SEC11.DOC file from D4.0 draft, after accepting revisions. No field codes were changed in order to make inclusion in the draft easier. As a result the numbering of the sections, tables and figures is incorrect in this paper. I apologize to the readers of this document for the inconvenience caused by it.

Text Changes follow:

14.1.1.1 PMD_SAP Service Primitives Parameters

The following table shows the parameters used by one or more of the PMD_SAP Service Primitives.

Parameter	Associate Primitive	Value
TXD_UNIT	PMD_DATA.request	1 Mbit/s: 0, 1 2 Mbit/s: 0, 1, 2, 3 3 Mbit/s: 0, 1, 2, 3, 4, 5, 6, 7
RXD_UNIT	PMD_DATA.indicate	1 Mbit/s: 0, 1 2 Mbit/s: 0, 1, 2, 3 3 Mbit/s: 0, 1, 2, 3, 4, 5, 6, 7
RF_STATE	PMD_TXRX.request	TRANSMIT, RECEIVE
RAMP_STATE	PMD_PARAMP.request	ON, OFF
ANTENNA_ STATE	PMD_ANTSEL.request	1 to 255
TXPWR_LEVEL	PMD_TXPWRLVL.request	LEVEL1, LEVEL2, LEVEL3, LEVEL 4
CHNL_ID	PMD_FREQ.request	2 through 80 inclusive
STRENGTH	PMD_RSSI.indicate	0 - RSSI Max
MODE	PMD_PWRMGNT.request	ON, OFF

14.2 FHSS Physical Medium Dependent Sublayer 3.0M Bit

14.2.1 Introduction

The following subclause details the RF specification differences of the optional 3.0 Mbit/s operation from the baseline 1 Mbit/s PMD as contained in subclause **Error! Reference source not found.** and the optional 2 Mbit/s PMD as contained in (reference). Unless otherwise specified in this subclause, the compliant PMD shall also meet all requirements of subclause **Error! Reference source not found.** when transmitting at 3 Mbit/s. When implementing the 3 Mbit/s PLCP_PDU option, the preamble and PHY Header shall be transmitted at 1 Mbit/s. Stations implementing the 3 Mbit/s option shall also be capable of transmitting and receiving PLCP_PDUs at 1 Mbit/s and 2 Mbit/s.

The 3 Mbit/s PMD description is augmented with comparative data regarding the 1 Mbit/s and 2 Mbit/s PMDs in order to convey the structural similarity among the PMD's being layers of same modulation

14.2.2 Multilevel GFSK Modulation

For a FHSS 3 Mbit/s PMD, the modulation scheme shall be 8 level Gaussian Frequency Shift Keying (8GFSK), with a nominal symbol-period bandwidth product (BT) = 0.5. The eight level deviation factor, defined as the frequency separation of adjacent symbols divided by symbol rate, h8, shall be related to the deviation factor of the 2GFSK modulation, h2, by the following equations:

$$h8/h2 = 0.225 +/- 0.005$$

An incoming bit stream at 3 Mbit/s will be converted to 3 bit, respectively, words or symbols, with a rate of Fclk=1 Msymbol/sec. The first received bit will be encoded as the left most bit of the symbol in the table below. In the case of 3 Mbit/s PMD trailing zeroes will be appended to the last data bit, if needed, until the last symbol is filled with 3 bits. The bits will be encoded into symbols as shown in Table A below:

1 Mbit/sec, 2-GFSK

Symbol	Carrier Deviation
1	1/2 * h2*Fclk
0	-1/2 * h2*Fclk

2 Mbit/sec, 4-GFSK

Symbol	Carrier Deviation
10	3/2 * h4*Fclk
11	1/2 * h4*Fclk
01	-1/2 * h4*Fclk
00	-3/2 * h4*Fclk

3 Mbit/sec, 8-GFSK

Symbol	Carrier Deviation
100	7/2 * h8*Fclk
101	5/2 * h8*Fclk
111	3/2 * h8*Fclk
110	1/2 * h8*Fclk
010	-1/2 * h8*Fclk
011	-3/2 * h8*Fclk
001	-5/2 * h8*Fclk
000	-7/2 * h8*Fclk

Table A, Symbol Encoding into Carrier Deviation

*Note: These deviation values are measured using the center symbol of 7 consecutive symbols of the same value. The instantaneous deviation will vary due to Gaussian pulse shaping.

