



## **10. 2.4 GHz ISM Band Frequency Hopping Spread Spectrum Physical Layer Specification**

## 10.1. Introduction

### 10.1.1. Introduction to FHSS Physical Layer

This section describes the physical layer services provided to the 802.11 Wireless LAN MAC for the 2.4 GHz Frequency Hopping Spread Spectrum (FHSS) system. The FHSS physical layer consists of the following two protocol functions:

- a) A physical layer convergence function which adapts the capabilities of the physical medium dependent system into the Physical Layer service. This function is supported by the Physical Layer Convergence Procedure (PLCP) which defines a method of mapping the 802.11 MAC layer Protocol Data Units (MPDU) into a framing format suitable for sending and receiving user data and management information between two or more stations using the associated physical medium dependent system.
- b) A Physical Medium Dependent (PMD) system whose function defines the characteristics of, and method of transmitting and receiving data via a wireless media between two or more stations.

### 10.1.2. FHSS Physical Layer Functions

The 2.4 GHz Frequency Hopping Spread Spectrum Physical Layer architecture is shown in Figure 10-1. The FHSS physical layer contains three functional entities: the physical medium dependent function, the physical layer convergence function, and the physical layer management function. Each of these functions is described in detail in the following subsections.

The FHSS Physical (PHY) Layer service is provided to the Media Access Control entity at the station through a PHY Service Access Point (SAP) as shown in Figure 10-1 called the PHY\_SAP. A set of primitives will also be defined to describe the interface between the physical layer convergence protocol sublayer and the physical medium dependent sublayer called the PMD\_SAP.

#### 10.1.2.1. Physical Layer Convergence Procedure Sublayer

In order to allow the 802.11 MAC to operate with minimum dependence on the PMD sublayer, a physical layer convergence sublayer is defined. This function simplifies a physical layer service interface to the 802.11 MAC services.

#### 10.1.2.2. Physical Layer Management Entity (LME)

The Physical LME performs management of the local Physical Layer Functions in conjunction with the MAC Management entity.

#### 10.1.2.3. Physical Medium Dependent Sublayer

The physical medium dependent sublayer provides a transmission interface used to send or receive data between two or more stations.

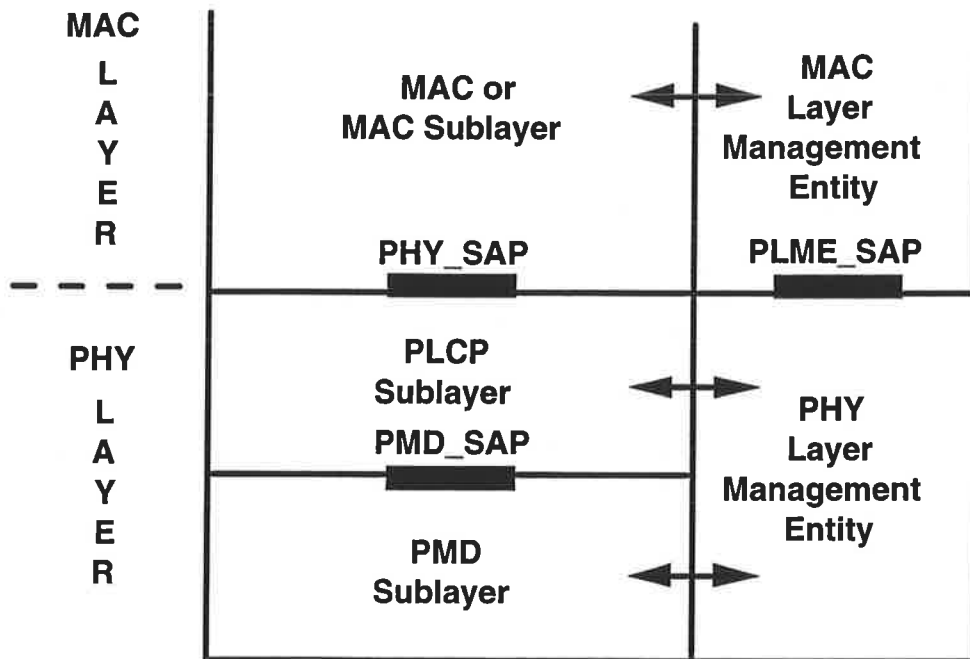


Figure 10-1: Protocol Reference Model

### 10.1.3. Service Specification Method and Notation

The models represented by state diagrams in the following sections are intended as the primary specifications of the functions provided. It is important to distinguish, however, between a model and a real implementation. The models are optimized for simplicity and clarity of presentation, while any realistic implementation may place heavier emphasis on efficiency and suitability to a particular implementation technology.

The service of a layer or sublayer is the set of capabilities that it offers to a user in the next higher layer (or sublayer). Abstract services are specified here by describing the service primitives and parameters that characterize each service. This definition of service is independent of any particular implementation.

## 10.2. FHSS PHY Specific Service Parameter Lists

### 10.2.1. Introduction

The architecture of the 802.11 MAC is intended to be physical layer independent. Some physical layer implementations require medium management state machines running in the media access sublayer in order to meet certain PMD requirements. These physical layer dependent MAC state machines reside in a sublayer define as the MAC Layer Management Entity (LME). The MAC LME in certain PMD implementations may need to interact with the Physical LME as part of the normal PHY\_SAP primitives. These interactions are defined by the Physical Layer Management Entity parameter list currently defined in the PHY Service Primitives as TXVECTOR and RXVECTOR. The list of these parameters and the values they may represent are defined in the specific physical layer specifications for each PMD. The following section addresses the PLME\_TXVECTOR and RXVECTOR for the FHSS PHY.

All of the values included in the TXVECTOR or RXVECTOR described in this section are considered mandatory unless otherwise specified.

### 10.2.2. TXVECTOR Parameters

The following parameters are defined as part of the TXVECTOR parameter list in the PHY\_DATA.request service primitive.

Parameter	Associate Primitive	Value
LENGTH	PHY_DATA.request(TXVECTOR)	0-2047
PLCP_BITRATE	PHY_DATA.request(TXVECTOR)	BASIC, HIGHSPEED

**Table 10-1: TXVECTOR Parameters**

#### 10.2.2.1. TXVECTOR LENGTH

The LENGTH parameter has the value of 0 to 2047. This parameter is used to indicate the number of octets in the MPDU that the MAC is currently requesting the PHY to transmit. This value is used by the PHY to determine the number of octet transfers which will occur between the MAC and the PHY after receiving a request to start a transmission.

### 10.2.2.2. TXVECTOR PLCP\_BITRATE

The PLCP\_BITRATE parameter is an optional parameter. Its value describes the bit rate the PLCP should use to transmit the PLCP\_PDU. Its value can be BASIC or HIGHSPEED. The BASIC rate is defined as the BSS\_Basic\_Rate in the FHSS PHY MIB. The HIGHSPEED rate is defined by the Current\_HighS\_Rate in the MIB.

### 10.2.3. PHY\_DATA.indicate RXVECTOR

The following parameters are defined as part of the RXVECTOR parameter list in the PHY\_DATA.indicate service primitive.

Parameter	Associate Primitive	Value
LENGTH	PHY_DATA.indicate (RXVECTOR)	0-2047
ANTSEL	PHY_DATA.indicate (RXVECTOR)	ANT1, ....., ANTn
RSSI	PHY_DATA.indicate (RXVECTOR)	0 - RSSI Max0-15

**Table 10-2: RXVECTOR Parameters**

#### 10.2.3.1. RXVECTOR LENGTH

The LENGTH parameter has the value of 0 to 2047. This parameter is used to indicate the value contained in the LENGTH field the PLCP has received in the PLCP Header. The MAC and PLCP will use this number to determine the number of octet transfers that will occur between the two sublayers during the transfer of the received MPDU.

#### 10.2.3.2. RXVECTOR ANTSEL

The ANTSEL parameter is an optional parameter. Its value describes the antenna used by the PLCP to receive the current MPDU. The antenna value is defined as ANT1, ....., ANTn where n is the number of antennae supported by the PMD implementation.

### 10.2.3.3. RXVECTOR RSSI

The Receive Signal Strength Indicator (RSSI) parameter has a value of 0 through ~~RSSI Max~~15. This parameter is an indication by the PHY sublayer the value of the energy observed on the antenna used to receive the current MPDU. RSSI shall be measured between the beginning of the start frame delimiter and the end of the PLCP Header error check. RSSI shall be measured between the beginning of the start frame delimiter and the end of the PLCP Header error check. RSSI is intended to be used in a relative manner. Absolute accuracy of the RSSI reading is not specified. ~~Since RSSI is only used in a relative manner by MAC sublayer, this parameter is define to have 16 values that range from 0 through 15. The value zero is the weakest signal strength while 15 is the strongest signal strength.~~

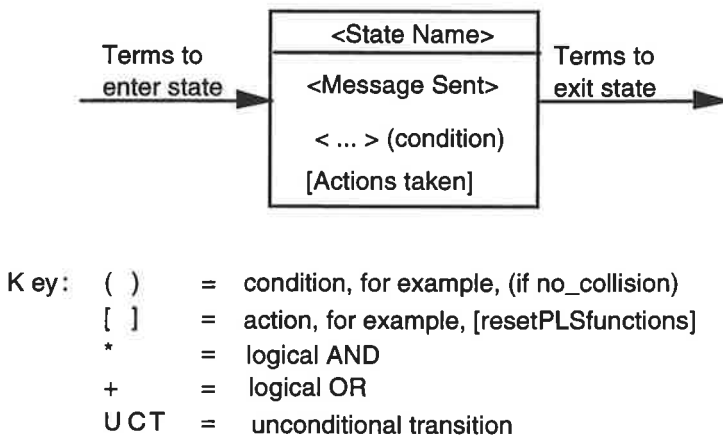
### 10.3. FHSS Physical Layer Convergence Procedure Sublayer

#### 10.3.1. Introduction

This section provides a convergence procedure to map MAC PDUs into a frame format designed for FHSS radio transceivers. The procedures for transmission, carrier sense, and reception are defined for single and multiple antenna diversity radios.

##### 10.3.1.1. State Diagram Notation

The operation of the procedures can be described by state diagrams. Each diagram represents the domain of a function and consists of a group of connected, mutually exclusive states. Only one state of a function is active at any given time. Each state that the function can assume is represented by a rectangle as shown in Figure 10-2. These are divided into two parts by a horizontal line. In the upper part the state is identified by a name in capital letters. The lower part contains the name of any signal that is generated by the function. Actions are described by short phrases and enclosed in brackets.



**Figure 10- 2: State Diagram Notation Example**

All permissible transitions between the states of a function are represented graphically by arrows between them. A transition that is global in nature (for example, an exit condition from all states to the IDLE or RESET state) is indicated by an open arrow. Labels on transitions are qualifiers that must be fulfilled before the transition will be taken. The label UCT designates an unconditional transition. Qualifiers described by short phrases are enclosed in parentheses.

State transitions and sending and receiving of messages occur instantaneously. When a state is entered and the condition to leave that state is not immediately fulfilled, the state executes continuously, sending the messages and executing the actions contained in the state in a continuous manner.



Some devices described in this standard are allowed to have two or more ports. State diagrams capable of describing the operation of devices with an unspecified number of ports, require qualifier notation that allows testing for conditions at multiple ports. The notation used is a term that includes a description in parentheses of which ports must meet the term for the qualifier to be satisfied (e.g., ANY and ALL). It is also necessary to provide for term-assignment statements that assign a name to a port that satisfies a qualifier. The following convention is used to describe a term-assignment statement that is associated with a transition:

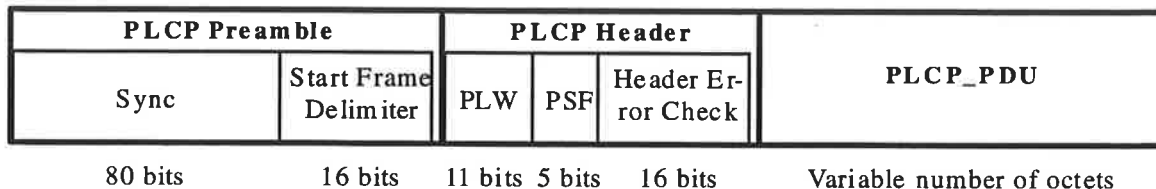
- (1) The character ":" (colon) is a delimiter used to denote that a term assignment statement follows.
- (2) The character "<" (left arrow) denotes assignment of the value following the arrow to the term preceding the arrow.

The state diagrams contain the authoritative statement of the functions they depict; when apparent conflicts between descriptive text and state diagrams arise, the state diagrams are to take precedence. This does not override, however, any explicit description in the text that has no parallel in the state diagrams.

The models presented by state diagrams are intended as the primary specifications of the functions to be provided. It is important to distinguish, however, between a model and a real implementation. The models are optimized for simplicity and clarity of presentation, while any realistic implementation may place heavier emphasis on efficiency and suitability to a particular implementation technology. It is the functional behavior of any unit that must match the standard, not its internal structure. The internal details of the model are useful only to the extent that they specify the external behavior clearly and precisely.

**10.3.2. Physical Layer Convergence Procedure Frame Format**

The PLCP Frame Format provides for the asynchronous transfer of MAC Layer MPDU from any transmitting station to all receiving stations within the wireless LAN. The PLCP frame format illustrated in Figure 10-3 consists of three parts: a PLCP Preamble, a PLCP Header, and a PLCP\_PDU. The PLCP Preamble provides a period of time for several receiver functions. These functions include antenna diversity, clock and data recovery and field delineation of the PLCP Header and the PLCP\_PDU. The PLCP Header is used to specify the length of the MPDU field and support any PLCP management information. The PLCP\_PDU contains the MPDU data modified by the PLCP\_PDU data whitener.



**Figure 10-3: PLCP Frame Format**

### 10.3.2.1. PLCP Preamble

The PLCP preamble contains two separate sub-fields; the sync field and the start frame delimiter (SFD), to allow the PHY circuitry to reach steady state demodulation and synchronization of bit clock and frame start.

#### 10.3.2.1.1. Sync

The preamble sync field is an 80-bit field containing an alternating zero-one pattern, transmitted starting with zero and ending with one, to be used by the PHY sub-layer to detect a signal to receive, select an antenna if diversity is utilized, and to reach steady-state frequency offset correction and synchronization with the received packet timing.

#### 10.3.2.1.2. Start Frame Delimiter

The start frame delimiter (SFD) consists of the 16-bit binary pattern 0000 1100 1011 1101 (transmitted left-most bit first). The first bit of the start frame delimiter follows the last bit of the sync pattern. The start frame delimiter defines the frame timing.

### 10.3.2.2. PLCP Header

The PLCP Header field contains three separate sub-fields: an 11-bit PLCP\_PDU Length Word (PLW), a 5-bit PLCP Signaling Field (PSF) and a 16-bit PLCP Header Error Check (HEC) field.

#### 10.3.2.2.1. PLCP\_PDU Length Word

The PLCP\_PDU Length Word (PLW) is passed down from the MAC as a parameter within the PHY\_DATA.request primitive in the transmitting station. The PLW represents the number of octets contained in the MPDU packet. Its valid states are 000h - 7FFh, representing counts of zero to 2047 octets. The PLW is transmitted LSB first and MSB last. The PLW is used by the receiving station to determine the last bit in the packet.

#### 10.3.2.2.2. PLCP Signaling Field

The 5-bit PLCP Signaling Field (PSF) is defined in Table 10-3. The PSF is transmitted LSB (bit 0) first and MSB (bit 4) last.

Bit	Parameter Name	Parameter Values	Description
0	Reserved	Default = 0	Reserved for length expansion
1	Reserved	Default = 0	Reserved
2	Reserved	Default = 0	Reserved
3	Reserved	Default = 0	Reserved
4	PDU_RATE	0=1Mb, 1=2Mb,	This field indicates the bit rate of the PLCP_PDU

**Table 10-3: PLCP Signaling Field Bit Descriptions****10.3.2.2.3. Header Error Check Field**

The Header Error Check (HEC) field is a 16-bit CCITT CRC-16 error detection field. The HEC uses the CCITT CRC-16 generator polynomial  $G(x)$  as follows:

$$G(x) = x^{16} + x^{12} + x^5 + 1$$

The HEC shall be the ones complement of the sum (modulo 2) of the following:

- 1) The remainder of  $x^k \cdot (x^{15} + x^{14} + \dots + x^2 + x^1 + 1)$  divided (modulo 2) by  $G(x)$ , where  $k$  is the number of bits in the PSF and PLW fields of the PLCP Header;
- 2) The remainder after multiplication by  $x^{16}$  and then division (modulo 2) by  $G(x)$  of the content (treated as a polynomial) of the PSF and PLW fields.

The HEC shall be transmitted with the coefficient of the highest term first.

As a typical implementation, at the transmitter, the initial remainder of the division is preset to all ones and is then modified by division of the PSF and PLW fields by the generator polynomial,  $G(x)$ . The ones complement of this remainder is inserted in the HEC field with the most significant bit transmitted first.

At the receiver, the initial remainder of the division is again preset to all ones. The division of the received PSF, PLW, and HEC fields by the generator polynomial,  $G(x)$ , results, in the absence of transmission errors, in a unique nonzero value, which is the following polynomial  $R(x)$ :

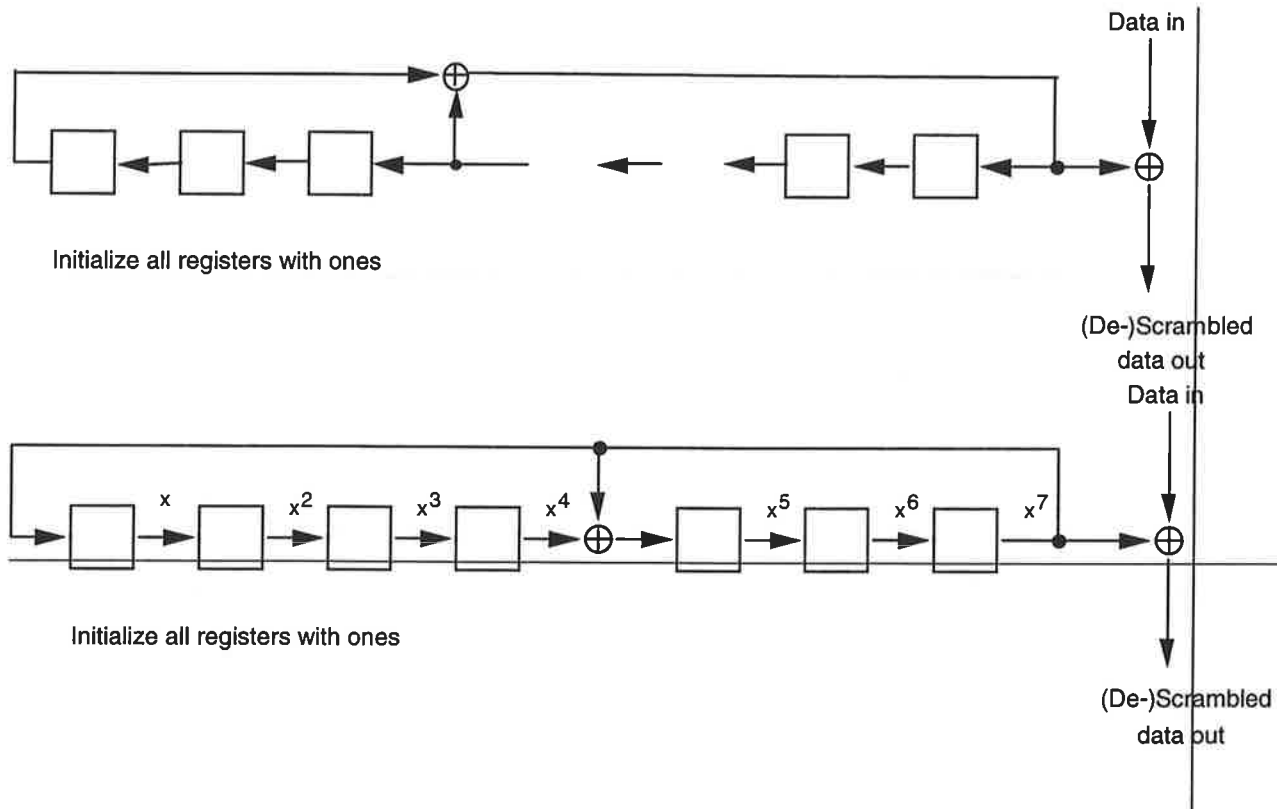
$$R(x) = x^{12} + x^{11} + x^{10} + x^8 + x^3 + x^2 + x^1 + 1$$

**10.3.2.3. PLCP\_PDU Data Whitener**

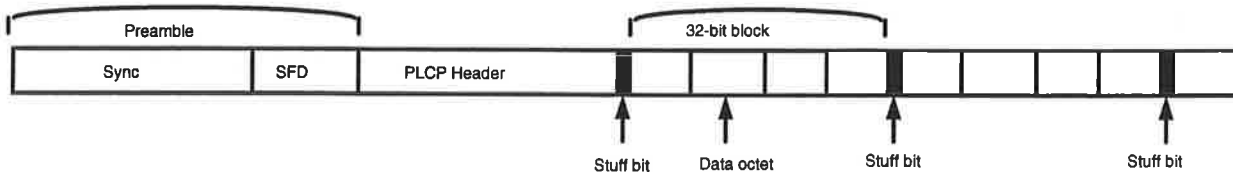
The PLCP\_PDU data whitener uses a length-127 frame synchronous scrambler followed by a 32/33 Bias Suppression Encoding to randomize the data and to minimize the data DC bias and maximum run lengths. Data octets are placed in the transmit serial bit stream LSB first and MSB last. The frame synchronous scrambler uses the generator polynomial  $S(x)$  as follows:

$$S(x) = x^7 + x^4 + 1$$

and is illustrated in Figure 10-4. The 127-bit sequence generated repeatedly by the scrambler is (leftmost used first) 00001110 11110010 11001001 00000010 00100110 00101110 10110110 00001100 11010100 11100111 10110100 00101010 11111010 01010001 10111000 11111111. -The same scrambler is used to scramble transmit data and descramble receive data. The data whitening starts with the first bit of the PLCP\_PDU which follows the last bit of the PLCP Header. The specific bias suppression encoding and decoding method used is defined in Figures 10-7a and 10-11a. The format of the packet after data whitening is as shown in Figure 10-5.



**Figure 10-4: Frame Synchronous Scrambler/Descrambler.**



**Figure 10-5: PLCP\_PDU Data Whitener Format.**

### 10.3.3. PLCP State Machines

The PLCP consists of three state machines as illustrated in the overview diagram of Figure 10-6: the transmit (TX), carrier sense/clear channel assessment (CS/CCA), and receive (RX) state machines. The three PLCP state machines are defined in the subsections below; figure 10-6 is not a state diagram itself. Execution of the PLCP state machines normally transfers from the FH PLME state machine and begins at the CS/CCA state machine. The PLCP exits back to the FH PLME state machine upon interrupt to service a PLME service request, e.g., PLME\_SETCHNL, PLME\_PHY\_RESET, etc.

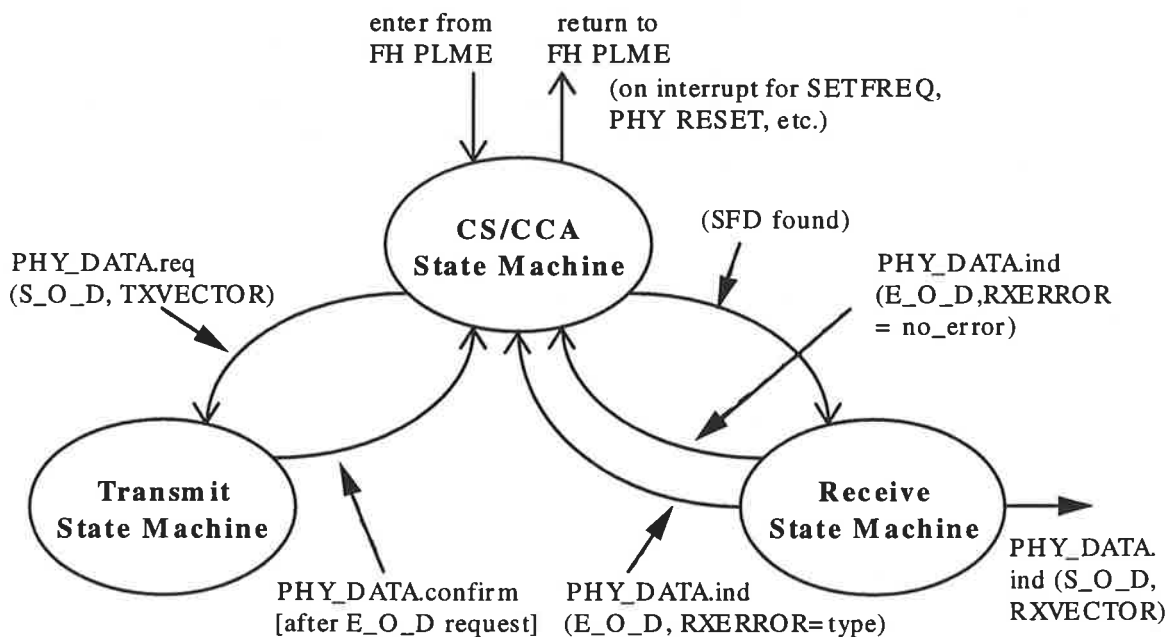


Figure 10-6: PLCP Top Level State Diagram.

#### 10.3.3.1. PLCP Transmit Procedure

The PLCP transmit procedure is invoked by the CS/CCA procedure immediately upon receiving a *PHY\_DATA.request(Start\_of\_Data, TXVECTOR)* from the MAC layer. The CSMA/CA protocol is performed by the MAC with the PHY PLCP in the CS/CCA procedure prior to executing the transmit procedure.

### 10.3.3.1.1. Transmit State Machine

The PLCP transmit state machine illustrated in Figure 10-7 includes functions that must be performed prior to, during, and after MPDU data transmission. Upon entering the transmit procedure in response to a *PHY\_DATA.request(Start\_of\_Data, TXVECTOR)* from the MAC, the PLCP shall switch the PHY PMD circuitry from receive to transmit state; ramp on the transmit power amplifier in the manner prescribed in Section 10.6 (PMD specification); and transmit the preamble sync pattern and start frame delimiter. The PLCP shall generate the PLCP header as defined in Section 10.3.2.2 (PLCP Header) in sufficient time to send the bits at their designated bit slot time. The PLCP shall add the PLCP header to the start of the PLCP\_PDU data.

Prior to transmitting the first MPDU data bit, the PLCP shall send a *PHY\_DATA.confirm* message to the MAC indicating that the PLCP is ready to receive an MPDU data octet. The MAC will respond by sending a *PHY\_DATA.request(Data, DATA)*. This sequence of *PHY\_DATA.confirm* and *PHY\_DATA.request(Data, DATA)* shall be executed whenever the PLCP is ready for more data and until the last data octet is passed to the PLCP. During transmission of the PLCP\_PDU data, each bit of the MPDU passed down from the MAC shall be processed by the data whitener algorithm defined in Figure 10-7a and described in section 10.3.2.3 (PLCP\_PDU Data Whitener). The MPDU data bytes are processed and transmitted LSB first and MSB last.

After the last MPDU octet is passed to the PLCP, the MAC will respond to the following *PHY\_DATA.confirm* with a *PHY\_DATA.request(End\_of\_Data, NULL)*. After the last bit of the PLCP\_PDU data has completed propagation through the radio and been transmitted onto the air, the PLCP shall complete the transmit procedure by sending a *PHY\_DATA.confirm* to the MAC layer, ramp off the power amplifier in the manner prescribed in the Section 10.6 (PMD), and switch the PHY PMD circuitry from transmit to receive state. The execution shall then return to the CS/CCA procedure.

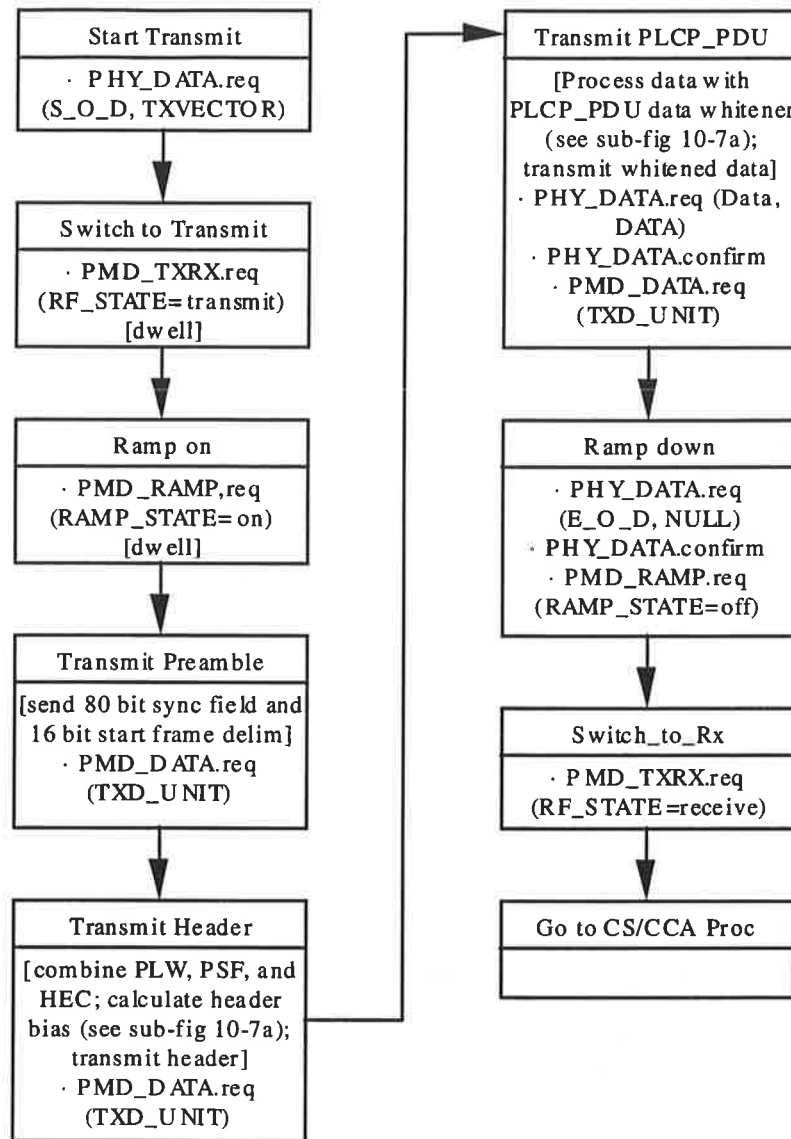


Figure 10-7: Transmit State Machine

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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 or 2 */
number_of_symbols = (number_of_MPDU_octets * 8) / 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 10-4 */
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 Mbps; b(0)=00 for 2 Mbps;          /* 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} or {0,1,2,3};
        1 - 8 octets, use PHY_DATA.req(Data, DATA), PHY_DATA.confirm for each octet */
    Scramble {b(1),...,b(N)};          /* see section 10.3.2.3 */
    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 10-7a: Data Whitener Encoding Procedure**

The weights assigned to each value of the symbols are defined in Table 10-4 for the 1 Mbps (2GFSK) and 2 Mbps (4GFSK) symbols.



2GFSK	4GFSK	weight
	10	3
1		2
	11	1
center	center	0
	01	-1
0		-2
	00	-3

**Table 10-4: PLCP Signaling Field Bit Descriptions**

### 10.3.3.1.2. Transmit State Timing

The transmit timing illustrated in Figure 10-8 is defined from the instant that the *PHY\_DATA.request(Start\_of\_Data, TXVECTOR)* is received from the MAC layer. The PLCP shall switch the PMD circuitry from receive to transmit, turn on and settle the transmitter, and begin transmitting the first bit of the preamble at the antenna within a maximum of 20  $\mu$ s of receiving the *PHY\_DATA.request(Start\_of\_Data, TXVECTOR)*. The PLCP preamble shall be transmitted at 1 Mbps and be completed in 96  $\mu$ s. The PLCP header shall be transmitted at 1 Mbps and be completed in 32  $\mu$ s. The variable length PLCP\_PDU shall be transmitted at the selected data rate. After the last bit of the PLCP\_PDU data has completed propagation through the radio and been transmitted onto the air, the PLCP shall send the last *PHY\_DATA.confirm* to the MAC layer. The PLCP shall turn off the power amplifier and be less than the specified off-mode transmit power within the time specified in section 10.6. At the end of the power amplifier ramp down period, the PLCP shall switch the PMD circuitry from transmit to receive. All of the *PHY\_DATA.confirm* and *PHY\_DATA.request(Data, DATA)* exchanges prior to the final *PHY\_DATA.confirm* shall occur prior to the points at which data octets are needed but do not have any additional time significance.

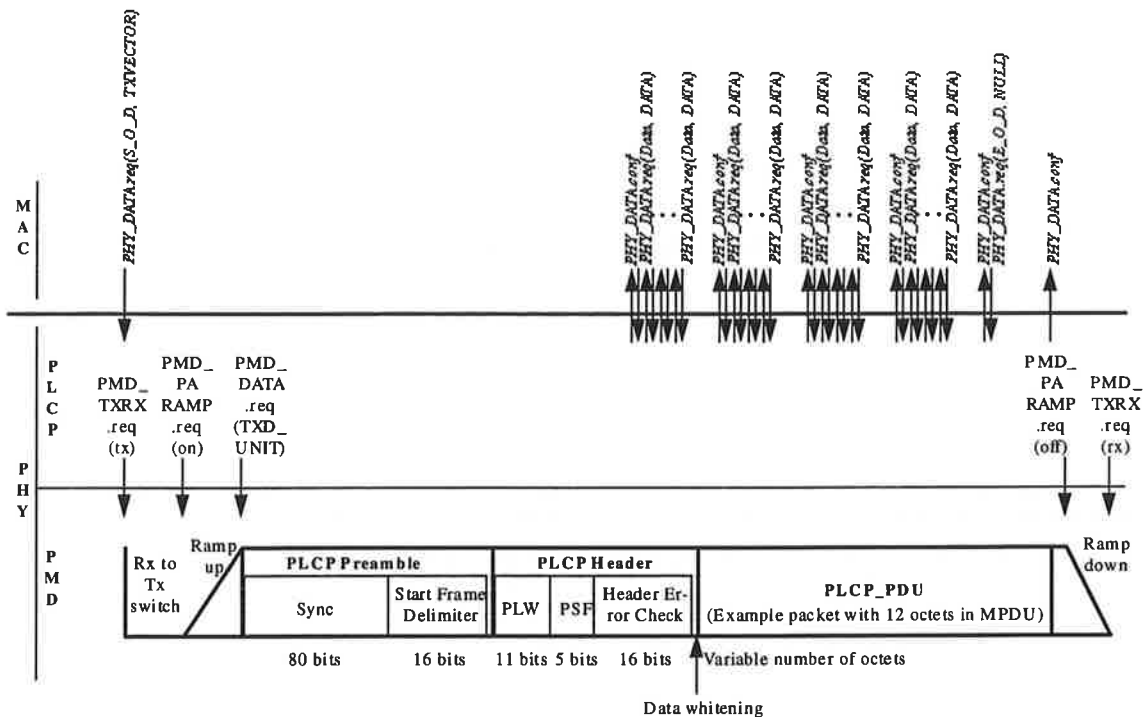


Figure 10-8: Transmit State Timing

10.3.3.2. Carrier Sense/Clear Channel Assessment Procedure

The PLCP carrier sense/clear channel assessment (CS/CCA) procedure is executed while the receiver is turned on and the station is not currently receiving or transmitting a packet. The CS/CCA procedure is used for two purposes: to detect the start of a network signal that can be received (CS) and to determine whether the channel is clear prior to transmitting a packet (CCA).

10.3.3.2.1. Carrier Sense/Clear Channel Assessment State Machine

The carrier sense/clear channel assessment (CS/CCA) state machine is shown in Figure 10-9. The PLCP shall perform a CS/CCA assessment on a minimum of one antenna within a contention backoff slot time of 50 μs. The PLCP shall be capable of detecting within the slot time an FH PHY conformant signal which is received at the selected antenna up to 20 μs after the start of the slot time with the detection performance specified in section 10.6.15.32.3. Section 10.6.15.32.3 specifies detection performance with zero-one sync patterns and with random data patterns. If a start of a transmission is asynchronous with the BSS and arrives after the start of the slot but at least 16 usec prior to the end of the slot, the PLCP shall indicate a busy channel prior to the end of the slot time with the detection performance specified in section 10.6.15.32.3. The CCA indication immediately prior to transmission shall be performed on an antenna with essentially the same free space gain and gain pattern as the antenna to be used for transmission. The

method of determining CS/CCA is unspecified except for the detection performance of a conformant method as specified in section 10.6.15.32-3.

If a *PHY\_DATA.request(Start\_of\_Data, TXVECTOR)* is received, the CS/CCA procedure shall exit to the transmit procedure. If a *PHY\_DATA.request(End\_of\_Activity, NULL)* is received, the PLCP shall reset all relevant CS/CCA assessment timers to the state appropriate for the end of a complete received frame. This service primitive is generated by the MAC at the end of a NAV period.

If a CS/CCA assessment returns a channel idle result, the PHY shall send a *PHY\_DATA.indicate(End\_of\_Activity, NULL)* to the MAC.

If a CS/CCA assessment returns a channel busy result, the PHY shall send a *PHY\_DATA.indicate(Start\_of\_Activity, NULL)* to the MAC. Upon a channel busy assessment, the PLCP shall stop any antenna switching prior to the earliest possible arrival time of the start frame delimiter (SFD) and detect a valid SFD if received. If a valid SFD is detected, the CS/CCA procedure shall exit to the receive procedure. The PLCP shall dwell and search for the SFD for a minimum period longer than the latest arrival time of the SFD. Indication of a busy channel does not necessarily lead to the successful reception of a frame.

Upon exiting the CS/CCA procedure to receive a frame, the last indication of CS/CCA was BUSY. The indication remains BUSY when returning from the receive procedure until the first CS/CCA assessment is performed and determines that the channel is IDLE.

The countdown timer may be a non-zero value when returning from the receive procedure if a signal in the process of being received was lost prior to the end as positively indicated in the length field of a valid PLCP header. The countdown timer shall be used to force the CS/CCA indication to remain in the BUSY state until the predicted end of the frame regardless of actual CS/CCA indications. However, if the CS/CCA procedure indicates the start of a new frame within the countdown timer period, it is possible to transition to the receive procedure prior to the end of the countdown timer period. When a non-zero countdown timer reaches zero, the PLCP shall reset all relevant CS/CCA assessment timers to the state appropriate for the end of a complete received frame. The initial value of the countdown timer upon entry of the CS/CCA procedure from power up or PHY reset is unspecified.

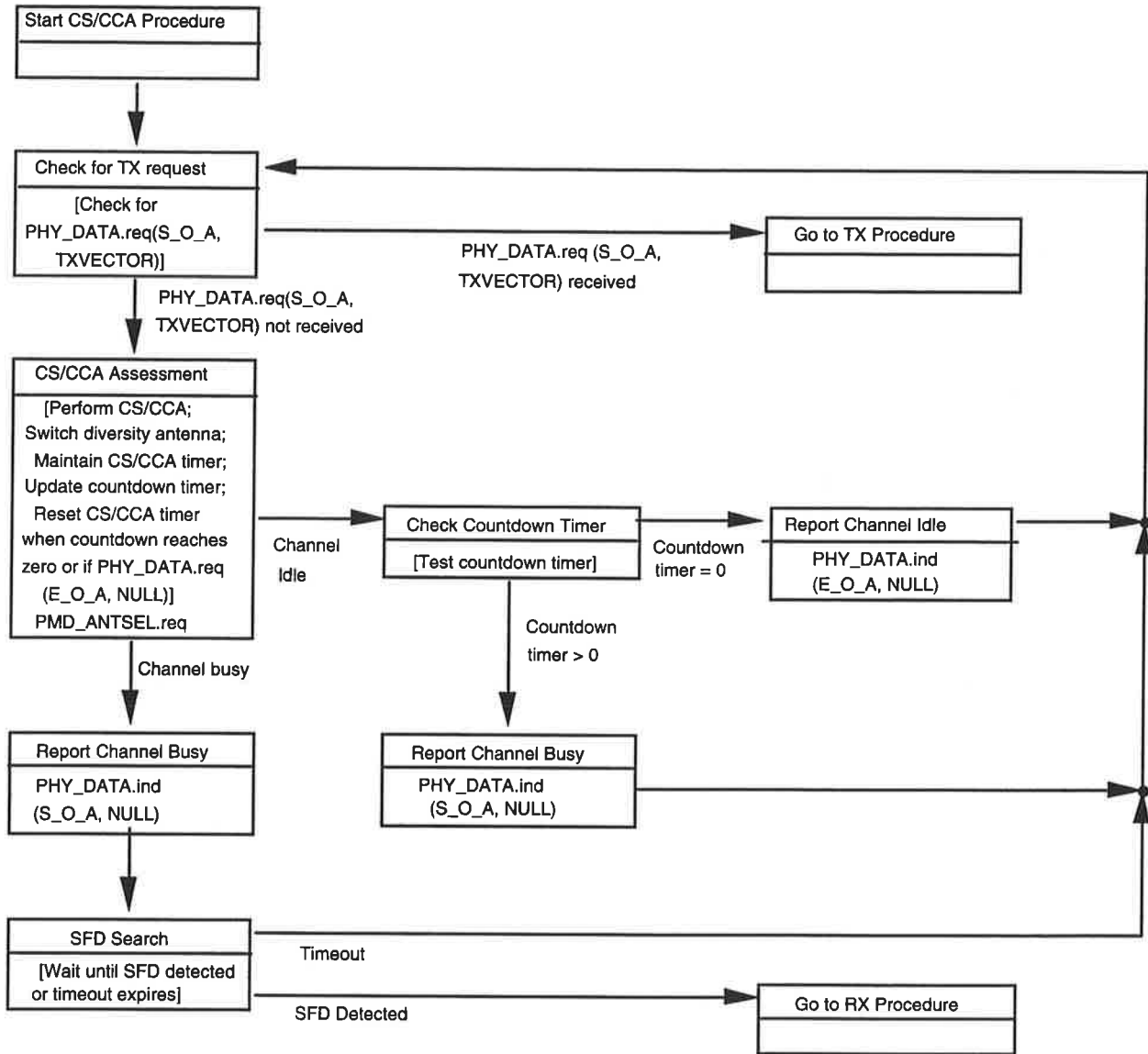


Figure 10-9: CS/CCA State Machine.

**10.3.3.2.2. Carrier Sense/Clear Channel Assessment State Timing**

Timing for priority (PIFS, DIFS), contention backoff (slot times), and CS/CCA assessment windows are defined relative to the end the last bit of the last packet on the air. The PLCP shall perform a CS/CCA assessment on a minimum of one antenna within a slot time including the PIFS and DIFS windows. The appropriate CS/CCA indication shall be generated prior to the end of each 50 μs slot time with the performance specified in section 10.6 (PMD).

If a station has not successfully received the previous packet, the perceived packet end time and slot boundary times will have a higher uncertainty for that station.