The deviation factor h2 for 2GFSK (measured as difference between frequencies measured in the middle of 0000 and 1111 patterns encountered in the SFD, divided by 1 MHz) will nominally be 0.32. h2 will be no less than 0.30 (with maximum dictated by regulatory bandwidth requirement). Accordingly, h4 (measured as a difference between the outermost frequencies, divided by 3, divided by 1 MHz) is nominally 0.45*0.32=0.144, and it will be no less than 0.45*0.3=0.135. For 3 Mb/s PMD, h8 (measured as a difference between the outermost frequencies, divided by 7, divided by 1 MHz) is nominally 0.225*0.32=0.072, and it will be no less than 0.225*0.3=0.0675.

The modulation error shall be less than +/-15 kHz or 8 kHz at the mid symbol time for 4GFSK and 8GFSK, respectively, from the frequency deviations specified above, for a symbol surrounded by identical symbols, and less than +/-25 kHz for any symbol. The deviation is relative to the actual center frequency of the RF carrier. For definition purposes, the actual center frequency is the mid frequency between symbols 11 and 01 for 4GFSK and between 001 and 101 symbols for 8GFSK. The actual center frequency shall be within +/- 60 kHz of the nominal channel center frequency defined in subclause**Error! Reference source not found.**and shall not vary by more than +/-10 kHz/msec, from the start to end of the PLCP_PDU. The peak-to-peak variation of the actual center frequency over the PLCP_PDU shall not exceed 15 kHz. Symbols and terms used within this subclause are illustrated in the Figure A below:

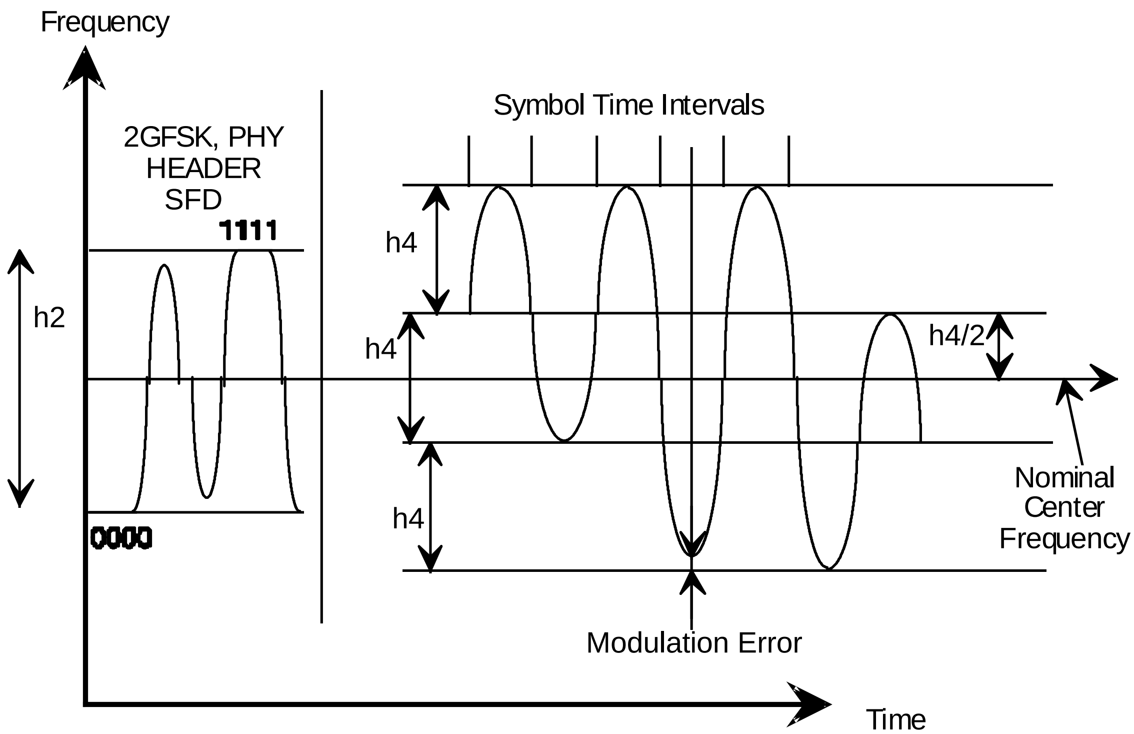

Figure A, 4 Level GFSK Transmit Modulation

14.2.2.1 Frame Structure for HS FHSS PHY

The High Rate FHSS PHY frame consists of PLCP preamble, PLCP header and PLCP_PDU. The PLCP preamble and PLCP header format are identical to 1 Mbit/s PHY, as described in **Error! Reference source not found.** The PLCP_PDU is transmitted in 2GFSK, 4GFSK or 8GFSK format, according to the rate chosen. The **rate** is indicated in a 3 bit field in a PLCP header, having value of 1, 2 or 3 bits/symbol (or Mbit/sec), correspondingly.