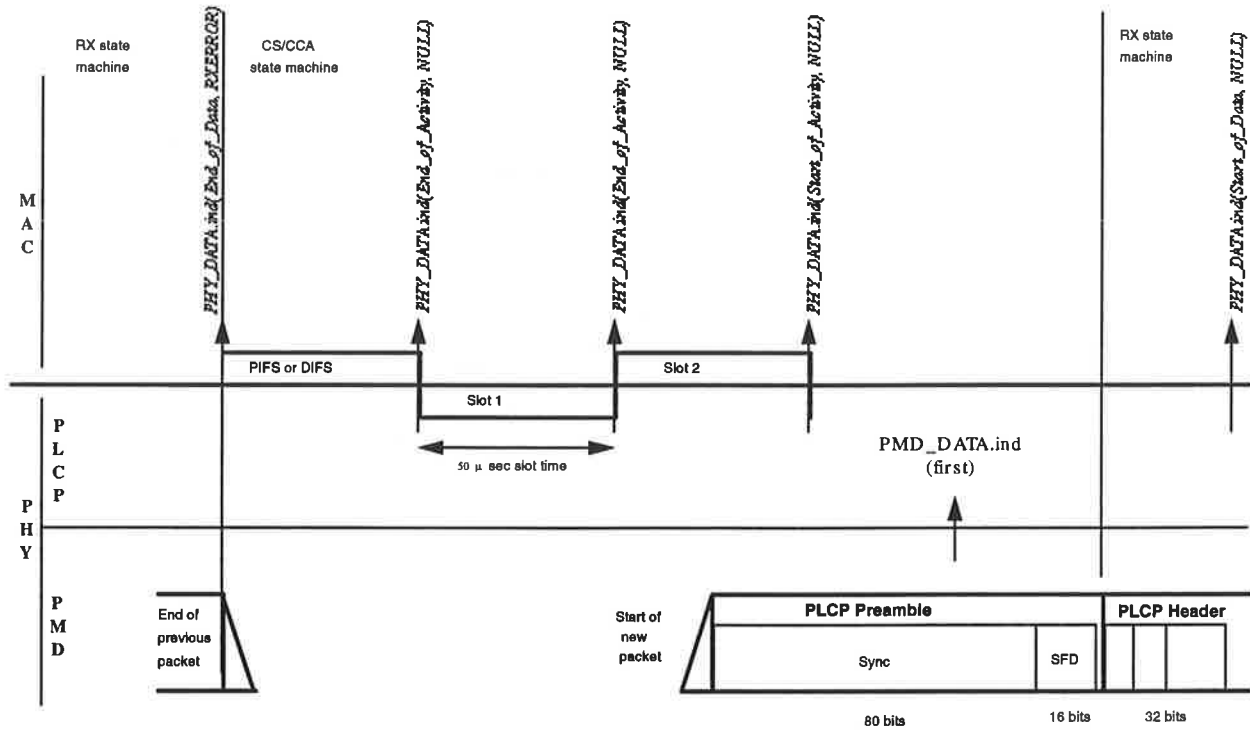


Figure 10-10: CS/CCA State Timing

### 10.3.3.3. PLCP Receive Procedure

The PLCP receive procedure is invoked by the PLCP carrier sense/clear channel assessment (CS/CCA) procedure upon detecting a portion of the preamble sync pattern followed by a complete start frame delimiter.

#### 10.3.3.3.1. Receive State Machine

The PLCP receive procedure shown in Figure 10-11 includes functions that must be performed while receiving the PLCP header and the PLCP\_PDU data. The PLCP receive procedure begins upon detection of a complete start frame delimiter in the CS/CCA procedure. The PLCP shall read in the 32-bit PLCP header and perform an error check using the header error check field. Immediately upon detection of a valid PLCP header, the PLCP shall send a *PHY\_DATA.indicate (Start\_of\_Data, RXVECTOR)* message to the MAC layer. The PLCP shall set a PLCP\_PDU byte/bit counter to indicate the last bit of the packet, receive the PLCP\_PDU data bits and perform the data whitening decoding procedure shown in Figure 10-11a on each PLCP\_PDU bit. The PLCP shall pass correctly received data octets to the MAC with a

PHY\_DATA.indicate(Data, DATA). After the last PLCP\_PDU bit is received and the last octet is passed up to the MAC, the PLCP shall send a *PHY\_DATA.indicate(End\_of\_Data, RXERROR= no\_error)* to the MAC layer. Upon error-free completion of a packet reception, the PLCP shall exit the receive procedure and return to the PLCP CS/CCA procedure with TIME\_REMAINING=0.

If the PLCP header contains any bit errors, the PLCP shall immediately set the byte/bit counter to zero, complete the receive procedure with a *PHY\_DATA.indicate(End\_of\_Data, RXERROR=header violation)* to the MAC, and return to the CS/CCA procedure with TIME\_REMAINING=0. If any format error was detected during the reception of the packet, the PLCP shall immediately complete the receive procedure with a *PHY\_DATA.indicate(End\_of\_DATA, RXERROR=format violation)* to the MAC, and return to the CS/CCA procedure with TIME\_REMAINING=byte/bit count remaining.

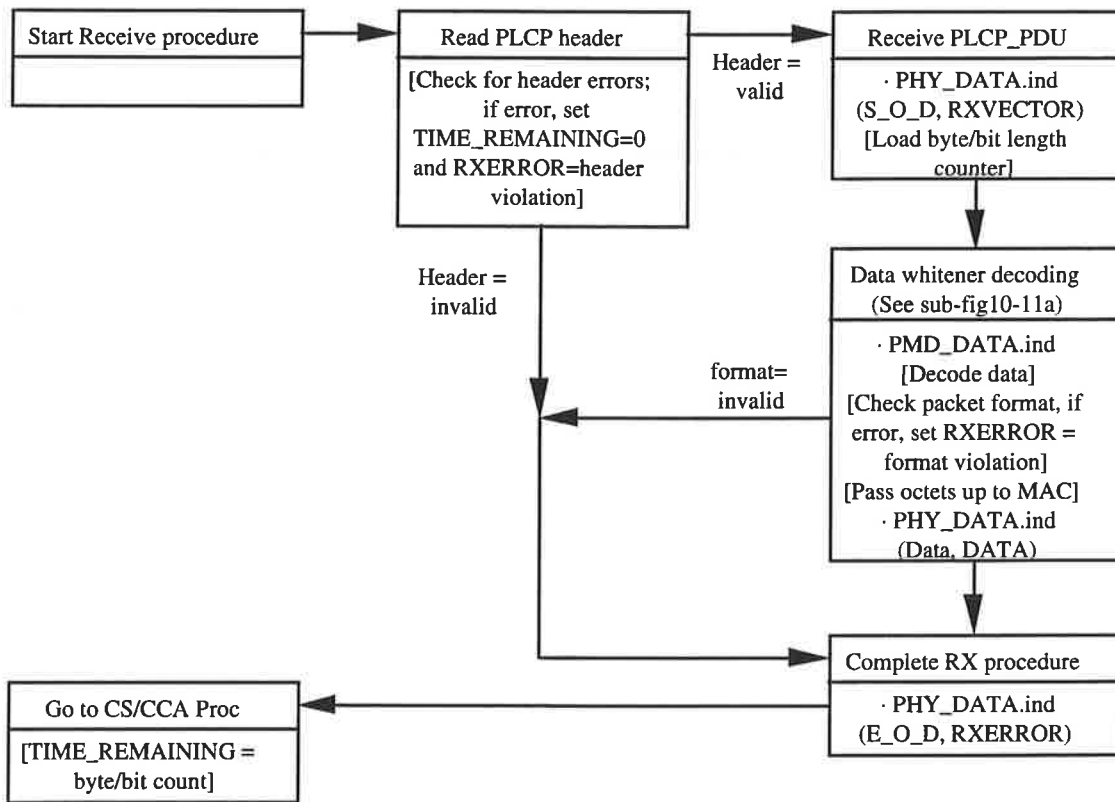


Figure 10-11: Receive State Machine

```

Data Whitener Decoding Algorithm:

/*      If stuff bit = 1 = next block is inverted; 0 = not inverted */
/*      Stuffing begins on first bit of PLCP Header following the start frame delimiter */
/*      Accumulate from start of PLCP Header to verify format */
/*      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 */
accum = 2 {Sum{b(1),...,b(32)}} (32); /* calculate bias in header */

Get number_of_MPDU_octets, rate from header;          /* rate is 1 or 2 */
number_of_symbols = (number_of_MPDU_octets*8)/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(4, # of bytes remaining) * 8;          /* N= block size in bits */
    Read in next block {b(0),...,b(N)};          /* b(n) = {0,1} or {0,1,2,3} */
    bias_next_block = Sum{weight(b(0)),...,weight(b(N))};
    /* calculate bias with b(0); weights are defined in Figure 10-7b */
    accum = accum + bias_next_block;
    If (((rate=1 & (accum < -64 or accum > +64)) or ((rate=2) & (accum < -96 or accum > +96)))
        send format error indication to MAC;

    If {[b(0)=1] then Invert {b(1),...,b(N)};          /* if invert bit=true */
    Descramble {b(1),...,b(N)};          /* see section 10.3.2.3 */
    Send {b(1),...,b(N)} to MAC
    /* 1 - 8 octets; use PHY_DATA.ind(Data, DATA) for each octet. */
}

```

**Figure 10-11a: Data Whitener Decoding Procedure**

### 10.3.3.3.2. Receive State Timing

The receive state timing shown in Figure 10-12 is defined to begin upon detection of a complete start frame delimiter in the carrier sense procedure. The PLCP shall send a *PHY\_DATA.indicate (Start\_of\_Data, RXVECTOR)* to the MAC layer after receiving the last bit of a valid PLCP header. The PLCP shall begin receiving the variable length PLCP\_PDU immediately after the end of the last bit of the PLCP header. The PLCP shall send a *PHY\_DATA.indicate (End\_of\_Data, RXERROR)* after receiving the last PLCP\_PDU data bit. There is no timing significance of the *PHY\_DATA.indicate (Data, DATA)* indications other than the requirement that they occur after the time-significant *PHY\_DATA.indicate (Start\_of\_Data, RXVECTOR)* and before the *PHY\_DATA.indicate (End\_of\_Data, RXERROR)*.

If there was an error in the PLCP header, the PLCP shall terminate the receive procedure within 8  $\mu$ s of the end of the PLCP header. If any other error was detected during the reception of the packet, the PLCP shall terminate the receive procedure within 8  $\mu$ s of detecting the error.

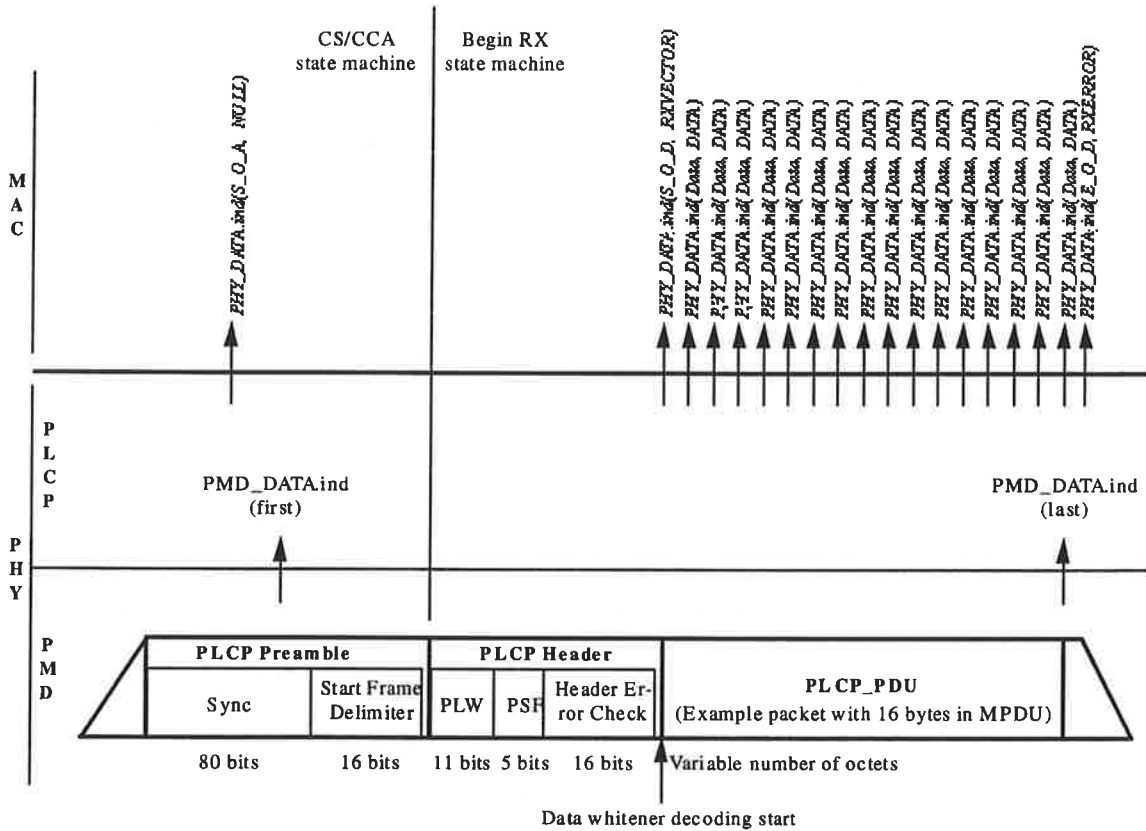


Figure 10-12: Receive Timing



## 10.4. PLME\_SAP Layer Management.

### 10.4.1. Introduction

This section describes the services provided by the FHSS PLME to the upper layer management entities. These primitives are abstract representations of the services and are not intended to restrict implementations. All of the service primitives described in this section are considered mandatory unless otherwise specified.

### 10.4.2. PLME\_SAP Sublayer Management Primitives

The following messages may be sent between the PHY sublayer entities and intralayer or higher Layer Management Entities (LME).

Primitive	Request	Indicate	Confirm	Response
PLME_PLCPRESET	X		X	
PLME_POWER	X		X	
PLME_SETCHNL	X		X	

Table 10-54: PLME\_SAP Sublayer Management Primitives

#### 10.4.2.1. PLME\_SAP Management Service Primitive Parameters

The following table shows the parameters used by one or more of the PLME\_SAP Sublayer Management Primitives.

Parameter	Associate Primitive	Value
SET	PLME_SETCHNL	0,1,2,3
PATTERN	PLME_SETCHNL	0, 2-23, 24-45,47-68
INDEX	PLME_SETCHNL	1-79
STATE	PLME_POWER	ON, OFF

Table 10-65: PHY\_SAP Service Primitive Parameters

#### 10.4.2.2. PLME\_SAP Detailed Service Specifications

The following section describes the services provided by each PLME\_SAP Service Primitive.

#### 10.4.2.2.1. PLME\_PLCPRESET.request

**Function.** This primitive is a request by the LME to reset the PHY sublayer PLCP state machine.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PLME\_PLCPRESET.request

There are no parameters associated with this primitive.

**When Generated.** This primitive can be generated at anytime to reset the PLCP state machine in the PHY sublayer.

**Effect of Receipt.** Receipt of this primitive by the PHY sublayer will cause the PHY entity to reset the PLCP state machine to its idle state.

#### 10.4.2.2.2. PLME\_PLCPRESET.confirm

**Function.** This primitive is a confirmation by the PHY sublayer to the local LME that the PLCP state machine was successfully reset.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PLME\_PLCPRESET.confirm

There are no parameters associated with this primitive.

**When Generated.** This primitive will be generated as a response to a PLME\_PLCPRESET.request primitive once the PLCP has successfully completed the reset.

**Effect of Receipt.** The effect of receipt of this primitive by the LME is unspecified.

#### 10.4.2.2.3. PLME\_POWER.request

**Function.** This primitive is a request by the LME to power the PHY sublayer and PMD state machine on or off.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PLME\_POWER.request(STATE)

The STATE parameter can have the value of ON or OFF. When the value is ON power will be applied to the PLCP and PMD electronics.

**When Generated.** This primitive can be generated at anytime to control the state of the PLCP and PMD power.

**Effect of Receipt.** Receipt of this primitive by the PHY sublayer will cause the PHY LME entity to modify the state of the PLCP and PMD power.

#### 10.4.2.2.4. PLME\_POWER.confirm

**Function.** This primitive is a confirmation by the PHY sublayer to the local LME that the PLCP and the PMD successfully powered up. It will not be sent to confirm a request to remove power.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PLME\_POWER.confirm

There are no parameters associated with this primitive.

**When Generated.** This primitive will be generated as a response to a PLME\_POWER.request(ON) primitive once the PLCP and PMD has successfully completed power restart.

**Effect of Receipt.** The effect of receipt of this primitive by the LME is unspecified.

#### 10.4.2.2.5. PLME\_SETCHNL.request

**Function.** This primitive is a request by the LME to the PHY sublayer to change frequency.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PLME\_SETCHNL.request (SET,PATTERN,INDEX)

The SET parameter can be one of four values: 0, 1, 2, and 3. This parameter selects the sets of hopping patterns as shown in the annex. SET equals 0 is a special set used by the MAC to discover what LANs currently exist prior to associating with a given LAN. The PATTERN parameter specifies one of 23 hop patterns within a given hop SET. The hop patterns are listed in the annex. PATTERN equal 0 is a special pattern used by the MAC to discover what LANs currently exist prior to associating with a given LAN. The INDEX parameter can be one of 80 values ranging from 1 to 80. The INDEX value is used to select a frequency within a given SET and PATTERN as shown in the annex. If the SET and PATTERN parameters are both zero, then the INDEX value is equal to the frequency or channel desired.

**When Generated.** This primitive can be generated at anytime to hop to a new channel or frequency.

**Effect of Receipt.** Receipt of this primitive by the PHY sublayer will cause the PHY entity to start the channel change or hop state machine.

#### 10.4.2.2.6. PLME\_SETCHNL.confirm

**Function.** This primitive is a confirmation by the PHY sublayer to the local LME that the frequency change or hop was successfully completed.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PLME\_SETCHNL.confirm

There are no parameters associated with this primitive.

**When Generated.** This primitive will be generated as a response to a PLME\_SETCHNL.request primitive once the PLME has successfully completed the frequency change.

**Effect of Receipt.** The effect of receipt of this primitive by the LME is unspecified.

### 10.4.3.FH PHY Specific MAC Layer Management State Machines

#### 10.4.3.1. Introduction

This section identifies the specific MAC Management state machines required for operating the FHSS PHY. The relationship between the MAC Management and FH PLME state machines are also described.

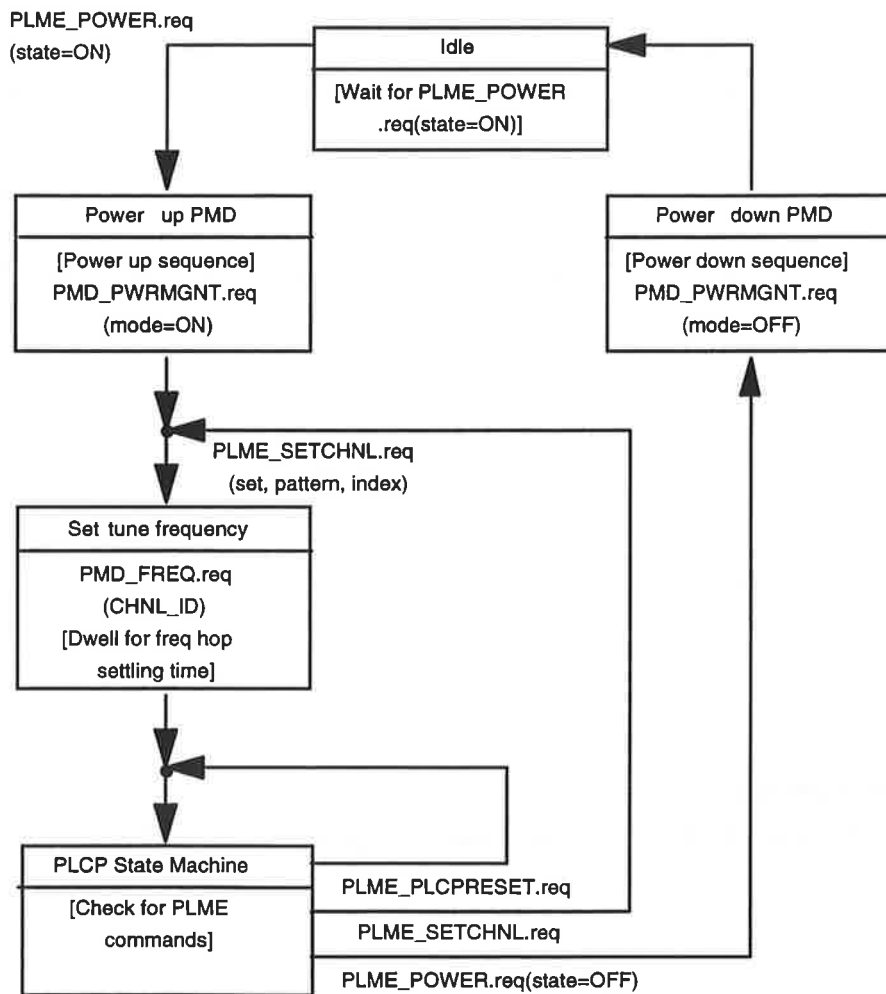
### 10.4.4. FH PHY Layer Management Entity State Machines

#### 10.4.4.1. Introduction

This section describes the FH PLME PHY Layer Management state machines to turn the PMD on/off, reset the PLCP state machine, and change the frequency hop channel.

**10.4.4.2. PLME State Machine**

The PLME state machine in Figure 10-13 begins with a *PLME\_POWER.request(State=ON)* request which turns on the PMD circuitry. The MAC then sends a *PLME\_SETCHNL.request(set, pattern, index)* to tune the PMD to the selected channel. The PLME then transfers execution to the PLCP state machine as defined in section 10.3.3. Upon receiving a PLME request from a higher level LME, the PLCP shall return execution to the PLME state machine and process the request. A *PLME\_PLCPRESET.request* returns the PLCP state machine to its entry state. A *PLME\_SETCHNL.request(set, pattern, index)* will cause the PLCP to terminate a receive or CS/CCA process and change frequency before returning to the PLCP state machine. A *PLME\_POWER.request(state=OFF)* request will cause the PLCP to terminate a receive or CS/CCA process, power down the PMD circuitry, and return the PLME state machine to the idle state. The MAC should not send a *PLME\_SETCHNL* or *PLME\_POWER* while the PLCP is in the transmit state.



**Figure 10-13: PLME State Machine**

## 10.5. FHSS Physical Medium Dependent Sublayer Services

### 10.5.1. Scope and Field of Application

This section describes the PMD services provided to the PLCP for the FHSS Physical Layer. Also defined in this section are the functional, electrical and RF characteristics required for interoperability of implementations conforming to this specification. The relationship of this specification to the entire FHSS Physical Layer is shown in Figure 10-14.

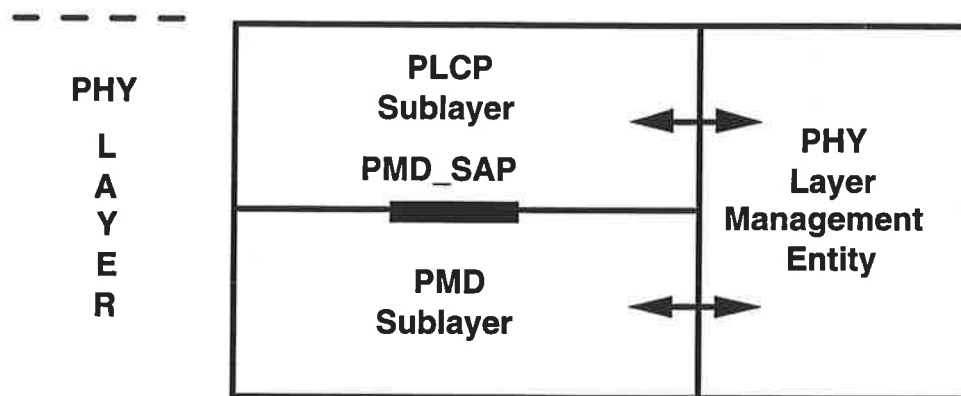


Figure 10-14: PMD Layer Reference Model

### 10.5.2. Overview of Services

In general, The FHSS Physical Medium Dependent Sublayer accepts Physical Layer Convergence Procedure sublayer-service primitives and provides the actual means by which the signals required by these primitives are imposed onto the medium. In the FHSS Physical Medium Dependent Sublayer at the receiver the process is reversed. The combined function of the transmitting and receiving FHSS PMD Sublayers results in a data stream, timing information, and receive parameter information being delivered to the receiving Physical Layer Convergence Procedure Sublayer.

### 10.5.3. Overview of Interactions

The primitives associated with the 802.11 PLCP sublayer to the FHSS PMD sublayer falls into two basic categories:

- (1) Service primitives that support PLCP peer-to-peer interactions

- (2) Service primitives that have local significance and support sublayer-to-sublayer interactions.

#### 10.5.4. Basic Service and Options

All of the service primitives described in this section are considered mandatory unless otherwise specified.

##### 10.5.4.1. PMD\_SAP Peer-to-Peer Service Primitives

The following table indicates the primitives for peer-to-peer interactions.

Primitive	Request	Indicate	Confirm	Response
PMD_DATA	X	X		

Table 10-76: PMD\_SAP Peer-to-Peer Service Primitives

##### 10.5.4.2. PMD\_SAP Sublayer-to-Sublayer Service Primitives

The following table indicates the primitives for sublayer-to-sublayer interactions.

Primitive	Request	Indicate	Confirm	Response
PMD_TXRX	X			
PMD_PARAMP	X			
PMD_ANTSEL	X			
PMD_TXPWRLVL	X			
PMD_FREQ	X			
PMD_RSSI		X		
PMD_PWRMGNT	X			
PMD_SYNLOCK		X		

Table 10-87: PMD\_SAP Sublayer-to-Sublayer Service Primitives

##### 10.5.4.3. 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 Mbps: 0, 1 2 Mbps: 0, 1, 2, 3
RXD_UNIT	PMD_DATA.indicate	1 Mbps: 0, 1 2 Mbps: 0, 1, 2, 3
RF_STATE	PMD_TXRX.request	TRANSMIT, RECEIVE
RAMP_STATE	PMD_PARAMP.request	ON, OFF
ANTENNA_ STATE	PMD_ANTSEL.request	1,2
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 <del>TBD</del>
MODE	PMD_PWRMGNT.request	ON, OFF
STATUS	PMD_SYNLOCK.indicate	LOCKED, UNLOCKED

**Table 10-98: List of Parameters for PMD Primitives.**

#### 10.5.5.PMD\_SAP Detailed Service Specification

The following section describes the services provided by each PMD primitive.

##### 10.5.5.1. PMD\_DATA.request

**Function.** This primitive defines the transfer of data from the PLCP sublayer to the PMD entity.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_DATA.request (TXD\_UNIT)



The TXD\_UNIT parameter can take on one of two values: ONE, or ZERO. This parameter represents a single data bit. The effect of this parameter is that the PMD will properly modulate the medium to represent ONEs or ZEROs as defined in the FHSS PMD Modulation Specifications for a given data rate.

**When Generated.** This primitive is generated by the PLCP sublayer to request the transmission of a single data bit on the Physical Medium Dependent sublayer. The bit clock is assumed to be resident or part of the PLCP and this primitive is issued at every clock edge once the PLCP has begun transmitting data.

**Effect of Receipt.** The receipt of this primitive will cause the PMD entity to encode and transmit a single data bit.

#### 10.5.5.2. PMD\_DATA.indicate

**Function.** This primitive defines the transfer of data from the PMD entity to the PLCP sublayer.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_DATA.indicate (RXD\_UNIT)

The RXD\_UNIT parameter can take on one of two values: ONE, or ZERO. This parameter represents the current state of the media as determined by the FHSS PMD Modulation Specifications for a given data rate.

**When Generated.** The PMD\_DATA.indicate is generated to all receiving PLCP entities in the network after a PMD\_DATA.request is issued.

**Effect of Receipt.** The effect of receipt of this primitive by the PLCP is unspecified.

#### 10.5.5.3. PMD\_TXRX.request

**Function.** This primitive is used to place the PMD entity into the transmit or receive function.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_TXRX.request (RF\_STATE)

The RF\_STATE parameter can take on one of two values: TRANSMIT or RECEIVE. When the value of the primitive is TRANSMIT, the RF state of the radio is transmit. If the value of the primitive is RECEIVE, the RF state of the radio is receive.

**When Generated.** This primitive is generated whenever the mode of the radio needs to be set or when changing from transmit to receive or receive to transmit.

**Effect of Receipt.** The receipt of this primitive by the PMD entity will cause the mode of the radio to be in either transmit or receive.

#### 10.5.5.4.PMD\_PARAMP.request

**Function.** This primitive defines the start of the ramp up or ramp down of the radio transmitter's Power Amplifier.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_PARAMP.request (RAMP\_STATE)

The RAMP\_STATE parameter can take on one of two values: ON or OFF. When the value of the primitive is ON, the state of the transmit power amplifier is "on". If the value of the primitive is OFF, the state of the transmit power amplifier is "off".

**When Generated.** This primitive is issued only during transmit and to establish the initial state. It is generated by the PLCP at the start of the transmit function to turn the transmitter's power amplifier "on". A power amplifier ramp up period follows the change of state from "off" to "on". After the PLCP has transferred all require data to the PMD entity, this primitive again will be issued by the PLCP to place the transmit power amplifier back into the "off" state. A power amplifier ramp down period follows the change of state from "on" to "off".

**Effect of Receipt.** The receipt of this primitive by the PMD entity will cause the transmit power amplifier to be on or off.

#### 10.5.5.5.PMD\_ANTSEL.request

**Function.** This primitive is used to select which antenna the PMD entity will use to transmit or receive data.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_ANTSEL.request (ANTENNA\_STATE)

The ANTENNA\_STATE parameter can take on one of two values: ONE or TWO. When the value of the primitive is a ONE, the PMD will switch to antenna 1 for receive or transmit. If the value of the primitive is TWO, the PMD entity will switch to antenna 2 for receive or transmit.

**When Generated.** This primitive is generate at various times by the PLCP entity to select an antenna. During receive, this primitive can be used to do antenna diversity. During transmit, this primitive can be use to select a transmit antenna. This primitive will also be used during Clear Channel Assessment.

**Effect of Receipt.** The receipt of this primitive by the PMD entity will cause the radio to select the antenna specified.

#### 10.5.5.6. PMD\_TXPWRLVL.request

**Function.** This primitive defines the power level the PMD entity will use to transmit data.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_TXPWRLVL.request (TXPWR\_LEVEL)

The TXPWR\_LEVEL parameter can be one of the following values listed in Table 10-109 below.

TXPWR_LEVEL	Level Description
LEVEL1	Defined as Tx_Pwr_Lvl_1 in MIB
LEVEL2	Defined as Tx_Pwr_Lvl_2 in MIB
LEVEL3	Defined as Tx_Pwr_Lvl_3 in MIB
LEVEL4	Defined as Tx_Pwr_Lvl_4 in MIB

**Table 10-109: Transmit Power Levels**

**When Generated.** This primitive is generated as part of the transmit sequence.

**Effect of Receipt.** The receipt of this primitive by the PMD entity will cause the transmit power level to be modify.

#### 10.5.5.7. PMD\_FREQ.request

**Function.** This primitive defines the frequency the PMD entity will use to receive or transmit data. Since changing the radio frequency is not an immediate function, this primitive serves also as

an indication of the start of this process. The completion of this process is dictated by other PMD specifications.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_FREQ.request (CHNL\_ID)

The CHNL\_ID parameter can be one of the following values list in Table 10-13~~4~~ or 10-14.

**When Generated.** This primitive is generated by the PLCP whenever a change to a new frequency is required.

**Effect of Receipt.** The receipt of this primitive by the PMD entity will cause the radio to change to a new frequency defined by the value of the CHNL\_ID.

#### 10.5.5.8. PMD\_RSSI.indicate

**Function.** This primitive transfers a receiver signal strength indication of the physical medium from the PMD sublayer to the PLCP sublayer. This value will be used by the PLCP to performing any diversity or clear channel assessment functions required by the PLCP or other sublayers.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_RSSI.indicate (STRENGTH)

The STRENGTH parameter can be a value from 0-15. This parameter is an indication by the PMD sublayer of the value of the energy observed on the selected antenna. This value is used to generate the RSSI term in the PHY\_DATA.ind(RXVECTOR) primitive and might also be used by any diversity function. Since RSSI is only used in a relative manner by MAC sublayer, this parameter is define to have 16 values that range from 0 through RSSI\_Max+5. The value zero is the weakest signal strength while RSSI\_Max+5 is the strongest signal strength.

**When Generated.** This primitive is generated continually by the PMD entity to transfer a receive signal strength indication to the PLCP.

**Effect of Receipt.** The effect of receipt of this primitive by the PLCP is unspecified.

#### 10.5.5.9. PMD\_PWRMGNT.request

**Function.** This primitive is used by the higher layers entities to manage or control the power consumption of the PMD when not in use. This allows higher layer entities to put the radio into a sleep or standby mode when not expecting to receive or send any data.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_PWRMGNT.request (MODE)

The MODE parameter can be one of two values: ON or OFF. When the value of the parameter is ON, the PMD entity will enter into a fully functional mode which allows it to send or receive data. When the value of the parameter is OFF, the PMD entity will place itself in a standby or low power mode. In the low power mode, the PMD entity is not expected to be able to perform any request by the PLCP nor is it expected to indicate any change in PMD state or status.

**When Generated.** This primitive is delivered by the PLCP but actually is generated by a high layer management entity

**Effect of Receipt.** Upon receipt of this primitive, the PMD entity will enter a fully functional or low power consumption state depending on the value of the primitive's parameter.

#### 10.5.5.10. PMD\_SYNLOCK.indicate

**Function.** This primitive is a indication by the PMD entity to the PLCP that the radio synthesizer is locked to the frequency specified by the PMD\_FREQ primitive.

**Semantics of the Service Primitive.** The primitive shall provide the following parameters:

PMD\_SYNLOCK.indicate (STATUS)

The STATUS parameter can be one of two values: LOCKED or UNLOCKED. When the value of the parameter is LOCKED, the radio's synthesizer will be on the frequency specified by the PMD\_FREQ primitive. When the value of the parameter is UNLOCKED, the radio's synthesizer frequency will not match the frequency specified in the PMD\_FREQ primitive.

**When Generated.** The primitive will be issued whenever the PMD entity is required to change channels or hop. The UNLOCKED value will always appear whenever the PMD\_FREQ primitive is issued and the CHNL\_ID value of that primitive doesn't match the current frequency of the synthesizer. The LOCKED value will be issued whenever the frequency of the synthesizer and the CHNL\_ID value become matched. In the case which the radio's synthesizer is already at the frequency specified by PMD\_FREQ primitive, the LOCKED indication will immediately be returned to the PLCP or high layer entity.

**Effect of Receipt.** The effect of receipt of this primitive by the PLCP is unspecified.

## 10.6. FHSS Physical Medium Dependent Sublayer 1.0M Bit

### 10.6.1. 1M Bit PMD Operating Specifications General

In general, the PMD accepts Convergence Layer-service primitives and provides the actual means by which the signals required by these primitives are imposed onto the medium. In the Physical Medium Dependent sublayer at the receiver the process is reversed. The combined function of the transmitting and receiving Physical Medium Dependent sublayers results in a data stream, timing information, and receive parameter information being delivered to the receiving Convergence Sublayer.

### 10.6.2. Regulatory Requirements

Wireless LANs implemented in accordance with this standard are subject to equipment certification and operating requirements established by Regional and National regulatory administrations. The PMD specification establishes minimum technical requirements for interoperability, based upon established regulations for Europe, Japan, and the USA at the time of the draft. These regulations are subject to revision, or may be superseded. Requirements that are subject to local geographic regulations are annotated within the PMD specification. Regulatory requirements that do not affect interoperability are not addressed within this standard. Implementers are referred to the following regulatory sources for further information. Operation in countries within Europe, or other regions outside Japan or North America, may be subject to additional or alternative National regulations.

The documents listed below specify the current regulatory requirements for various geographic areas at the time the standard was developed. They are provided for information only, and are subject to change or revision at any time.

#### Europe:

Approval Standards: European Technical Standards Institute

Documents: ETS 300-328, ETS 300-339

Approval Authority: National Type Approval Authorities

#### Japan:

Approval Standards: Research and Development Center for Radio Communications (RCR)

Documents: RCR STD-33

Approval Authority: Ministry of Telecommunications (MKK)

#### North America:

Approval Standards: Department of Communications (DOC), Canada

Documents: GL36

Federal Communications Commission (FCC), USA

Documents: CFR47, Part 15, Sections 15.205, 15.209, 15.247.

Approval Authority: DOC (Canada), FCC (USA)

### 10.6.3. Operating Frequency Range

A conformant PMD implementation shall be able to select the carrier frequency (Fc) from the full geographic-specific set of available set of carrier frequencies. Table 10-11-10. summarizes these frequencies for a number of geographic locations:

Lower Limit	Upper Limit	Regulatory Range	Geography
2.402 GHz	2.402 GHz	2.400-2.4835 GHz	USA*
2.402 GHz	2.480 GHz	2.400-2.4835 GHz	Europe*
2.473 GHz	2.495 GHz	2.471-2.497 GHz	Japan*

**Table 10-110: Operating Frequency Range.**

\* The frequency ranges in this table are subject to the geographic specific Regulatory Authorities

### 10.6.4. Number of Operating Channels

The number of transmit and receive frequency channels used for operating the PMD entity is 79 for the US and Europe and 23 channels for Japan. This is more fully defined in Tables 10-13-12 and 10-14-13 of Section 10.6.54.

Minimum*	Hopping Set	Geography
75	79	USA*
20	79	Europe*
10	23	Japan*

**Table 10-121: Number of Operating Channels**

\* The number of required hopping channels are subject to the geographic specific Regulatory Authorities

### 10.6.5. Operating Channel Center Frequency

The channel center frequency is defined in sequential 1.0 MHz steps beginning with the first channel, channel 2.402 GHz for the U.S.A. and Europe, as listed in Table 10-132. The channel centers for Japan, starting at 2.473 GHz with 1 MHz increments, is listed in Table 10-143.



Channel #	Value	Channel #	Value	Channel #	Value
2	2.402	28	2.428	54	2.454
3	2.403	29	2.429	55	2.455
4	2.404	30	2.430	56	2.456
5	2.405	31	2.431	57	2.457
6	2.406	32	2.432	58	2.458
7	2.407	33	2.433	59	2.459
8	2.408	34	2.434	60	2.460
9	2.409	35	2.435	61	2.461
10	2.410	36	2.436	62	2.462
11	2.411	37	2.437	63	2.463
12	2.412	38	2.438	64	2.464
13	2.413	39	2.439	65	2.465
14	2.414	40	2.440	66	2.466
15	2.415	41	2.441	67	2.467
16	2.416	42	2.442	68	2.468
17	2.417	43	2.443	69	2.469
18	2.418	44	2.444	70	2.470
19	2.419	45	2.445	71	2.471
20	2.420	46	2.446	72	2.472
21	2.421	47	2.447	73	2.473
22	2.422	48	2.448	74	2.474
23	2.423	49	2.449	75	2.475
24	2.424	50	2.450	76	2.476
25	2.425	51	2.451	77	2.477
26	2.426	52	2.452	78	2.478
27	2.427	53	2.453	79	2.479
				80	2.480

**Table 10-132: USA and European Requirements**

(Values specified in GHz)

Channel #	Value	Channel #	Value	Channel #	Value
73	2.473	81	2.481	89	2.489
74	2.474	82	2.482	90	2.490
75	2.475	83	2.483	91	2.491
76	2.476	84	2.484	92	2.492
77	2.477	85	2.485	93	2.493
78	2.478	86	2.486	94	2.494
79	2.479	87	2.487	95	2.495
80	2.480	88	2.488	-	-

**Table 10-143: Japan Requirements**

(Values specified in GHz)

#### 10.6.6. Occupied Channel Bandwidth

Occupied channel bandwidth shall meet all applicable local geographic regulations for 1 MHz channel spacing. The rate at which the PMD entity will hop at is governed by the MAC. The hop rate, on the other hand, is a managed object with a maximum dwell time subject to local geographic regulations. Occupied channel bandwidth shall meet all applicable requirements issued by regulatory organizations for the geography of operation.

#### 10.6.7. Minimum Hop Rate

The PMD entity will hop at a rate governed by the MAC. Since the MAC must have the ability to maximize the use of each hop interval, the MAC must tell the PMD when to hop, thus defining the system hop rate.

The minimum hop rate will be governed by the regulatory authorities. The minimum hop rate is specified by the number of channels visited divided by the total time spent on each of these channels. For the U.S.A., Part 15.247 of the Rules of the FCC states that a PMD must visit at least 75 channels in a 30 second period:

$$\frac{\text{Number of Channels}}{\text{Total Dwell Time}} = \frac{75 \text{ (channels)}}{30 \text{ (seconds)}} = 2.5 \text{ hops/second in U.S.A.}$$

#### 10.6.8. Hop Sequences

The hopping sequence of an individual PMD entity is used to co-locate multiple PMD entities in similar networks in the same geographic area and to enhance the overall efficiency and throughput capacity of each individual network. A frequency hopping pattern,  $F_x$ , consists of a permutation of all frequency channels defined in Tables 10-132 and 10-143. For a given pattern number,  $x$ , the hopping sequence can be written as:

$$F_x = \{f_x(1), f_x(2), \dots, f_x(p)\}$$

where,

$f_x(i)$  = channel number (as defined in 10.6.4) for  $i^{\text{th}}$  frequency in  $x^{\text{th}}$  hopping pattern  
 $p$  = number of frequency channels in hopping pattern (79 for US/Europe, 23 for Japan)

Given the hopping pattern number,  $x$ , and the index for the next frequency,  $i$ , the channel number shall be defined to be:

$$f_x(i) = [(i - 1) * x] \bmod (79) + 2 \quad \text{in US and Europe} \\ = [(i - 1) * x] \bmod (23) + 73 \quad \text{in Japan.}$$

Each of the  $F_x$  contains each of the  $p$  frequency channels equally often. Given a pattern length of  $p$  and the criterion of minimal adjacent channel interference, the number of usable hopping sequences in a geographically co-located area that can be derived is:

$$\frac{(p - 1) - (2 * F)}{2k + 1} = \frac{(p - 13)}{2k + 1} = 22 \text{ patterns/set for} \\ \text{US and Europe (F = 6)} \\ = \frac{(p - 11)}{2k + 1} = 4 \text{ patterns/set for} \\ \text{Japan (F = 5)}$$

where  $k$  = the number of adjacent channel interferers on each side of the channel frequency and  $F$  is the minimum distance in frequency between contiguous hops. For the 802.11 compliant FHSS PMD in the USA and Europe, there are three sets of hopping sequences with 22 patterns per sequence that meet the criterion of one adjacent channel interferer on each side of the desired channel. The three sets of hopping sequences of 22 patterns each are listed Tables A, B, and C in ~~the Annex Section 10.8~~. Similarly, there are three sets in Japan, except each set has four patterns as listed in Table D in ~~the Annex Section 10.8~~. The channel numbers listed under each pattern refer to the actual frequency values listed in Tables 10-131 and 10-142.

### 10.6.9. Unwanted Emissions

Conformant PMD implementations of this FHSS standard shall limit the emissions that fall outside of the operating frequency range, defined in Table 10-110 of Section 10.6.32, to the geographically applicable ~~limits regulations. For the U.S.A., the Rules of the FCC parts 15.247, 15.205 and 15.209 are the applicable regulations that govern these emissions. For Japan, RCR-STD-33 and for Europe, ETS 300-328, are the applicable regulations.~~

### 10.6.10. Modulation

The minimum set of requirements for a PMD to be compliant with the 802.11 FHSS PHY shall be as follows.

The PMD shall be capable of operating using 2 level Gaussian Frequency Shift Key (GFSK) modulation with a nominal bandwidth bit-period (BT)=0.5. The PMD shall accept symbols from the set  $\{1,0\}$  from the PLCP. The symbol  $\{1\}$  shall be encoded with a peak deviation of  $(+f)$ , giving a peak

transmit frequency of  $(F_c+f)$ , which is greater than the carrier center frequency ( $F_c$ ). The symbol {0} shall be encoded with a peak frequency deviation of  $(-f)$ , giving a peak transmit frequency of  $(F_c-f)$ .

The peak frequency deviation, as shown in Figure 10-156 below shall be greater than 110 kHz relative to the nominal center frequency  $F_c$ .  $F_c$  is the average center frequency of the last 8 bits of the preamble prior to the unique word. The deviation shall be measured mid symbol. Maximum deviation is not specified, but modulation is subject to the occupied bandwidth limits of 10.6.5.

The zero crossing error shall be less than  $\pm 1/8$  of a symbol period. The zero crossing error is the time difference between the ideal symbol periods and measured crossings of  $F_c$ . This is illustrated in Figure 10-156 below.