The PLCP_PDU is transmitted as 2, 4 or 8 level symbols, with the amount determined by

number_of_symbols = (number_of_MPDU_bytes*8+(rate-1))/rate .

The input bits are scrambled according to the method in **Error! Reference source not found.**

The scrambled bit stream is divided into groups of **rate** (1, 2 or 3) consecutive bits. The bits are mapped into symbols according to Table A.

A Bias suppression algorithm is applied to the resulting symbol stream. The bias suppression algorithm is defined in (table following - encoding) and (table following-decoding), and (figure). A polarity control symbol is inserted prior to each block of 32 symbols (or less for the last block). The polarity control signals used are symbols with the outermost frequency deviations. The algorithm is equivalent to the case of 2GFSK, with the polarity symbol 2GFSK '1' replaced with 4GFSK symbol '10' or 8GFSK symbol '100', respectively, and the 2GFSK polarity symbol '0' replaced with a 4GFSK symbol '00' or 8GFSK symbol '000', respectively.

Data Whitener Encoding Algorithm:

```
/*        If msb of stuff symbol = 1 = next block is inverted; 0 = not inverted */
/*        Accumulate PLCP Header; begin stuffing on first bit of the PLCP_PDU */

/********* Calculate number of 32-symbol BSE blocks required to send MPDU;
                  no padding is necessary for number of symbols not multiple of 32 *********/
Input parameter: number_of_MPDU_octets, rate;              /* rate is 1, 2 or 3*/
number_of_symbols= truncate{(number_of_MPDU_octets *8+(rate-1)) /rate};
number_of_blocks_in_packet = truncate{(number_of_symbols + 31) / 32)};

/********* Accumulate the bias in the header to use in calculating the inversion state of the first
                  block of PLCP_PDU data *********/
Read in header {b(1),...,b(32)};                           /* b(1) is first bit in */
header_bias = Sum{weight(b(1)),...,weight(b(32))};
                        /* calculate bias in header; weights are defined in Table 11-4 */
Transmit {b(1),...,b(32)};                                 /* no stuffing on header */
accum=header_bias;                                         /* initialize accum */
Initialize scrambler to all ones;

/********* Whiten the  PLCP_PDU data with scrambler and BSE encoder *********/
For n = 1 to number_of_blocks_in_packet
{
        b(0) = 0 for 1 Mbit/s; b(0)=00 for 2 Mbit/s; b(0)=000 for 3 Mbit/s;/* b(0) is the stuff symbol */
        N = min(32, number_of_symbols);                    /* N= block size in symbols */
        Read in next symbol block {b(1),...,b(N)};         /* b(n) = {0,1} , {0,1,2,3} or {0,..,7};
                  1 - 4*rate octets, use PHY_DATA.req(DATA), PHY_DATA.confirm for each octet*/
        Scramble {b(1),...,b(N)};                          /* see subclause Error! Reference source not
found. */
        bias_next_block = Sum{weight(b(0)),...,weight(b(N))};      /* calculate bias with b(0)=0 */

        /***** if accum and bias of next block has the same sign, then invert block;
        if accum=0 or bias_next_block=0, don't invert*****/
        If {[accum * bias_next_block > 0] then
          {
                  Invert {b(0),...,b(N)};                  /* Invert deviation, or, negate msb of symbol */
                  bias_next_block = - bias_next_block;
          }

        accum = accum + bias_next_block;
        transmit {b(0),...,b(N)};                          /* b(0) is first symbol out */
        number_of_symbols = number_of_symbols - N
}
```

Figure B, Data Whitener Encoding Procedure

The weights assigned to each value of the symbols are defined in **Error! Reference source not found.** for the 1 Mbit/s (2GFSK), 2 Mbit/s (4GFSK) and 3 Mbps (8GFSK) symbols.