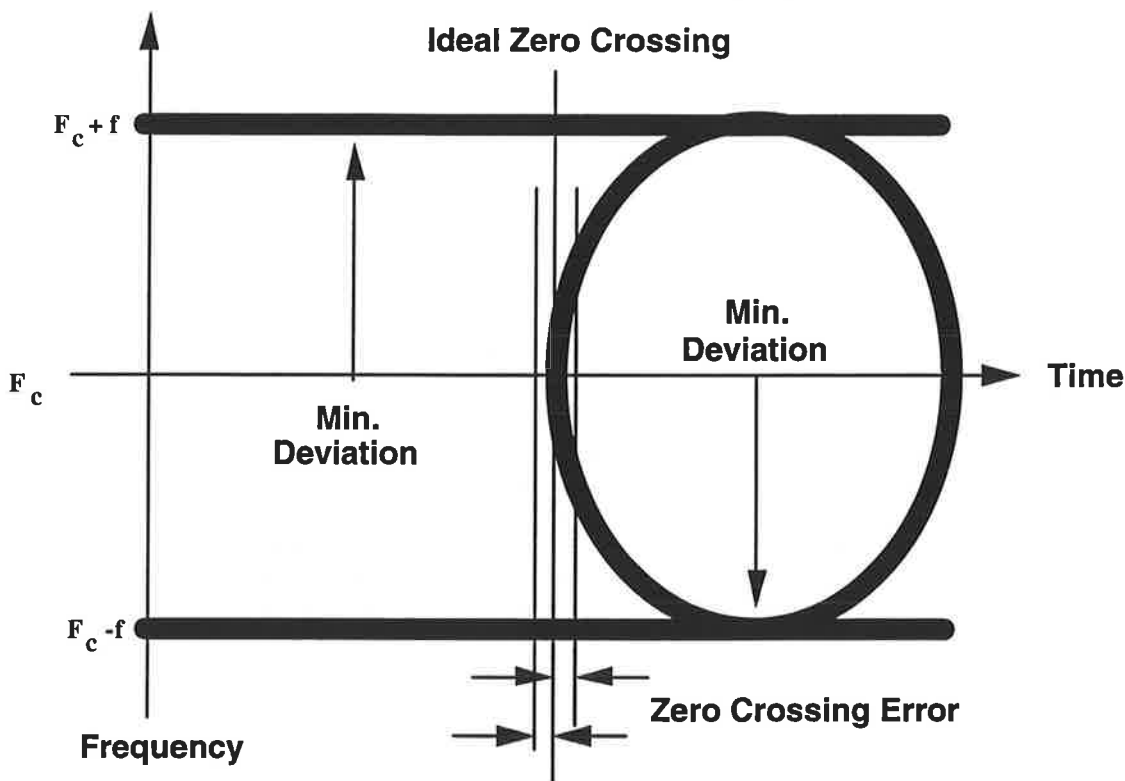


Figure 10-156: Transmit Modulation Mask

#### 10.6.11. Channel Data Rate

A compliant 802.11 FHSS PMD shall be capable of transmitting and receiving at a nominal data rate of 1.0 Mbps.

### 10.6.12. Channel Switching/Settling Time

The time to change from one operating channel frequency, as specified in section 10.6.32, is defined as 224 usec. A conformant PMD is said to meet this switching time specification when the desired final operating channel center frequency has settled to within +/- 60 kHz of the operating channel center frequency as outlined in section 10.6.32.

#### ~~10.6.12.1. (Not Used)~~

### 10.6.13. Receive to Transmit Switch Time

The maximum time for a conformant PMD to switch the radio from the receive state to the transmit state and place the start of the first bit on the air shall be 19 usec. At the end of this 19 usec, the rf carrier shall be within 1 dB of its final transmit power level, and within the described modulation specifications.

#### ~~10.6.13.1. (Not Used)~~

### 10.6.14. PMD Transmit Specifications

The following section describes the transmit functions and parameters associated with the Physical Medium Dependent sublayer. In general, these are specified by primitives from the PLCP and the Transmit PMD entity provides the actual means by which the signals required by the PLCP primitives are imposed onto the medium.

#### 10.6.14.1. Nominal Frame Transmit Power

The nominal transmit power of a frame is defined as the power averaged between the start of the first symbol in the PLCP header to the end of the last symbol in the PLCP header. When in the transmit state, the transmit power shall be within 2dB of the nominal transmit power from the start of the first symbol in the PLPC header to the last symbol at the end of the frame.

#### 10.6.14.2. Transmit Power Levels

Unless governed by more stringent local geographic regulations, the radiated emissions from compliant devices shall meet ANSI C95.1-1991 (latest revision) limits for controlled or uncontrolled environments, in accordance with their intended usage. In addition, all conformant PMD implementations shall support at least one power level with a minimum Equivalent Isotropically Radiated Power (EIRP) of 10 mW.

#### 10.6.14.3. Transmit Power Level Control

If a conformant PMD implementation has the ability to transmit in a manner that results in the EIRP of the transmit signal exceeding the level of 100 mW, at least one level of transmit power control shall be implemented. This transmit power control shall be such that the level of the emission is reduced to a level at or below 100 mW under the influence of said power control.

#### 10.6.14.4. Transmit Spectrum Shape

Transmitter shall pass a spectrum mask test. The duty cycle between Tx and Rx is nominally 50% and the transmit frame length is nominally 400 usec. The adjacent channel power, which is the sum of the power measured in a 1 MHz band, shall be either less than -70 dBm or a function of channel offset N from the assigned transmitter channel M.

**Channel**

$N=M+/-2$  -20dBm or -40dBc, whichever is the lower power.

$N>=M+/-3$  -40dBm or -60dBc, whichever is the lowest power.

The levels given in dBc are measured relative to the transmitter power measured in a 1MHz channel centered on the transmitter center frequency. The adjacent channel power and the transmitter power for this section of the specification shall be measured with a resolution bandwidth of 100 kHz, with a peak detector and the measurement device set to maximum hold.

Within the frequency band of 2.4 GHz to 2.4835 GHz, two failures are permitted providing they are less than -50dBc.

**10.6.14.5. Transmit Center Frequency Tolerance**

The PMD shall have a transmit center frequency accuracy, as measured from  $F_c$ , of  $\pm 60$  KHz.

**10.6.14.6. Transmitter Ramp Periods**

The transmitter shall go from off to within 2 dB of the nominal transmit power in 8 usec or less. The transmitter shall go from within 2dB of the nominal transmit power, to off (less than -50dBm) in 8 usec. or less.

**10.6.15. PMD Receiver Specifications**

The following section describes the receive functions and parameters associated with the Physical Medium Dependent sublayer. In general, these are specified by primitives from the PLCP and the Receive PMD entity provides the actual means by which the signals required by the PLCP primitives are recovered from the medium. The PMD sublayer monitors signals on the medium and will return symbols from the set  $\{\{1\},\{0\}\}$  to the PLCP Sublayer. The signal leakage when receiving shall not exceed -45 dBm peak in the operating frequency range.

**10.6.15.1. Input Dynamic Range**

The PMD shall be capable of recovering a conformant PMD signal from the medium, as described in related sections, whose level at the output of the antenna is between -80 dBm (defined as minimum sensitivity) and -10 dBm (defined as maximum allowable input level). A conformant PMD shall maintain a ~~PERBER~~ of less than or equal to  $10^{-25}$  over this dynamic range.

**10.6.15.2. Receive Center Frequency Acceptance Range**

An 802.11 FHSS compliant PMD shall meet all specifications with an input signal having a center frequency range of  $\pm 60$ kHz from nominal.

**10.6.15.3. Clear Channel Assessment Power Threshold**

The PHY shall, in the presence of any 802.11 compliant FH PMD signal above -85 dBm, signal busy with a 90% probability in detection of the preamble within the CCA assessment window. The PHY shall, in the

presence of any 802.11 compliant FH PMD signal above -65 dBm, signal busy with a 70% probability for detection of random data within the CCA assessment window. This specification applies to a PMD operating with a nominal EIRP of <100mW. A compliant PMD operating at a nominal output power greater than 100mW shall use the following equation to define the CCA threshold. Pt represents Transmit Power.

$$\text{CCA Threshold (Preamble)} = -85\text{dBm} - (5 * \log_{10}(P_t/100\text{mW}))\text{dBm}$$

$$\text{CCA Threshold (Random Data)} = \text{CCA Threshold (Preamble)} + 20 \text{ dB}$$

#### 10.6.15.3.1. Ramp Up Period

The purpose of a conformant PMD Ramp Up Time Period is to control the rate of change of the amplitude of the transmit signal during its transition to the desired steady state transmit output level. The ramp up period is defined as a window consisting of 8 usec and is governed by the mask of Figure 10-18.

The following states are defined by the mask of diagram Figure 10-18. The transmitter is considered "off" (i.e. less than -50 dBm EIRP) at the start of the first 1 usec period and is less than 0 dBm at the end of the first 1 usec period. The output level at the end of the seventh 1 usec period is within 3 dB of the desired steady state transmit power level and within 1 dB at the end of the eighth 1 usec period.

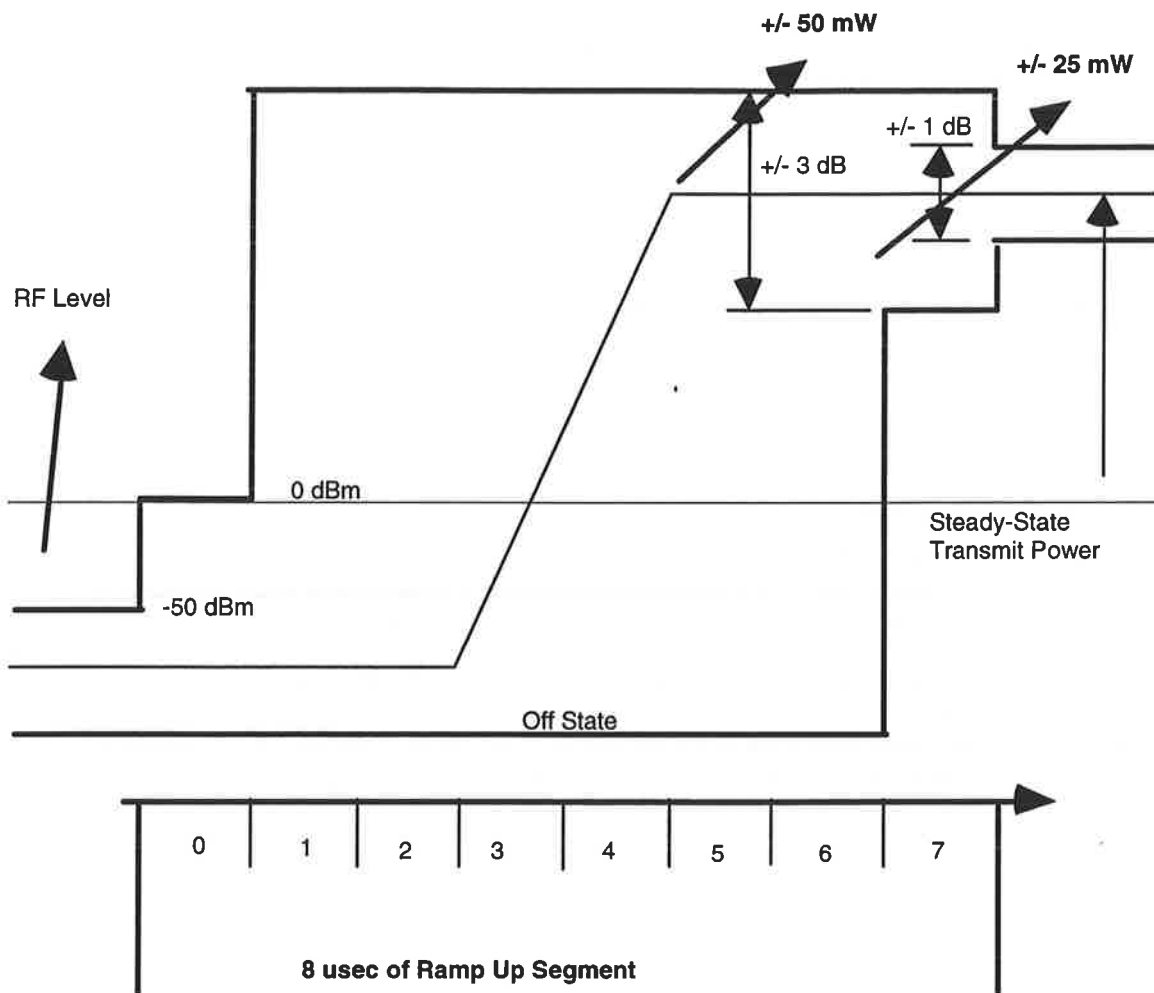


Figure 10-18: Ramp Up

**10.6.15.3.2. Ramp Down Period**

The purpose of a conformant PMD Ramp Down Time Period is to control the rate of change of the amplitude of the transmit signal during its transition to the desired steady state transmit output level. The ramp down period is defined as a window consisting of an 8 usec period and is governed by the mask of Figure 10-19.

The following states are defined by the mask of Figure 10-19. The transmitter is considered "off" (i.e. less than -50 dBm EIRP) at the start of the first 1 usec period and is less than 0 dBm at the end of the first 1 usec. The output level at the end of the seventh 1 usec period is within 3 dB of the desired steady state transmit power level and within 1 dB at the end of the eighth 1 usec period.



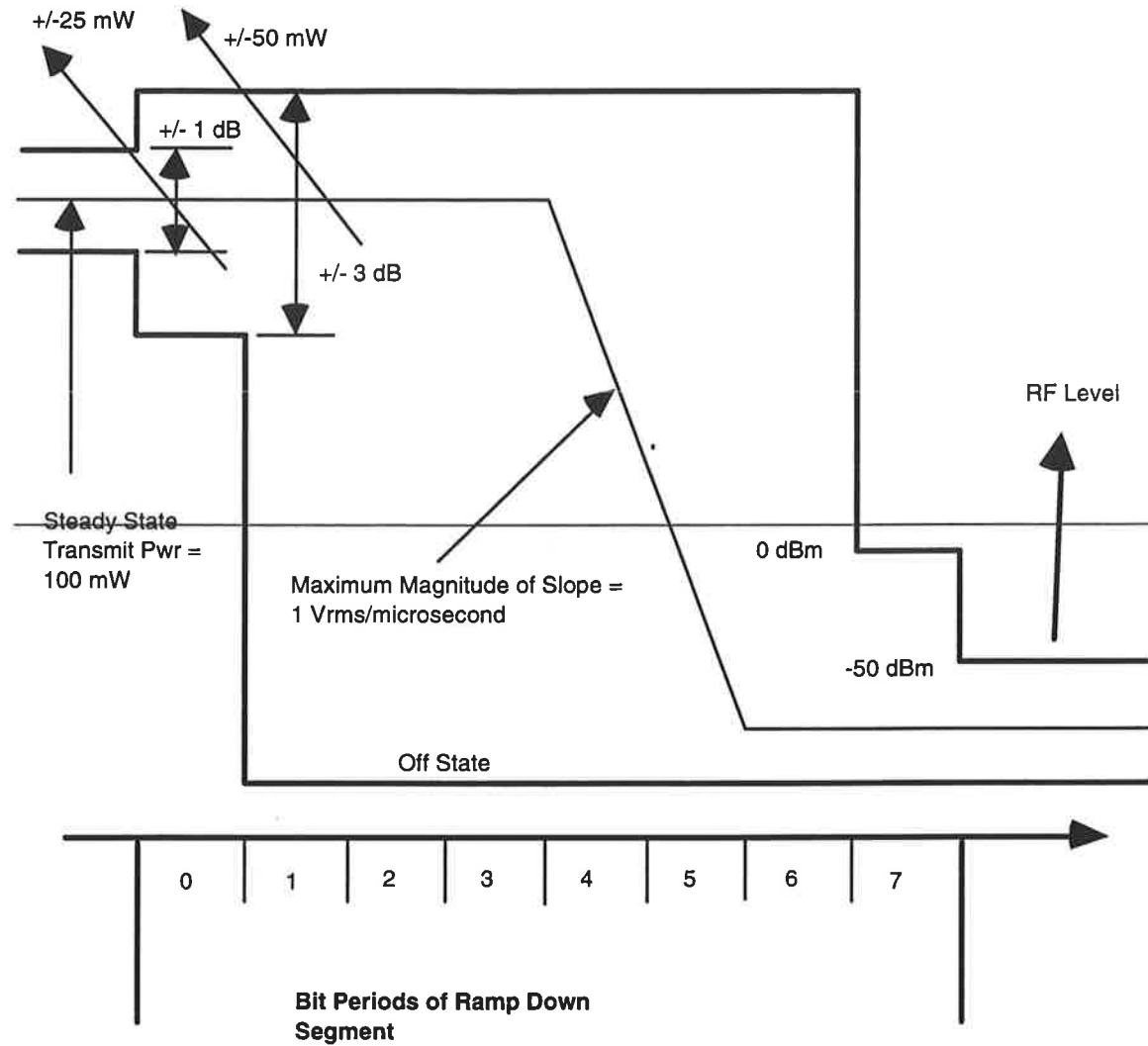


Figure 10-19: Ramp-Down

**10.6.15.4. Minimum Receiver Sensitivity**

Minimum sensitivity is defined as the minimum signal level required to produce a ~~PERBER~~ of  $10^{-25}$ . The PMD shall have the minimum sensitivity be less than or equal to -80 dBm across the operating frequency range specified in 10.6.2.

**10.6.15.5. Intermodulation**

Intermodulation protection (IMp) is defined as the ratio ~~of the desired signal strength to measured sensitivity~~ 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 ~~PERBER~~ of the receiver to be increased to  $10^{-25}$ , when the desired signal is ~~-77 dBm~~ ~~3 dB above sensitivity~~. Each interfering signal is modulated with the FH PMD modulation uncorrelated in time to each other or the desired signal. The PMD shall have the IMp for the interfering signal at 4 and 8 MHz be greater than or equal to 30 dB.

### 10.6.15.6. Desensitization

Desensitization (Dp) is defined as the ratio to measured sensitivity of the minimum amplitude of an interfering signal that causes the PERBER at the output of the receiver to be increased to  $10^{-25}$  when the desired signal is -77 dBm. 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 10-154. The spectral purity of the interferer shall be sufficient to ensure that the measurement is limited by the receiver performance.

Interferer Frequency	DP Minimum
$M=N\pm 2$	30dB
$M=N\pm 3$ or more	40dB

**Table 10-154: 1M Bit Desensitization**

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

### 10.6.16. Operating Temperature Range

Two temperature ranges for full operation compliance to the FH PHY are specified. Type 1 is defined as 0° to 40° C is designated for office environments. Type 2 is defined as -30° to 70° C and is designated for industrial environments.

## 10.7. FHSS Physical Medium Dependent Sublayer 2.0M Bit

### 10.7.1. Introduction

The following section defines the requirements for implementing the FHSS PHY 2.0M bit PMD. Since many of the requirements of this PMD are the same as the 1.0M bit PMD, this section only identifies the specifications where the two PMDs differ. When the specifications are the same, these specifications will be contained in section 10.6.

### 10.7.2. Regulatory Requirements

See section 10.6.2

### 10.7.3. Operating Frequency Range

See Section 10.6.32

### 10.7.4. Number of Operating Channels

See Section 10.6.43

### 10.7.5. Operating Channel Center Frequency

See Section 10.6.54

### 10.7.6. Occupied Channel Bandwidth

See Section 10.6.65

### 10.7.7. Minimum Hop Rate

See Section 10.6.76

### 10.7.8. Hop Sequences

See Section 10.6.87

### 10.7.9. Unwanted Emissions

See Section 10.6.98

### 10.7.10. 4 Level GFSK Modulation

For a FHSS 2MB/sec PMD, the modulation scheme shall be 4 level Gaussian Frequency Shift Keying (4GFSK), with a nominal symbol-period bandwidth product (BT) = 0.5. The four level deviation factor, defined as the frequency separation of adjacent symbols divided by symbol rate,  $h_4$ , shall be related to the deviation factor of the 2GFSK modulation,  $h_2$ , by the following equation:

$$h_4/h_2 = 0.45 \pm 0.01$$

An incoming bit stream at 2 Mb/sec will be converted to 2 bit words or symbols, with a rate of  $F_{clk}=1M$  symbol/sec. The first received bit will be encoded as the left most bit of the symbol in the table below. The bits will be encoded into symbols as shown in Table 10-16-15 below:

1 Mbit/sec, 2-GFSK

Symbol	Carrier Deviation
1	$1/2 * h2 * F_{clk}$
0	$-1/2 * h2 * F_{clk}$

2 Mbit/sec, 4-GFSK

Symbol	Carrier Deviation
10	$3/2 * h4 * F_{clk}$
11	$1/2 * h4 * F_{clk}$
01	$-1/2 * h4 * F_{clk}$
00	$-3/2 * h4 * F_{clk}$

Table 10-16-15. Symbol Encoding into Carrier Deviation

\*Note: The frequency deviations shown in the Table 10-16-15 are achieved by symbols being surrounded by identical symbols; in actual data stream the instantaneous deviation will vary due to Gaussian pulse shaping.

The modulation error shall be less than  $\pm 15$ kHz at the mid symbol time for 4-GFSK, from the frequency deviations specified above, for a symbol surrounded by identical symbols, and less than  $\pm 25$  KHz for any symbol. The deviation is relative to the nominal center frequency of the RF carrier. For definition purposes, the nominal center frequency is the mid frequency between symbols 11 and 01. The nominal center frequency shall not vary greater than  $\pm 10$ kHz/msec, from the start to end of the 4GFSK data word.  $H4$ , measured as a difference between the outmost frequencies, divided by 3, divided by 1 MHz, should have a minimum value of 0.140. The ratio  $h4/h2$  will be  $0.45 \pm 0.01$ . The peak to peak deviation  $h2$  of the 2-GFSK is measured in the middle of 0000 and 1111 patterns encountered in the unique word in the PHY header. Symbols and terms used within this section are illustrated in the figure 10-16-20 below:

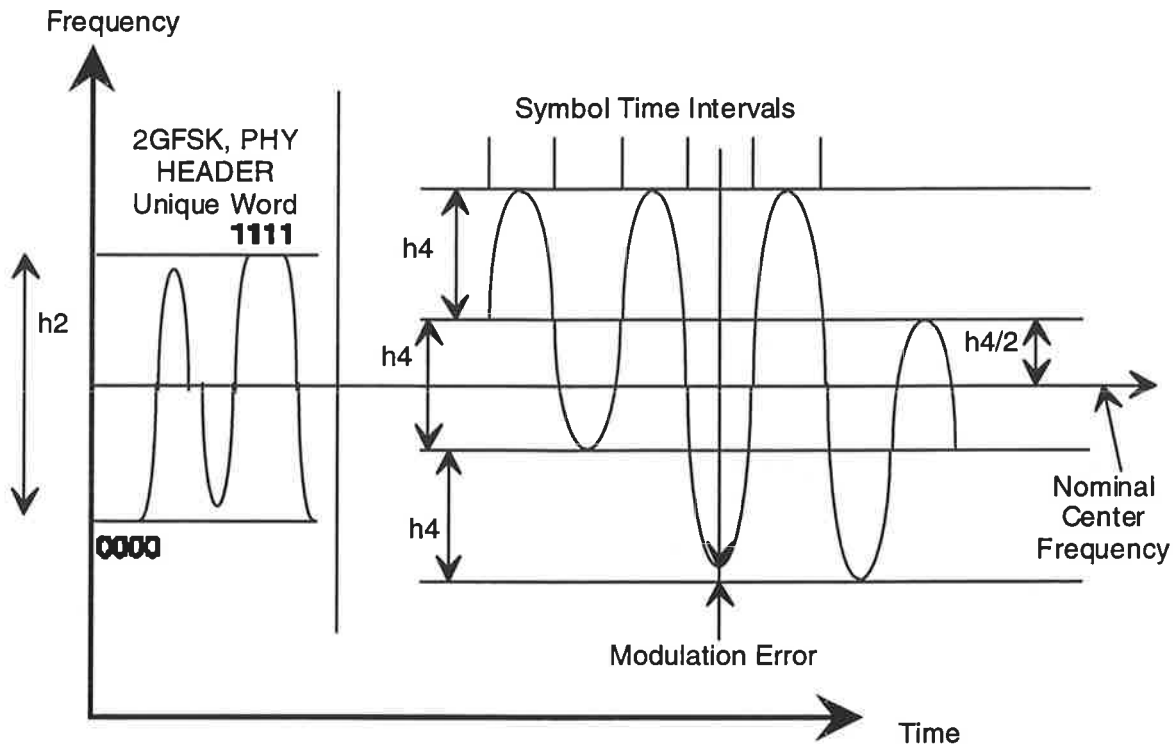


Figure 10-1620. 4 Level GFSK Transmit Modulation

### 10.7.10.1. Frame Structure for HS FHSS PHY

The HS FHSS PHY frame consists of PLCP preamble, PLCP header and PLCP\_PDU. The PLCP preamble and PLCP header format are identical to 1 Mbit PHY, as described in 10.3.2. The PLCP\_PDU is transmitted in 2GFSK, 4GFSK or higher format, according to the rate chosen. The **rate** is indicated in a 2 bit field in a PLCP header, having value of 1 or 2 bits/symbol (or Mbit/sec).

The PLCP\_PDU is transmitted as 4 level symbols, with the amount determined by  $\text{number\_of\_symbols} = (\text{number\_of\_MPDU\_bytes} * 8) / \text{rate}$ .

The input bits are scrambled according to method in 10.3.2.3.

The scrambled bit stream is divided into groups of **rate** (1 or 2) consecutive bits. The bits are mapped into symbols according to Table 10-16-15.

A Bias suppression algorithm is applied to the resulting symbol stream. The bias suppression algorithm is defined in 10.3.2.3, figs. 10-5, 10-7a. A polarity control symbol is inserted prior to each block of 32 symbols (or less for the last block). The polarity control signals are 4GFSK symbols 10 or 00. The algorithm is equivalent to the case of 2GFSK, with the polarity symbol 2GFSK '1' replaced with 4GFSK symbol 10, and the 2GFSK polarity symbol '0' replaced with a 4GFSK symbol '00'.

**10.7.11. Channel Data Rate**

The FHSS 2M bit per sec PMD will be capable of transmitting and receiving at a nominal data rate of 2.0 Mbps and 1 Mbps.

**10.7.12. Channel Switching/Settling Time**

See Section 10.6.121.

**~~10.7.12.1. Transmit to Receive Switch Time~~**

~~See Section 10.6.12~~

**10.7.13. Receive to Transmit Switch Time**

See Section 10.6.13

**~~10.7.13.1. Operating Channel Availability~~**

~~See Section 10.6.14~~

**10.7.14. PMD Transmit Specifications**

See Section 10.6.145

**10.7.14.1. Nominal Frame Transmit Power**

See Section 10.6.14.1

**10.7.14.2. Transmit Power Levels**

See Section 10.6.14.216

**10.7.14.3. Transmit Power Level Control**

See Section 10.6.14.317

**10.7.14.4. Transmit Spectrum Shape**

See Section 10.6.14.418

**10.7.14.5. Transmit Center Frequency Tolerance**

See Section 10.6.14.519

**10.7.14.6. Transmitter Ramp Periods**

See Section 10.6.14.6

**10.7.15. PMD Receiver Specifications**

See Section 10.6.1520

### 10.7.15.1. Input Dynamic Range

The PMD implementation shall be capable of recovering a conformant PMD signal from the medium, as described in related sections, whose level is between -75 dBm (defined as minimum sensitivity) and -10 dBm (defined as maximum allowable input level).

### 10.7.15.2. Receive Center Frequency Acceptance Range

See Sections 10.6.15.222

### 10.7.15.3. Clear Channel Assessment Power Threshold

See Sections 10.6.15.323

#### 10.7.15.3.1. Ramp Up Period

See Sections 10.6.24

#### 10.7.15.3.2. Ramp Down Period

See Sections 10.6.25

### 10.7.15.4. Minimum Receiver Sensitivity

Sensitivity is defined as the minimum signal level required to produce a PERBER of 10-25. The PMD shall have the minimum signal level be less than or equal to -75 dBm across the operating frequency range specified in 10.6.2.

### 10.7.15.5. 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 PERBER of the receiver to be increased to 10-25, when the desired signal is -72 dBm. Each interfering signal is modulated with the FH 1Mb/sec PMD modulation uncorrelated in time to each other or the desired signal. The FHSS 2Mb/sec PMD shall have the IMp for the interfering signal at 4 and 8 MHz be greater than or equal to 30 dB.

### 10.7.15.6. Desensitization

Desensitization (Dp) is defined as the ratio to measured sensitivity of the minimum amplitude of an interfering signal that causes the PERBER of the receiver to be increased to 10-25 when the desired signal is -72 dB (3 dB above sensitivity specified in section 10.7.26). The interfering signal shall be modulated with the FHSS PMD modulation uncorrelated in time to the desired signal. Dp shall be greater than or equal to the values given in Table 10-176 below:

<b>Interferer Frequency</b>	<b>DP Minimum</b>
$M=N\pm 2$	24dB
$M=N\pm 3$ or more	35dB

**Table 10-176: 2M Bit Desensitization**

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

**10.7.16. Operating Temperature Range**

See Section 10.6.16





## 10.8. Hopping Sequences

Table A—Hopping Sequence Set-1

Pattern

Index	7	10	13	16	19	22	25	28	31	34	37
1	2	2	2	2	2	2	2	2	2	2	2
2	9	12	15	18	21	24	27	30	33	36	39
3	16	22	28	34	40	46	52	58	64	70	76
4	23	32	41	50	59	68	77	7	16	25	34
5	30	42	54	66	78	11	23	35	47	59	71
6	37	52	67	3	18	33	48	63	78	14	29
7	44	62	80	19	37	55	73	12	30	48	66
8	51	72	14	35	56	77	19	40	61	3	24
9	58	3	27	51	75	20	44	68	13	37	61
10	65	13	40	67	15	42	69	17	44	71	19
11	72	23	53	4	34	64	15	45	75	26	56
12	79	33	66	20	53	7	40	73	27	60	14
13	7	43	79	36	72	29	65	22	58	15	51
14	14	53	13	52	12	51	11	50	10	49	9
15	21	63	26	68	31	73	36	78	41	4	46
16	28	73	39	5	50	16	61	27	72	38	4
17	35	4	52	21	69	38	7	55	24	72	41
18	42	14	65	37	9	60	32	4	55	27	78
19	49	24	78	53	28	3	57	32	7	61	36
20	56	34	12	69	47	25	3	60	38	16	73
21	63	44	25	6	66	47	28	9	69	50	31
22	70	54	38	22	6	69	53	37	21	5	68
23	77	64	51	38	25	12	78	65	52	39	26
24	5	74	64	54	44	34	24	14	4	73	63
25	12	5	77	70	63	56	49	42	35	28	21
26	19	15	11	7	3	78	74	70	66	62	58
27	26	25	24	23	22	21	20	19	18	17	16
28	33	35	37	39	41	43	45	47	49	51	53
29	40	45	50	55	60	65	70	75	80	6	11
30	47	55	63	71	79	8	16	24	32	40	48
31	54	65	76	8	19	30	41	52	63	74	6
32	61	75	10	24	38	52	66	80	15	29	43
33	68	6	23	40	57	74	12	29	46	63	80
34	75	16	36	56	76	17	37	57	77	18	38
35	3	26	49	72	16	39	62	6	29	52	75
36	10	36	62	9	35	61	8	34	60	7	33
37	17	46	75	25	54	4	33	62	12	41	70
38	24	56	9	41	73	26	58	11	43	75	28
39	31	66	22	57	13	48	4	39	74	30	65
40	38	76	35	73	32	70	29	67	26	64	23

**Table A Hopping Sequence Set 1**

**Pattern**

Index	7	10	13	16	19	22	25	28	31	34	27
41	45	7	48	10	51	13	54	16	57	19	60
42	52	17	61	26	70	35	79	44	9	53	18
43	59	27	74	42	10	57	25	72	40	8	55
44	66	37	8	58	29	79	50	21	71	42	13
45	73	47	21	74	48	22	75	49	23	76	50
46	80	57	34	11	67	44	21	77	54	31	8
47	8	67	47	27	7	66	46	26	6	65	45
48	15	77	60	43	26	9	71	54	37	20	3
49	22	8	73	59	45	31	17	3	68	54	40
50	29	18	7	75	64	53	42	31	20	9	77
51	36	28	20	12	4	75	67	59	51	43	35
52	43	38	33	28	23	18	13	8	3	77	72
53	50	48	46	44	42	40	38	36	34	32	30
54	57	58	59	60	61	62	63	64	65	66	67
55	64	68	72	76	80	5	9	13	17	21	25
56	71	78	6	13	20	27	34	41	48	55	62
57	78	9	19	29	39	49	59	69	79	10	20
58	6	19	32	45	58	71	5	18	31	44	57
59	13	29	45	61	77	14	30	46	62	78	15
60	20	39	58	77	17	36	55	74	14	33	52
61	27	49	71	14	36	58	80	23	45	67	10
62	34	59	5	30	55	80	26	51	76	22	47
63	41	69	18	46	74	23	51	79	28	56	5
64	48	79	31	62	14	45	76	28	59	11	42
65	55	10	44	78	33	67	22	56	11	45	79
66	62	20	57	15	52	10	47	5	42	79	37
67	69	30	70	31	71	32	72	33	73	34	74
68	76	40	4	47	11	54	18	61	25	68	32
69	4	50	17	63	30	76	43	10	56	23	69
70	11	60	30	79	49	19	68	38	8	57	27
71	18	70	43	16	68	41	14	66	39	12	64
72	25	80	56	32	8	63	39	15	70	46	22
73	32	11	69	48	27	6	64	43	22	80	59
74	39	21	3	64	46	28	10	71	53	35	17
75	46	31	16	80	65	50	35	20	5	69	54
76	53	41	29	17	5	72	60	48	36	24	12
77	60	51	42	33	24	15	6	76	67	58	49
78	67	61	55	49	43	37	31	25	19	13	7
79	74	71	68	65	62	59	56	53	50	47	44

Table A Hopping Sequence Set 1 continued

**Pattern**

Index	40	43	46	49	52	55	58	61	64	67	70
1	2	2	2	2	2	2	2	2	2	2	2
2	42	45	48	51	54	57	60	63	66	69	72
3	3	9	15	21	27	33	39	45	51	57	63
4	43	52	61	70	79	9	18	27	36	45	54
5	4	16	28	40	52	64	76	9	21	33	45
6	44	59	74	10	25	40	55	70	6	21	36
7	5	23	41	59	77	16	34	52	70	9	27
8	45	66	8	29	50	71	13	34	55	76	18
9	6	30	54	78	23	47	71	16	40	64	9
10	46	73	21	48	75	23	50	77	25	52	79
11	7	37	67	18	48	78	29	59	10	40	70
12	47	80	34	67	21	54	8	41	74	28	61
13	8	44	80	37	73	30	66	23	59	16	52
14	48	8	47	7	46	6	45	5	44	4	43
15	9	51	14	56	19	61	24	66	29	71	34
16	49	15	60	26	71	37	3	48	14	59	25
17	10	58	27	75	44	13	61	30	78	47	16
18	50	22	73	45	17	68	40	12	63	35	7
19	11	65	40	15	69	44	19	73	48	23	77
20	51	29	7	64	42	20	77	55	33	11	68
21	12	72	53	34	15	75	56	37	18	78	59
22	52	36	20	4	67	51	35	19	3	66	50
23	13	79	66	53	40	27	14	80	67	54	41
24	53	43	33	23	13	3	72	62	52	42	32
25	14	7	79	72	65	58	51	44	37	30	23
26	54	50	46	42	38	34	30	26	22	18	14
27	15	14	13	12	11	10	9	8	7	6	5
28	55	57	59	61	63	65	67	69	71	73	75
29	16	21	26	31	36	41	46	51	56	61	66
30	56	64	72	80	9	17	25	33	41	49	57
31	17	28	39	50	61	72	4	15	26	37	48
32	57	71	6	20	34	48	62	76	11	25	39
33	18	35	52	69	7	24	41	58	75	13	30
34	58	78	19	39	59	79	20	40	60	80	21
35	19	42	65	9	32	55	78	22	45	68	12
36	59	6	32	58	5	31	57	4	30	56	3
37	20	49	78	28	57	7	36	65	15	44	73
38	60	13	45	77	30	62	15	47	79	32	64
39	21	56	12	47	3	38	73	29	64	20	55
40	61	20	58	17	55	14	52	11	49	8	46

Table A Hopping Sequence Set 1 continued

## Pattern

Index	40	43	46	49	52	55	58	61	64	67	70
41	22	63	25	66	28	69	31	72	34	75	37
42	62	27	71	36	80	45	10	54	19	63	28
43	23	70	38	6	53	21	68	36	4	51	19
44	63	34	5	55	26	76	47	18	68	39	10
45	24	77	51	25	78	52	26	79	53	27	80
46	64	41	18	74	51	28	5	61	38	15	71
47	25	5	64	44	24	4	63	43	23	3	62
48	65	48	31	14	76	59	42	25	8	70	53
49	26	12	77	63	49	35	21	7	72	58	44
50	66	55	44	33	22	11	79	68	57	46	35
51	27	19	11	3	74	66	58	50	42	34	26
52	67	62	57	52	47	42	37	32	27	22	17
53	28	26	24	22	20	18	16	14	12	10	8
54	68	69	70	71	72	73	74	75	76	77	78
55	29	33	37	41	45	49	53	57	61	65	69
56	69	76	4	11	18	25	32	39	46	53	60
57	30	40	50	60	70	80	11	21	31	41	51
58	70	4	17	30	43	56	69	3	16	29	42
59	31	47	63	79	16	32	48	64	80	17	33
60	71	11	30	49	68	8	27	46	65	5	24
61	32	54	76	19	41	63	6	28	50	72	15
62	72	18	43	68	14	39	64	10	35	60	6
63	33	61	10	38	66	15	43	71	20	48	76
64	73	25	56	8	39	70	22	53	5	36	67
65	34	68	23	57	12	46	80	35	69	24	58
66	74	32	69	27	64	22	59	17	54	12	49
67	35	75	36	76	37	77	38	78	39	79	40
68	75	39	3	46	10	53	17	60	24	67	31
69	36	3	49	16	62	29	75	42	9	55	22
70	76	46	16	65	35	5	54	24	73	43	13
71	37	10	62	35	8	60	33	6	58	31	4
72	77	53	29	5	60	36	12	67	43	19	74
73	38	17	75	54	33	12	70	49	28	7	65
74	78	60	42	24	6	67	49	31	13	74	56
75	39	24	9	73	58	43	28	13	77	62	47
76	79	67	55	43	31	19	7	74	62	50	38
77	40	31	22	13	4	74	65	56	47	38	29
78	80	74	68	62	56	50	44	38	32	26	20
79	41	38	35	32	29	26	23	20	17	14	11

Table B Hopping Sequence Set 2

## Pattern

Index	8	11	14	17	20	23	26	29	32	35	38
1	2	2	2	2	2	2	2	2	2	2	2
2	10	13	16	19	22	25	28	31	34	37	40
3	18	24	30	36	42	48	54	60	66	72	78
4	26	35	44	53	62	71	80	10	19	28	37
5	34	46	58	70	3	15	27	39	51	63	75
6	42	57	72	8	23	38	53	68	4	19	34
7	50	68	7	25	43	61	79	18	36	54	72
8	58	79	21	42	63	5	26	47	68	10	31
9	66	11	35	59	4	28	52	76	21	45	69
10	74	22	49	76	24	51	78	26	53	80	28
11	3	33	63	14	44	74	25	55	6	36	66
12	11	44	77	31	64	18	51	5	38	71	25
13	19	55	12	48	5	41	77	34	70	27	63
14	27	66	26	65	25	64	24	63	23	62	22
15	35	77	40	3	45	8	50	13	55	18	60
16	43	9	54	20	65	31	76	42	8	53	19
17	51	20	68	37	6	54	23	71	40	9	57
18	59	31	3	54	26	77	49	21	72	44	16
19	67	42	17	71	46	21	75	50	25	79	54
20	75	53	31	9	66	44	22	79	57	35	13
21	4	64	45	26	7	67	48	29	10	70	51
22	12	75	59	43	27	11	74	58	42	26	10
23	20	7	73	60	47	34	21	8	74	61	48
24	28	18	8	77	67	57	47	37	27	17	7
25	36	29	22	15	8	80	73	66	59	52	45
26	44	40	36	32	28	24	20	16	12	8	4
27	52	51	50	49	48	47	46	45	44	43	42
28	60	62	64	66	68	70	72	74	76	78	80
29	68	73	78	4	9	14	19	24	29	34	39
30	76	5	13	21	29	37	45	53	61	69	77
31	5	16	27	38	49	60	71	3	14	25	36
32	13	27	41	55	69	4	18	32	46	60	74
33	21	38	55	72	10	27	44	61	78	16	33
34	29	49	69	10	30	50	70	11	31	51	71
35	37	60	4	27	50	73	17	40	63	7	30
36	45	71	18	44	70	17	43	69	16	42	68
37	53	3	32	61	11	40	69	19	48	77	27
38	61	14	46	78	31	63	16	48	80	33	65
39	69	25	60	16	51	7	42	77	33	68	24
40	77	36	74	33	71	30	68	27	65	24	62

Table B—Hopping Sequence Set 2

## Pattern

Index	8	11	14	17	20	23	26	29	32	35	38
41	6	47	9	50	71	75	79	4	8	12	16
42	14	58	23	67	12	19	26	33	40	47	54
43	22	69	37	5	32	42	52	62	72	3	13
44	30	80	51	22	52	65	78	12	25	38	51
45	38	12	65	39	72	9	25	41	57	73	10
46	46	23	79	56	13	32	51	70	10	29	48
47	54	34	14	73	33	55	77	20	42	64	7
48	62	45	28	11	53	78	24	49	74	20	45
49	70	56	42	28	73	22	50	78	27	55	4
50	78	67	56	45	14	45	76	28	59	11	42
51	7	78	70	62	34	68	23	57	12	46	80
52	15	10	5	79	54	12	49	7	44	2	39
53	23	21	19	17	74	35	75	36	76	37	77
54	31	32	33	34	15	58	22	65	29	72	36
55	39	43	47	51	35	2	48	15	61	28	74
56	47	54	61	68	55	25	74	44	14	63	33
57	55	65	75	6	75	48	21	73	46	19	71
58	63	76	10	23	16	71	47	23	78	54	30
59	71	8	24	40	36	15	73	52	31	10	68
60	79	19	38	57	56	38	20	2	63	45	27
61	8	30	52	74	76	61	46	31	16	80	65
62	16	41	66	12	17	5	72	60	48	36	24
63	24	52	80	29	37	28	19	10	80	71	62
64	32	63	15	46	57	51	45	39	33	27	21
65	40	74	29	63	77	74	71	68	65	62	59
66	48	6	43	80	18	18	18	18	18	18	18
67	56	17	57	18	38	41	44	47	50	53	56
68	64	28	71	35	58	64	70	76	3	9	15
69	72	39	6	52	78	8	17	26	35	44	53
70	80	50	20	69	19	31	43	55	67	79	12
71	9	61	34	7	39	54	69	5	20	35	50
72	17	72	48	24	59	77	16	34	52	70	9
73	25	4	62	41	79	21	42	63	5	26	47
74	33	15	76	58	20	44	68	13	37	61	6
75	41	26	11	75	40	67	15	42	69	17	44
76	49	37	25	13	60	11	41	71	22	52	3
77	57	48	39	30	80	34	67	21	54	8	41
78	65	59	53	47	21	57	14	50	7	43	79
79	73	70	67	64	41	80	40	79	39	78	38

Table B Hopping Sequence Set 2 continued

## Pattern

Index	41	44	47	50	53	56	59	62	65	68	71
1	2	2	2	2	2	2	2	2	2	2	2
2	43	46	49	52	55	58	61	64	67	70	73
3	5	11	17	23	29	35	41	47	53	59	65
4	46	55	64	73	3	12	21	30	39	48	57
5	8	20	32	44	56	68	80	13	25	37	49
6	49	64	79	15	30	45	60	75	11	26	41
7	11	29	47	65	4	22	40	58	76	15	33
8	52	73	15	36	57	78	20	41	62	4	25
9	14	38	62	7	31	55	79	24	48	72	17
10	55	3	30	57	5	32	59	7	34	61	9
11	17	47	77	28	58	9	39	69	20	50	80
12	58	12	45	78	32	65	19	52	6	39	72
13	20	56	13	49	6	42	78	35	71	28	64
14	61	21	60	20	59	19	58	18	57	17	56
15	23	65	28	70	33	75	38	80	43	6	48
16	64	30	75	41	7	52	18	63	29	74	40
17	26	74	43	12	60	29	77	46	15	63	32
18	67	39	11	62	34	6	57	29	80	52	24
19	29	4	58	33	8	62	37	12	66	41	16
20	70	48	26	4	61	39	17	74	52	30	8
21	32	13	73	54	35	16	76	57	38	19	79
22	73	57	41	25	9	72	56	40	24	8	71
23	35	22	9	75	62	49	36	23	10	76	63
24	76	66	56	46	36	26	16	6	75	65	55
25	38	31	24	17	10	3	75	68	61	54	47
26	79	75	71	67	63	59	55	51	47	43	39
27	41	40	39	38	37	36	35	34	33	32	31
28	3	5	7	9	11	13	15	17	19	21	23
29	44	49	54	59	64	69	74	79	5	10	15
30	6	14	22	30	38	46	54	62	70	78	7
31	47	58	69	80	12	23	34	45	56	67	78
32	9	23	37	51	65	79	14	28	42	56	70
33	50	67	5	22	39	56	73	11	28	45	62
34	12	32	52	72	13	33	53	73	14	34	54
35	53	76	20	43	66	10	33	56	79	23	46
36	15	41	67	14	40	66	13	39	65	12	38
37	56	6	35	64	14	43	72	22	51	80	30
38	18	50	3	35	67	20	52	5	37	69	22
39	59	15	50	6	41	76	32	67	23	58	14
40	21	59	18	56	15	53	12	50	9	47	6