2GFSK	4GFSK	8GFSK	weight
		100	7
	10		6
		101	5
1			4
		111	3
	11		2
		110	1
center	center		0
		010	-1
	01		-2
		011	-3
0			-4
		001	5
	00		-6
		000	-7

Table B,Weights for Whitening Encoding Procedure

Note: The operation of the whitening algorithm does not change when all the weights are scaled by same factor. For example, a PMD supporting 1 Mbit/s only can use -1 and +1 as weights for '0' and '1', respectively.

Data Whitener Decoding Algorithm:

```
/*      If msb of stuff symbol = 1 = next block is inverted; 0 = not inverted */
/*      Stuffing begins on first symbol of PLCP Header following the start frame delimiter */
/*      Algorithm begins after verifying validity of header with HEC */

/********* Calculate bias in header for format error checking *********/
Read in header {b(1),...,b(32)};                      /* b(1) is first bit in */

Get number_of_MPDU_octets, rate from header;          /* rate is 1, 2 or 3 */
number_of_symbols = truncate{(number_of_MPDU_octets*8+(rate-1))/rate};
number_of_blocks_in_packet = truncate{(number_of_symbols + 31) / 32};
Initialize scrambler to all ones;

/********* De-whiten the PLCP_PDU data with BSE decoder and de-scrambler *********/
For n = 1 to number_of_blocks_in_packet
{
        N = min(32, # of symbols remaining);      /* N= block size in symbols */
        Read in next block {b(0),...,b(N)};           /* b(n) =  {0,1} , {0,1,2,3} or {0,..,7} */

        If {[msb of b(0)=1] then Invert {b(1),...,b(N)};          /* if invert bit=true */
        Descramble {b(1),...,b(N)};                   /* see subclause Error! Reference source not found. */
        Send {b(1),...,b(N)} to MAC
                                /* 1 - 8 octets; use PHY_DATA.ind(DATA) for each octet. */
}
```

Figure C, Data Whitener Decoding Procedure

14.2.3 Channel Data Rate

The channel symbol rate shall be 1.0 Msymbol/sec +/- 50 ppm. Accordingly, the data rate for the PLCP_PDU at the optional 3 Mbit/s rate shall be 3.0 Mbit/s +/- 50 ppm, respectively.

14.2.3.1 Input Dynamic Range

The PMD shall be capable of recovering a conformant PMD signal from the medium, as described in related subclauses, with a FER less than or equal to 3% for MPDUs of 400 octets generated with pseudo-random data, for receiver input signal levels in the range from -20 dBm to the receiver sensitivity (as specified in 14.2.3.2), across the frequency band of operation.

14.2.3.2 Receiver Sensitivity

The sensitivity is defined as the minimum signal level required for a Frame Error Ratio (FER) of 3% for MPDUs of 400 octets generated with pseudo random data. For a 3 Mbit/s PDU the sensitivity shall be less than or equal to -68 dBm. The reference sensitivity is defined as -68 dBm for the 3 Mbit/s FH PHY specifications.

14.2.3.3 Intermodulation

Intermodulation protection (IMp) is defined as the ratio to -77 dBm of the minimum amplitude of one of the two equal level interfering signals at 4 and 8 MHz removed from center frequency, both on the same side of center frequency, that cause the FER of the receiver to be increased to 3% for MPDUs of 400 octets generated with pseudo random data, when the desired signal is -65 dBm (3dB above the specified sensitivity specified in subclause 14.2.3.2) for 3 Mbit/s, respectively. Each interfering signal is modulated with the FH 1 Mbit/s PMD modulation uncorrelated in time to each other or the desired signal. The FHSS optional 3 Mbit/s rate IMp shall be greater than or equal to 25 dB.

14.2.3.4 Desensitization

Desensitization (Dp) is defined as the ratio to measured sensitivity of the minimum amplitude of an interfering signal that causes the FER of the receiver to be increased to 3% for MPDUs of 400 octets generated with pseudo random data, when the desired signal is -72 dBm or -65 dBm (3 dB above sensitivity specified in subclause 14.2.3.2) for 2 Mbit/s and 3 Mbit/s, respectively. The interfering signal shall be modulated with the FHSS PMD modulation uncorrelated in time to the desired signal. The minimum Dp shall be as given in Table C below:

Interferer Frequency	DP Minimum
M=N+/-2	20dB
M=N+/-3 or more	30dB

Table C, 3M Bit Desensitization

*M is the interferer frequency and N is the desired channel frequency