Table B—Hopping Sequence Set 2—continued

**Pattern**

Index	41	44	47	50	53	56	59	62	65	68	71
41	62	24	65	27	68	30	71	33	74	36	77
42	24	68	33	77	42	7	51	16	60	25	69
43	65	33	80	48	16	63	31	78	46	14	61
44	27	77	48	19	69	40	11	61	32	3	53
45	68	42	16	69	43	17	70	44	18	71	45
46	30	7	63	40	17	73	50	27	4	60	37
47	71	51	31	11	70	50	30	10	69	49	29
48	33	16	78	61	44	27	10	72	55	38	21
49	74	60	46	32	18	4	69	55	41	27	13
50	36	25	14	3	71	60	49	38	27	16	5
51	77	69	61	53	45	37	29	21	13	5	76
52	39	34	29	24	19	14	9	4	78	73	68
53	80	78	76	74	72	70	68	66	64	62	60
54	42	43	44	45	46	47	48	49	50	51	52
55	4	8	12	16	20	24	28	32	36	40	44
56	45	52	59	66	73	80	8	15	22	29	36
57	7	17	27	37	47	57	67	77	8	18	28
58	48	61	74	8	21	34	47	60	73	7	20
59	10	26	42	58	74	11	27	43	59	75	12
60	51	70	10	29	48	67	7	26	45	64	4
61	13	35	57	79	22	44	66	9	31	53	75
62	54	79	25	50	75	21	46	71	17	42	67
63	16	44	72	21	49	77	26	54	3	31	59
64	57	9	40	71	23	54	6	37	68	20	51
65	19	53	8	42	76	31	65	20	54	9	43
66	60	18	55	13	50	8	45	3	40	77	35
67	22	62	23	63	24	64	25	65	26	66	27
68	63	27	70	34	77	41	5	48	12	55	19
69	25	71	38	5	51	18	64	31	77	44	11
70	66	36	6	55	25	74	44	14	63	33	3
71	28	80	53	26	78	51	24	76	49	22	74
72	69	45	21	76	52	28	4	59	35	11	66
73	31	10	68	47	26	5	63	42	21	79	58
74	72	54	36	18	79	61	43	25	7	68	50
75	34	19	4	68	53	38	23	8	72	57	42
76	75	63	51	39	27	15	3	70	58	46	34
77	37	28	19	10	80	71	62	53	44	35	26
78	78	72	66	60	54	48	42	36	30	24	18
79	40	37	34	31	28	25	22	19	16	13	10

Table C Hopping Sequence Set 3

Pattern

Index	9	12	15	18	21	24	27	30	33	36	39
1	2	2	2	2	2	2	2	2	2	2	2
2	11	14	17	20	23	26	29	32	35	38	41
3	20	26	32	38	44	50	56	62	68	74	80
4	29	38	47	56	65	74	4	13	22	31	40
5	38	50	62	74	7	19	31	43	55	67	79
6	47	62	77	13	28	43	58	73	9	24	39
7	56	74	13	31	49	67	6	24	42	60	78
8	65	7	28	49	70	12	33	54	75	17	38
9	74	19	43	67	12	36	60	5	29	53	77
10	4	31	58	6	33	60	8	35	62	10	37
11	13	43	73	24	54	5	35	65	16	46	76
12	22	55	9	42	75	29	62	16	49	3	36
13	31	67	24	60	17	53	10	46	3	39	75
14	40	79	39	78	38	77	37	76	36	75	35
15	49	12	54	17	59	22	64	27	69	32	74
16	58	24	69	35	80	46	12	57	23	68	34
17	67	36	5	53	22	70	39	8	56	25	73
18	76	48	20	71	43	15	66	38	10	61	33
19	6	60	35	10	64	39	14	68	43	18	72
20	15	72	50	28	6	63	41	19	76	54	32
21	24	5	65	46	27	8	68	49	30	11	71
22	33	17	80	64	48	32	16	79	63	47	31
23	42	29	16	3	69	56	43	30	17	4	70
24	51	41	31	21	11	80	70	60	50	40	30
25	60	53	46	39	32	25	18	11	4	76	69
26	69	65	61	57	53	49	45	41	37	33	29
27	78	77	76	75	74	73	72	71	70	69	68
28	8	10	12	14	16	18	20	22	24	26	28
29	17	22	27	32	37	42	47	52	57	62	67
30	26	34	42	50	58	66	74	3	11	19	27
31	35	46	57	68	79	11	22	33	44	55	66
32	44	58	72	7	21	35	49	63	77	12	26
33	53	70	8	25	42	59	76	14	31	48	65
34	62	3	23	43	63	4	24	44	64	5	25
35	71	15	38	61	5	28	51	74	18	41	64
36	80	27	53	79	26	52	78	25	51	77	24
37	10	39	68	18	47	76	26	55	5	34	63
38	19	51	4	36	68	21	53	6	38	70	23
39	28	63	19	54	10	45	80	36	71	27	62
40	37	75	34	72	31	69	28	66	25	63	22

Table C Hopping Sequence Set 3

## Pattern

Index	9	12	15	18	21	24	27	30	33	36	39
41	46	8	49	11	52	14	55	17	58	20	61
42	55	20	64	29	73	38	3	47	12	56	21
43	64	32	79	47	15	62	30	77	45	13	60
44	73	44	15	65	36	7	57	28	78	49	20
45	3	56	30	4	57	31	5	58	32	6	59
46	12	68	45	22	78	55	32	9	65	42	19
47	21	80	60	40	20	79	59	39	19	78	58
48	30	13	75	58	41	24	7	69	52	35	18
49	39	25	11	76	62	48	34	20	6	71	57
50	48	37	26	15	4	72	61	50	39	28	17
51	57	49	41	33	25	17	9	80	72	64	56
52	66	61	56	51	46	41	36	31	26	21	16
53	75	73	71	69	67	65	63	61	59	57	55
54	5	6	7	8	9	10	11	12	13	14	15
55	14	18	22	26	30	34	38	42	46	50	54
56	23	30	37	44	51	58	65	72	79	7	14
57	32	42	52	62	72	3	13	23	33	43	53
58	41	54	67	80	14	27	40	53	66	79	13
59	50	66	3	19	35	51	67	4	20	36	52
60	59	78	18	37	56	75	15	34	53	72	12
61	68	11	33	55	77	20	42	64	7	29	51
62	77	23	48	73	19	44	69	15	40	65	11
63	7	35	63	12	40	68	17	45	73	22	50
64	16	47	78	30	61	13	44	75	27	58	10
65	25	59	14	48	3	37	71	26	60	15	49
66	34	71	29	66	24	61	19	56	14	51	9
67	43	4	44	5	45	6	46	7	47	8	48
68	52	16	59	23	66	30	73	37	80	44	8
69	61	28	74	41	8	54	21	67	34	80	47
70	70	40	10	59	29	78	48	18	67	37	7
71	79	52	25	77	50	23	75	48	21	73	46
72	9	64	40	16	71	47	23	78	54	30	6
73	18	76	55	34	13	71	50	29	8	66	45
74	27	9	70	52	34	16	77	59	41	23	5
75	36	21	6	70	55	40	25	10	74	59	44
76	45	33	21	9	76	64	52	40	28	16	4
77	54	45	36	27	18	9	79	70	61	52	43
78	63	57	51	45	39	33	27	21	15	9	3
79	72	69	66	63	60	57	54	51	48	45	42

Table C Hopping Sequence Set 3-continued

## Pattern

Index	42	45	48	51	54	57	60	63	66	69	72
1	2	2	2	2	2	2	2	2	2	2	2
2	44	47	50	53	56	59	62	65	68	71	74
3	7	13	19	25	31	37	43	49	55	61	67
4	49	58	67	76	6	15	24	33	42	51	60
5	12	24	36	48	60	72	5	17	29	41	53
6	54	69	5	20	35	50	65	80	16	31	46
7	17	35	53	71	10	28	46	64	3	21	39
8	59	80	22	43	64	6	27	48	69	11	32
9	22	46	70	15	39	63	8	32	56	80	25
10	64	12	39	66	14	41	68	16	43	70	18
11	27	57	8	38	68	19	49	79	30	60	11
12	69	23	56	10	43	76	30	63	17	50	4
13	32	68	25	61	18	54	11	47	4	40	76
14	74	34	73	33	72	32	71	31	70	30	69
15	37	79	42	5	47	10	52	15	57	20	62
16	79	45	11	56	22	67	33	78	44	10	55
17	42	11	59	28	76	45	14	62	31	79	48
18	5	56	28	79	51	23	74	46	18	69	41
19	47	22	76	51	26	80	55	30	5	59	34
20	10	67	45	23	80	58	36	14	71	49	27
21	52	33	14	74	55	36	17	77	58	39	20
22	15	78	62	46	30	14	77	61	45	29	13
23	57	44	31	18	5	71	58	45	32	19	6
24	20	10	79	69	59	49	39	29	19	9	78
25	62	55	48	41	34	27	20	13	6	78	71
26	25	21	17	13	9	5	80	76	72	68	64
27	67	66	65	64	63	62	61	60	59	58	57
28	30	32	34	36	38	40	42	44	46	48	50
29	72	77	3	8	13	18	23	28	33	38	43
30	35	43	51	59	67	75	4	12	20	28	36
31	77	9	20	31	42	53	64	75	7	18	29
32	40	54	68	3	17	31	45	59	73	8	22
33	3	20	37	54	71	9	26	43	60	77	15
34	45	65	6	26	46	66	7	27	47	67	8
35	8	31	54	77	21	44	67	11	34	57	80
36	50	76	23	49	75	22	48	74	21	47	73
37	13	42	71	21	50	79	29	58	8	37	66
38	55	8	40	72	25	57	10	42	74	27	59
39	18	53	9	44	79	35	70	26	61	17	52
40	60	19	57	16	54	13	51	10	48	7	45

Table C—Hopping Sequence Set 3—continued

**Pattern**

Index	42	45	48	51	54	57	60	63	66	69	72
41	23	64	26	67	29	70	32	73	35	76	38
42	65	30	74	39	4	48	13	57	22	66	31
43	28	75	43	11	58	26	73	41	9	56	24
44	70	41	12	62	33	4	54	25	75	46	17
45	33	7	60	34	8	61	35	9	62	36	10
46	75	52	29	6	62	39	16	72	49	26	3
47	38	18	77	57	37	17	76	56	36	16	75
48	80	63	46	29	12	74	57	40	23	6	68
49	43	29	15	80	66	52	38	24	10	75	61
50	6	74	63	52	41	30	19	8	76	65	54
51	48	40	32	24	16	8	79	71	63	55	47
52	11	6	80	75	70	65	60	55	50	45	40
53	53	51	49	47	45	43	41	39	37	35	33
54	16	17	18	19	20	21	22	23	24	25	26
55	58	62	66	70	74	78	3	7	11	15	19
56	21	28	35	42	49	56	63	70	77	5	12
57	63	73	4	14	24	34	44	54	64	74	5
58	26	39	52	65	78	12	25	38	51	64	77
59	68	5	21	37	53	69	6	22	38	54	70
60	31	50	69	9	28	47	66	6	25	44	63
61	73	16	38	60	3	25	47	69	12	34	56
62	36	61	7	32	57	3	28	53	78	24	49
63	78	27	55	4	32	60	9	37	65	14	42
64	41	72	24	55	7	38	69	21	52	4	35
65	4	38	72	27	61	16	50	5	39	73	28
66	46	4	41	78	36	73	31	68	26	63	21
67	9	49	10	50	11	51	12	52	13	53	14
68	51	15	58	22	65	29	72	36	79	43	7
69	14	60	27	73	40	7	53	20	66	33	79
70	56	26	75	45	15	64	34	4	53	23	72
71	19	71	44	17	69	42	15	67	40	13	65
72	61	37	13	68	44	20	75	51	27	3	58
73	24	3	61	40	19	77	56	35	14	72	51
74	66	48	30	12	73	55	37	19	80	62	44
75	29	14	78	63	48	33	18	3	67	52	37
76	71	59	47	35	23	11	78	66	54	42	30
77	34	25	16	7	77	68	59	50	41	32	23
78	76	70	64	58	52	46	40	34	28	22	16
79	39	36	33	30	27	24	21	18	15	12	9

Table D—Hopping Sequence for Japan

## Pattern

Index	Set 1				Set 2				Set 3			
	6	9	12	15	7	10	13	16	8	11	14	17
1	73	73	73	73	73	73	73	73	73	73	73	73
2	79	82	85	88	80	83	86	89	81	84	87	90
3	85	91	74	80	87	93	76	82	89	95	78	84
4	91	77	86	95	94	80	89	75	74	83	92	78
5	74	86	75	87	78	90	79	91	82	94	83	95
6	80	95	87	79	85	77	92	84	90	82	74	89
7	86	81	76	94	92	87	82	77	75	93	88	83
8	92	90	88	86	76	74	95	93	83	81	79	77
9	75	76	77	78	83	84	85	86	91	92	93	94
10	81	85	89	93	90	94	75	79	76	80	84	88
11	87	94	78	85	74	81	88	95	84	91	75	82
12	93	80	90	77	81	91	78	88	92	79	89	76
13	76	89	79	92	88	78	91	81	77	90	80	93
14	82	75	91	84	95	88	81	74	85	78	94	87
15	88	84	80	76	79	75	94	90	93	89	85	81
16	94	93	92	91	86	85	84	83	78	77	76	75
17	77	79	81	83	93	95	74	76	86	88	90	92
18	83	88	93	75	77	82	87	92	94	76	81	86
19	89	74	82	90	84	92	77	85	79	87	95	80
20	95	83	94	82	91	79	90	78	87	75	86	74
21	78	92	83	74	75	89	80	94	95	86	77	91
22	84	78	95	89	82	76	93	87	80	74	91	85
23	90	87	84	81	89	86	83	80	88	85	82	79

## **10.9.FHSS PHY Management Information Base**

### **10.9.1.Introduction**

The following is the Management Information Base for the Frequency Hopping Spread Spectrum PHY.

### **10.9.2. FHSS PHY Management Information Base Definitions**

#### **10.9.2.1. FHSS PHY Attributes**

##### **10.9.2.1.1. agPhyOperation\_grp**

- aPHY\_Type
- aNbr\_Geo\_Supported
- aGeo\_USA
- aGeo\_Japan
- aGeo\_Europe
- aCCA\_Method
- aCCA\_MaxP\_Det\_Time
- aCCA\_Asmnt\_Time
- aCCA\_Decay\_Time
- aRxTx\_Switch\_Time
- aTxRx\_Switch\_Time
- aTxRamp\_On\_Time
- aTxRamp\_Off\_Time
- aTx\_RF\_Delay
- aRx\_RF\_Delay
- aTx\_PLCP\_Delay
- aRx\_Clk\_Revy\_Delay
- aTxRx\_Turnaround\_Time
- aRxTx\_Turnaround\_Time
- aMAC\_Ack\_Delay
- aTx\_SIFS
- aRx\_SIFS
- aSlot\_Time
- aMPDU\_Maximum\_Length
- aMPDU\_Current\_Max\_Length

##### **10.9.2.1.2. agPhyRate\_grp**

- aNbr\_Supported\_Rates
- aRate\_1MHz
- aRate\_2MHz
- aBSS\_Basic\_rate

**10.9.2.1.3. agPhyAntenna\_grp**

aNbr\_Supported\_Antenna  
aAntenna\_One\_Type  
aAntenna\_Two\_Type

**10.9.2.1.4. agPhyPower\_grp**

aNbr\_Supported\_Power\_Levels  
aTx\_Pwr\_Lvl\_1  
aTx\_Pwr\_Lvl\_2  
aTx\_Pwr\_Lvl\_3  
aTx\_Pwr\_Lvl\_4  
aCurrent\_Tx\_PwrLvl

**10.9.2.1.5. agPhyHopping\_grp**

aCurrent\_Channel\_ID  
aCurrent\_Country\_Code  
aHop\_Time  
aMax\_Dwell\_Time  
aCurrent\_Dwell\_Time  
aSynthesizer\_Locked

**10.9.2.2. FHSS PHY Object Class**

PHY MANAGED OBJECT CLASS  
DERIVED FROM "ISO/IEC 10165-2":top;  
CHARACTERIZED BY

\_\_\_\_\_ pPHY\_base \_\_\_\_\_ PACKAGE

\_\_\_\_\_ BEHAVIOR

\_\_\_\_\_ bPHY\_base BEHAVIOR

DEFINED AS "The PHY object class provides the necessary support for the timing information, rate support, antenna definition, and power level information which may vary from PHY to PHY and from STA to STA to be communicated to upper layers."

\_\_\_\_\_ ATTRIBUTES

aPHY\_Type \_\_\_\_\_ GET,  
aNbr\_Geo\_Supported \_\_\_\_\_ GET,  
aGeo\_USA \_\_\_\_\_ GET,  
aGeo\_Japan \_\_\_\_\_ GET,  
aGeo\_Europe \_\_\_\_\_ GET,



```

aCCA_Method _____ GET,
aCCA_MaxP_Det_Time _____ GET,
aCCA_Asmnt_Time _____ GET,
aCCA_Decay_Time _____ GET,
aRxTx_Switch_Time _____ GET,
aTxRx_Switch_Time _____ GET,
aTxRamp_On_Time _____ GET,
aTxRamp_Off_Time _____ GET,
aTx_RF_Delay _____ GET,
aRx_RF_Delay _____ GET,
aTx_PLCP_Delay _____ GET,
aRx_Clk_Revy_Delay _____ GET,
aTxRx_Turnaround_Time _____ GET,
aRxTx_Turnaround_Time _____ GET,
aMAC_Ack_Delay _____ GET REPLACE,
aTx_SIFS _____ GET,
aRx_SIFS _____ GET,
aSlot_Time _____ GET,
aMPDU_Maximum _____ GET,
aMPDU_Current_Max _____ GET REPLACE,
aNbr_Supported_Rates _____ GET,
aRate_1MHz _____ GET,
aRate_2MHz _____ GET,
aCurrent_Bit_rate _____ GET REPLACE
aNbr_Supported_Antenna _____ GET,
aAntenna_One_Type _____ GET,
aAntenna_Two_Type _____ GET,
aNbr_Supported_Power_Levels _____ GET,
aTx_Pwr_Lvl_1 _____ GET,
aTx_Pwr_Lvl_2 _____ GET,
aTx_Pwr_Lvl_3 _____ GET,
aTx_Pwr_Lvl_4 _____ GET,
aCurrent_Tx_PwrLvl _____ GET REPLACE,
aCurrent_Channel_ID _____ GET,
aCurrent_Country_Code _____ GET REPLACE,
aHop_Time _____ GET,
aMax_Dwell_Time _____ GET,
aCurrent_Dwell_Time _____ GET REPLACE
aSynthesizer_Locked _____ GET,

```

ATTRIBUTE GROUPS

```

agPhyOperation_grp,
agPhyRate_grp,
agPhyAntenna_grp,
agPhyPower_grp,
agPhyHopping_grp

```

ACTIONS

```

aePHY_init,
aePHY_reset;

```

NOTIFICATIONS

```

none

```

REGISTERED AS { iso(1) member body(2) us(840) ieee802dot11(xxxx) PHY(1) };

**10.9.2.3. FHSS PHY Attribute Group Templates****10.9.2.3.1. agPhyOperation\_grp****PhyRate\_grp ATTRIBUTE GROUP****GROUP ELEMENTS**

aPHY\_Type  
 aNbr\_Geo\_Supported  
 aGeo\_USA  
 aGeo\_Japan  
 aGeo\_Europe  
 aCCA\_Method  
 aCCA\_MaxP\_Det\_Time  
 aCCA\_Asmnt\_Time  
 aCCA\_Decay\_Time  
 aRxTx\_Switch\_Time  
 aTxRx\_Switch\_Time  
 aTxRamp\_On\_Time  
 aTxRamp\_Off\_Time  
 aTx\_RF\_Delay  
 aRx\_RF\_Delay  
 aTx\_PLCP\_Delay  
 aRx\_Clk\_Revy\_Delay  
 aTxRx\_Turnaround\_Time  
 aRxTx\_Turnaround\_Time  
 aMAC\_Ack\_Delay  
 aTx\_SIFS  
 aRx\_SIFS  
 aSlot\_Time  
 aMPDU\_Maximum  
 aMPDU\_Current\_Max

REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(1) PhyRate\_grp(0) };

**10.9.2.3.2. agPhyRate\_grp****PhyRate\_grp ATTRIBUTE GROUP****GROUP ELEMENTS**

aNbr\_Supported\_Rates  
 aRate\_1MHz  
 aRate\_2MHz  
 aCurrent\_Bit\_rate

REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(1) PhyRate\_grp(1) };

**10.9.2.3.3. agPhyAntenna\_grp**

PhyRate\_grp ATTRIBUTE GROUP

GROUP ELEMENTS

aNbr\_Supported\_Antenna

aAntenna\_One\_Type

aAntenna\_Two\_Type

REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(1) PhyRate\_grp(2) };

**10.9.2.3.4. agPhyPower\_grp**

PhyRate\_grp ATTRIBUTE GROUP

GROUP ELEMENTS

aNbr\_Supported\_Power\_Levels

aTx\_Pwr\_Lvl\_1

aTx\_Pwr\_Lvl\_2

aTx\_Pwr\_Lvl\_3

aTx\_Pwr\_Lvl\_4

aCurrent\_Tx\_PwrLvl

REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(1) PhyRate\_grp(3) };

**10.9.2.3.5. agPhyHopping\_grp**

PhyRate\_grp ATTRIBUTE GROUP

GROUP ELEMENTS

aCurrent\_Channel\_ID

aCurrent\_Country\_Code

aHop\_Time

aMax\_Dwell\_Time

aCurrent\_Dwell\_Time

aSynthesizer\_Locked

REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) phy(1) PhyRate\_grp(4) };

**10.9.2.4. FHSS PHY Attribute Templates****10.9.2.4.1. aPHY\_Type**

PHY\_Type ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"This identifies the PHY Type supported by the attached PLCP and PMD";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) PHY\_Type(1) };

**10.9.2.4.2. aNbr\_Cntry\_Supported**

Nbr\_Cntry\_Supported ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"There are different operational requirements dependent on the geographical location. This attribute indicates the number of geographical locations supported by this implementation.";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)  
Nbr\_Cntry\_Supported(2) };

**10.9.2.4.3. aGeo\_USA**

Geo\_USA ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Boolean;

BEHAVIOR DEFINED AS

"An indication whether or not the PHY implementation supports the operational requirements of the USA";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Geo\_USA(3) };

**10.9.2.4.4. aGeo\_Japan**

Geo\_Japan ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Boolean;

BEHAVIOR DEFINED AS

~~"An indication whether or not the current PHY implementation supports the operational requirements of Japan";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Geo\_Japan(4) };~~

#### **10.9.2.4.5. aGeo\_Europe**

~~Geo\_Europe ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Boolean;~~

~~BEHAVIOR DEFINED AS~~

~~"An indication whether or not the current PHY implementation supports the operational requirements of Europe";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Geo\_Europe(5) };~~

#### **10.9.2.4.6. aCCA\_Method**

~~CCA\_Method ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"This integer specifies whether the current PHY implementation supports Clear Channel Assessment using Carrier Sense only or Carrier Sense and Compliant Data Detect";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) CCA\_Method(6) };~~

#### **10.9.2.4.7. aCCA\_MaxP\_Det\_Time**

~~CCA\_MaxP\_Det\_Time ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"The maximum time in nanoseconds for the CCA mechanism to determine that the state of the media has changed from clear to busy when evaluating a valid preamble";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)  
CCA\_MaxP\_Det\_Time(7) };~~

#### **10.9.2.4.8. aCCA\_Asmnt\_Time**

~~CCA\_Asmnt\_Time ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

**BEHAVIOR DEFINED AS**

"The time in nanoseconds the CCA mechanism must assess the media within every slot to determine whether the media is clear or busy";

**REGISTERED AS**

```
{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)-CCA_Asmnt_Time(8)
};
```

**10.9.2.4.9. ~~aCCA\_Decay\_Time~~****~~CCA\_Decay\_Time~~ ATTRIBUTE****WITH APPROPRIATE SYNTAX**

~~Integer;~~

**BEHAVIOR DEFINED AS**

~~"The maximum time in nanoseconds the CCA mechanism can take to signal that the channel has become clear after the end of a data transaction";~~

**REGISTERED AS**

```
{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)-CCA_Decay_Time(9)
};
```

**10.9.2.4.10. ~~aRxTx\_Switch\_Time~~****~~RxTx\_Switch\_Time~~ ATTRIBUTE****WITH APPROPRIATE SYNTAX**

~~Integer;~~

**BEHAVIOR DEFINED AS**

~~"The time in nanoseconds the PMD takes to switch the radio from Receive to Transmit";~~

**REGISTERED AS**

```
{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)
RxTx_Switch_Time(10) };
```

**10.9.2.4.11. ~~aTxRx\_Switch\_Time~~****~~TxRx\_Switch\_Time~~ ATTRIBUTE****WITH APPROPRIATE SYNTAX**

~~Integer;~~

**BEHAVIOR DEFINED AS**

~~"The time in nanoseconds the PMD takes to switch the radio from Transmit to Receive";~~

**REGISTERED AS**

```
{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)
TxRx_Switch_Time(11) };
```

**10.9.2.4.12. ~~aTxRamp\_On\_Time~~**

~~TxRamp\_On\_Time ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PMD takes to turn the Transmit Power Amplifier (PA) on";  
REGISTERED AS  
{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) TxRamp\_On\_Time(12)  
};~~

#### **10.9.2.4.13. aTxRamp\_Off\_Time**

~~TxRamp\_Off\_Time ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PMD takes to turn the Transmit PA off";  
REGISTERED AS  
{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7)  
TxRamp\_Off\_Time(13) };~~

#### **10.9.2.4.14. aTx\_RF\_Delay**

~~Tx\_RF\_Delay ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PMD uses to transfer a bit through the Transmit path of the PMD";  
REGISTERED AS  
{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) Tx\_RF\_Delay(14) };~~

#### **10.9.2.4.15. aRx\_RF\_Delay**

~~Rx\_RF\_Delay ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PMD uses to deliver a bit from the antenna to the clock recovery circuitry in the Receive path of the PMD";  
REGISTERED AS  
{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) Tx\_RF\_Delay(15) };~~

#### **10.9.2.4.16. aTx\_PLCP\_Delay**

~~Tx\_PLCP\_Delay ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PLCP uses to deliver a bit from the MAC interface to the transmit data path of the PMD";  
REGISTERED AS  
{ iso(1) member body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Tx\_PLCP\_Delay(16) };~~

#### 10.9.2.4.17. aRx\_Clk\_Revy\_Delay

~~Rx\_Clk\_Revy\_Delay ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PHY uses to recover clock and data and perform the required PLCP processing in the receive path prior to delivering data to the MAC interface";  
REGISTERED AS  
{ iso(1) member body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Rx\_Clk\_Revy\_Delay(17) };~~

#### 10.9.2.4.18. aTxRx\_Turnaround\_Time

~~TxRx\_Turnaround\_Time ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PHY requires to change from transmitting the last bit out of the MAC to being prepared to receive a bit at the antenna";  
REGISTERED AS  
{ iso(1) member body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) TxRx\_Turnaround\_Time(18) };~~

#### 10.9.2.4.19. aRxTx\_Turnaround\_Time

~~RxTx\_Turnaround\_Time ATTRIBUTE  
WITH APPROPRIATE SYNTAX  
Integer;  
BEHAVIOR DEFINED AS  
"The time in nanoseconds the PHY requires from to changing from receiving data to transmitting the first bit out on the air";  
REGISTERED AS  
{ iso(1) member body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) RxTx\_Turnaround\_Time(19) };~~

#### 10.9.2.4.20. aMAC\_Ack\_Delay

~~MAC\_Ack\_Delay ATTRIBUTE~~



WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"The time in nanoseconds the MAC requires to process an acknowledge. This value is set by the MAC and passed to the PHY via this attribute. This delay is measured from the last bit received by the MAC to the time the MAC indicates to the PHY to start the RxTx turnaround process";

REGISTERED AS

{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)-MAC\_Ack\_Delay (20) };

#### 10.9.2.4.21. aTx\_SIFS

~~Tx\_SIFS ATTRIBUTE~~

WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"The maximum time in nanoseconds the PHY will experience in waiting for an acknowledge to appear on its antenna if it is the station transmitting the data requiring the acknowledge";

REGISTERED AS

{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)-Tx\_SIFS (21) };

#### 10.9.2.4.22. aRx\_SIFS

~~Rx\_SIFS ATTRIBUTE~~

WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"The maximum time in nanoseconds the PHY will experience in waiting for an acknowledge to appear on its antenna if it was not the station transmitting the data requiring the acknowledge";

REGISTERED AS

{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)-Rx\_SIFS (22) };

#### 10.9.2.4.23. aSlot\_time

~~Slot\_Time ATTRIBUTE~~

WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"The time in nanoseconds the MAC will use for defining the PIFS and DIFS periods";

REGISTERED AS

{ iso(1) member-body(2)-us(840)-ieee802dot11(xxxx)-PHY(1)-attribute(7)-Slot\_Time (23) };

#### 10.9.2.4.24. aMPDU\_Maximum\_Length

~~MPDU\_Maximum\_Length ATTRIBUTE~~

WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"The maximum number of bytes in the MPDU that can be load into the PLCP\_PDU";

**REGISTERED AS**

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)
MPDU_Maximum_Length (24) };
```

**10.9.2.4.25. aMPDU\_Current\_Max\_Length**

**MPDU\_Current\_Max\_Length ATTRIBUTE**  
WITH APPROPRIATE SYNTAX

Integer;

**BEHAVIOR DEFINED AS**

"The maximum number of bytes in the MPDU that can be load into the PLCP\_PDU as currently defined by the MAC";

**REGISTERED AS**

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)
MPDU_Current_Max_Length (25) };
```

**10.9.2.4.26. aNbr\_Supported\_Rates**

**Nbr\_Supported\_Rates ATTRIBUTE**  
WITH APPROPRIATE SYNTAX

Integer;

**BEHAVIOR DEFINED AS**

"The number of bit rates supported by the PLCP and PMD";

**REGISTERED AS**

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Nbr_Supported_Rates
(26) };
```

**10.9.2.4.27. aRate\_1MHz**

**Rate\_1MHz ATTRIBUTE**  
WITH APPROPRIATE SYNTAX

Boolean;

**BEHAVIOR DEFINED AS**

"This attribute defines if the PMD supports the 2 Level GFSK modulation scheme and the PLCP supports the 1Mbit data rate";

**REGISTERED AS**

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Rate_1MHz (27) };
```

**10.9.2.4.28. aRate\_2MHz**

**Rate\_2MHz ATTRIBUTE**  
WITH APPROPRIATE SYNTAX

Boolean;

**BEHAVIOR DEFINED AS**

"This attribute defines if the PMD supports the 4 Level GFSK modulation scheme and the PLCP supports the 2Mbit data rate";

**REGISTERED AS**

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Rate_1MHz (28) };
```

**10.9.2.4.29. aCurrent\_Bit\_Rate**

Current\_Bit\_Rate ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"This defines the current modulation scheme and bit rate the PMD and PLCP are operating under";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Current\_Bit\_Rate(29) };

**10.9.2.4.30. aNbr\_Supported\_Antenna**

Nbr\_Supported\_Antenna ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"This is the number of antennae supported by the PMD";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Nbr\_Supported\_Antenna(30) };

**10.9.2.4.31. aAntenna\_One\_Type**

Antenna\_One\_Type ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"This defines the antenna type for antenna number one";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Antenna\_One\_Type(31) };

**10.9.2.4.32. aAntenna\_Two\_Type**

Antenna\_Two\_Type ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

BEHAVIOR DEFINED AS

"This defines the antenna type for antenna number two";

REGISTERED AS

{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Antenna\_Two\_Type(32) };

**10.9.2.4.33. aNbr\_Supported\_Power\_Levels**

Nbr\_Supported\_Power\_Levels ATTRIBUTE  
WITH APPROPRIATE SYNTAX

Integer;

**BEHAVIOR DEFINED AS**

"This defines the number of power levels supported by the PMD";

**REGISTERED AS**

{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7)  
Nbr\_Supported\_Power\_Levels (33) };

**10.9.2.4.34. aTx\_Pwr\_Lvl\_1**

~~Tx\_Pwr\_Lvl\_1 ATTRIBUTE  
WITH APPROPRIATE SYNTAX~~

~~Integer;~~

**BEHAVIOR DEFINED AS**

"This defines the transmit output power for LEVEL1";

**REGISTERED AS**

{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) Tx\_Pwr\_Lvl\_1 (34) };

**10.9.2.4.35. aTx\_Pwr\_Lvl\_2**

~~Tx\_Pwr\_Lvl\_2 ATTRIBUTE  
WITH APPROPRIATE SYNTAX~~

~~Integer;~~

**BEHAVIOR DEFINED AS**

"This defines the transmit output power for LEVEL2";

**REGISTERED AS**

{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) Tx\_Pwr\_Lvl\_2 (35) };

**10.9.2.4.36. aTx\_Pwr\_Lvl\_3**

~~Tx\_Pwr\_Lvl\_3 ATTRIBUTE  
WITH APPROPRIATE SYNTAX~~

~~Integer;~~

**BEHAVIOR DEFINED AS**

"This defines the transmit output power for LEVEL3";

**REGISTERED AS**

{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) Tx\_Pwr\_Lvl\_3 (36) };

**10.9.2.4.37. aTx\_Pwr\_Lvl\_4**

~~Tx\_Pwr\_Lvl\_4 ATTRIBUTE  
WITH APPROPRIATE SYNTAX~~

~~Integer;~~

**BEHAVIOR DEFINED AS**

"This defines the transmit output power for LEVEL4";

**REGISTERED AS**

{ iso(1) member-body(2) us(840) ieee802dot11(XXXX) PHY(1) attribute(7) Tx\_Pwr\_Lvl\_4 (37) };

**10.9.2.4.38. aCurrent\_Tx\_PwrLvl****Current\_Tx\_PwrLvl ATTRIBUTE**

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"This defines the transmit output power for LEVEL4";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Current\_Tx\_PwrLvl  
(38) };~~

#### **10.9.2.4.39. aCurrent\_Channel\_ID**

~~Current\_Channel\_ID ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"This defines the current channel number of the frequency loaded in the RF synthesizer";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Current\_Channel\_ID  
(39) };~~

#### **10.9.2.4.40. aCurrent\_Country\_Code**

~~Current\_Country\_Code ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"This defines the current country implementation the PMD is supporting";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Current\_Country\_Code  
(40) };~~

#### **10.9.2.4.41. aHop\_Time**

~~Hop\_Time ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"The time in nanoseconds for the PMD to change from channel 2 to 80";~~

~~REGISTERED AS~~

~~{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Hop\_Time (41) };~~

#### **10.9.2.4.42. aMax\_Dwell\_Time**

~~Max\_Dwell\_Time ATTRIBUTE~~

~~WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"The maximum time in nanoseconds that the radio can operate on a single channel";~~

~~REGISTERED AS~~

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Max_Dwell_Time (42)
};
```

#### **10.9.2.4.43. ~~aCurrent\_Dwell\_Time~~**

~~Max\_Dwell\_Time ATTRIBUTE  
WITH APPROPRIATE SYNTAX~~

~~Integer;~~

~~BEHAVIOR DEFINED AS~~

~~"The current maximum time in nanoseconds that the radio can operate on a single channel set by the MAC";~~

~~REGISTERED AS~~

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Current_Dwell_Time (43)
};
```

#### **10.9.2.4.44. ~~aSynthesizer\_Locked~~**

~~Synthesizer\_Locked ATTRIBUTE  
WITH APPROPRIATE SYNTAX~~

~~Boolean;~~

~~BEHAVIOR DEFINED AS~~

~~"This is an indication that the PMD's synthesizer is locked to the current channel specified in the Current\_Channel\_ID";~~

~~REGISTERED AS~~

```
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Synthesizer_Locked (44)
};
```

### 10.9.3. FH-PHY Managed Objects

The following section defines the managed objects for the FHSS MIB. Table 10-6 lists these managed objects and the default values. Preceding the table is a description of each managed object.

**Table 10-17: FHSS-PHY Managed Objects**

Managed Object	Default Value	Operational Semantics	Operational Behavior
PHY_Type	FHSS	Static	Identical for all PHYs
Nbr_Geo_Supported	Implementation-Dep.	Static	Identical for all PHYs
Geo_USA	FF=Suprt, 00=none	Static	Identical for all PHYs
Geo_Japan	FF=Suprt, 00=none	Static	Identical for all PHYs
Geo_Europe	FF=Suprt, 00=none	Static	Identical for all PHYs
CCA_Method	00=CS only, FF=CS & Data Det.	Static	Identical for all PHYs
CCA_MaxP_Det_Time	16 usec.	Static	Identical for all PHYs
CCA_Asmnt_Time	30 usec.	Static	Identical for all PHYs
CCA_Decay_Time	Implementation-Dep.	Static	Identical for all PHYs
RxTx_Switch_Time	10 usec.	Static	Implementation-Dep.
TxRx_Switch_Time	10 usec.	Static	Implementation-Dep.
TxRamp_On_Time	8 usec.	Static	Implementation-Dep.
TxRamp_Off_Time	8 usec.	Static	Implementation-Dep.
Tx_RF_Delay	1 usec.	Static	Implementation-Dep.
Rx_RF_Delay	4 usec.	Static	Implementation-Dep.
Tx_PLCP_Delay	1 usec	Static	Implementation-Dep.
Rx_Clk_Revy_Delay	2 usec	Static	Implementation-Dep.
TxRx_Turnaround_Time	Implementation-Dep.	Static	Implementation-Dep.
RxTx_Turnaround_Time	20 usec	Static	Identical for all PHYs
MAC_Aek_Delay	0	Static	Set by LME
Tx_SIFS	Implementation-Dep.	Static	Identical for all PHYs
Rx_SIFS	Implementation-Dep.	Static	Identical for all PHYs
Slot_Time	50 usec	Static	Identical for all PHYs
MPDU_Maximum_Length	400 bytes	Static	Identical for all PHYs
MPDU_Current_Max_Length	0	Dynamic	Set by LME
Nbr_Supported_Rates	Implementation-Dep.	Static	Implementation-Dep.
Rate_1MHz	FF=Suprt, 00=none	Static	Implementation-Dep.
Rate_2MHz	FF=Suprt, 00=none	Static	Implementation-Dep.
Current_Bit_Rate		Dynamic	Set by LME
Nbr_Supported_Antennae	Implementation-Dep.	Static	Implementation-Dep.
Antenna_One_Type	Implementation-Dep.	Static	Implementation-Dep.
Antenna_Two_Type	Implementation-Dep.	Static	Implementation-Dep.

**FHSS PHY Managed Objects-Continued**

Managed-Object	Default Value	Operational Semantics	Operational Behavior
Nbr_Supported_Power_Levels	Implementaion-Dep.	Static	Implementation-Dep.
Tx_Pwr_Lvl_1	Implementaion-Dep.	Static	Implementation-Dep.
Tx_Pwr_Lvl_2	Implementaion-Dep.	Static	Implementation-Dep.
Tx_Pwr_Lvl_3	Implementaion-Dep.	Static	Implementation-Dep.
Tx_Pwr_Lvl_4	Implementaion-Dep.	Static	Implementation-Dep.
Current_Tx_PwrLvl	0	Dynamic	Set by LME
Current_Channel_ID	0	Dynamic	Set by LME
Current_Country_Code	0	Dynamic	Set by LME
Hop_Time	224 usec.	Static	Identical for all PHYs
Max_Dwell_Time	400 msec	Static	Identical for all PHYs
Current_Dwell_Time	20 msec	Dynamic	Set by LME
Synthesizer_Locked	0	Dynamic	Set by PLME

**10.9.3.1. FH PHY Managed Objects Definitions****10.9.3.1.1. PHY\_Type**

The PHY\_Type is Frequency Hopping Spread Spectrum. The LME uses this object to determine what PLCP and PMD is providing services to the MAC. It also is used by the MAC to determine what MAC Layer Management State machines must be invoke to support the PHY.

**10.9.3.1.2. Nbr\_Geo\_Supported.**

Operational requirements for FHSS PHY are define by agencies representing certain geographical regions. The FHSS PHY has defined operating specifications for three specific regions. These regions are USA, Japan and Europe. This object defines the number of regions supported by any FHSS implementation. This number therefore can be 1, 2, or 3.

**10.9.3.1.3. Geo\_USA.**

This is a boolean indication of whether or not the implementation supports the operational requirements for the USA. A 00h indicates that the USA requirements are not supported while a FFh indicates that the implementation does support operation in the USA.

**10.9.3.1.4. Geo\_Japan.**

This is a boolean indication of whether or not the implementation supports the operational requirements for Japan. A 00h indicates that the Japanese requirements are not supported while a FFh indicates that the implementation does support operation in Japan.



**~~10.9.3.1.5. Geo\_Europe.~~**

~~This is a boolean indication of whether or not the implementation supports the operational requirements for Europe. A 00h indicates that the European requirements are not supported while a FFh indicates that the implementation does support operation in Europe.~~

**~~10.9.3.1.6. CCA\_Method.~~**

~~—add Text~~

**~~10.9.3.1.7. CCA\_MaxP\_Det\_Time.~~**

~~—add Text~~

**~~10.9.3.1.8. CCA\_Asmnt\_Time.~~**

~~—add Text~~

**~~10.9.3.1.9. CCA\_Decay\_Time.~~**

~~—add Text~~

**~~10.9.3.1.10. RxTx\_Switch\_Time.~~**

~~—add Text~~

**~~10.9.3.1.11. TxRx\_Switch\_Time.~~**

~~—add Text~~

**~~10.9.3.1.12. TxRamp\_On\_Time.~~**

~~—add Text~~

**~~10.9.3.1.13. TxRamp\_Off\_Time.~~**

~~—add Text~~

**~~10.9.3.1.14. Tx\_RF\_Delay.~~**

~~—add Text~~

**~~10.9.3.1.15. Rx\_RF\_Delay.~~**

~~—add Text~~

**~~10.9.3.1.16. Tx\_PLCP\_Delay.~~**

~~—add Text~~

**10.9.3.1.17. Rx\_Clk\_Revvy\_Delay.**

—add Text

**10.9.3.1.18. TxRx\_Turnaround\_Time.**

—add Text

**10.9.3.1.19. RxTx\_Turnaround\_Time.**

—add Text

**10.9.3.1.20. MAC\_Ack\_Delay.**

—add Text

**10.9.3.1.21. TX\_SIFS.**

—add Text

**10.9.3.1.22. RX\_SIFS.**

—add Text

**10.9.3.1.23. Slot\_Time.**

—add Text

**10.9.3.1.24. MPDU\_Maximum\_Length.**

—add Text

**10.9.3.1.25. MPDU\_Current\_Max\_Length.**

This is the current maximum MPDU length the MAC has determined to use for the present state of the media. The PHY can use this value to timeout the CCA state machine if the channel is be busy for a longer period of time than what would normally take to receive an MPDU of this length.

**10.9.3.1.26. Nbr\_Supported\_Rates.**

—add Text

**10.9.3.1.27. Rate\_1MHz.**

—add Text

**10.9.3.1.28. Rate\_2MHz.**

—add Text

**10.9.3.1.29. Current\_Bit\_Rate.**

—add Text

**10.9.3.1.30. Nbr\_Supported\_Antenna.**

—add Text

**10.9.3.1.31. Antenna\_One\_Type.**

—add Text

**10.9.3.1.32. Antenna\_Two\_Type.**

—add Text

**10.9.3.1.33. Nbr\_Supported\_Power\_Levels.**

—add Text

**10.9.3.1.34. Tx\_Pwr\_Lvl\_1.**

—add Text

**10.9.3.1.35. Tx\_Pwr\_Lvl\_2.**

—add Text

**10.9.3.1.36. Tx\_Pwr\_Lvl\_3.**

—add Text

**10.9.3.1.37. Tx\_Pwr\_Lvl\_4.**

—add Text

**10.9.3.1.38. Current\_Tx\_PwrLvl.**

—add Text

**10.9.3.1.39. Current\_Channel\_ID.**

—add Text

**10.9.3.1.40. Current\_Country\_Code.**

—add Text

**10.9.3.1.41. Hop\_Time.**

—add Text

**10.9.3.1.42. Max\_Dwell\_Time.**

—add Text

**~~10.9.3.1.43. Current\_Dwell\_Time.~~**

~~—add Text~~

**~~10.9.3.1.44. Synthesizer\_Locked.~~**

~~—add Text~~