IEEE Project 802.11
Wireless Local Area Networks

Propose Standard:

Physical Layer Specifications for 2.4GHz Frequency Hopping Spread Spectrum Wireless LAN

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9.1 Introduction

9.1.1 Introduction to FHSS Phyiscal Layer. This document 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:

(1) 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 nodes using the associated physical medium dependent system.

(2) 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 nodes.

9.1.2 FHSS Physical Layer Functions. The 2.4 GHz Frequency Hopping Spread Spectrum Physical Layer architecture is shown in Figure 9-1. 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 node through a PHY Service Access Point (SAP) as shown in Figure 9-1 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.

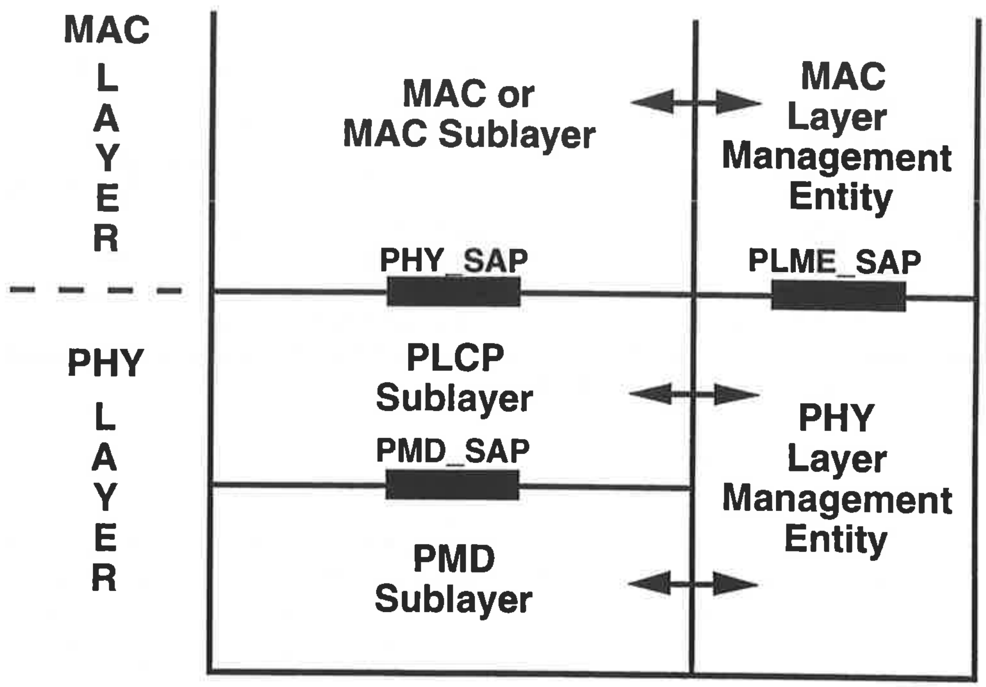


Figure 9-1 Protocol Reference Model

9.1.2.1 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.

9.1.2.2 Physical Layer Management Entity (LME). The Physical LME (PLME) performs management of the local Physical Layer Functions in conjunction with the MAC Management entity.

9.1.2.3 Physical Medium Dependent Sublayer. The physical medium dependent sublayer provides a transmission interface used to send or receive data between two or more nodes.

9.1.3 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.

9.2 FHSS PHY Specific Service Parameter Lists. (new text)

9.2.1 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 Management Entity (MME). The MAC MME in certain PMD implementations may need to interact with the Physical Layer ME as part of the normal PHY SAP primitives. These interactions are defined by the *Physical Layer Management Entity parameter list currently define in the PHY Serivce 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.

9.2.2 PHY_DATA.request TXVECTOR. ~~(new text)~~

The TXVECTOR for the FHSS PHY has not parameters currently specified.
~~*ANTSEL (optional)* The ANTSEL parameter is an optional parameter and is defined by the PMD_ANTSEL primitive in section ???? of the PMD sublayer specification. This parameter allows the MAC entity to specify the antenna used by the PLCP to transmit on a per MPDU basis.~~
~~*TXPWRLVL (optional)* The TXPWRLVL parameter is an optional parameter and is defined by the PMD_TXPWRLVL primitive in section ???? of the PMD sublayer specification. This parameter allows the MAC entity to specify the transmit power level on a per MPDU basis.~~

9.2.3 PHY_DATA.indicate RXVECTOR The following parameters are defined as part of the RXVECTOR parameter list in the PHY_DATA.indicate service primitve.

Parameter	Associate Primitive	Value
RSSI	PHY_DATA.indicate (RXVECTOR)	0-15

Table 9.1. RXVECTOR Parameters

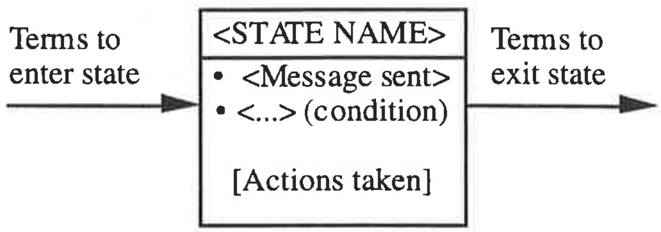
~~*ANTSEL (optional)*. The ANTSEL parameter is an optional parameter and can be a value of 1 or 2. This parameter is an indication by the PHY entity as to the antenna it used to receive the current MPDU it is transferring to the MAC sublayer.~~

9.2.3.1 RSSI ~~*RSSI (optional)*.~~ The Receive Signal Strength Indicator (RSSI) parameter ~~is an optional parameter and can be~~has a value of 0 through 15~~(TBD)~~ This parameter is an indication by the PHY sublayer the value of the energy observed on the antenna used to receive the current MPDU. ~~it is transferring to the MAC sublayer.~~ 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.

9.3. FHSS Physical Layer Convergence Procedure Sublayer

9.3.1 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.

9.3.1.1 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 9-2. 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 ON signal that is generated by the function. Actions are described by short phrases and enclosed in brackets.



Key:			
	( )	=	condition, for example, (if no_collision)
	[ ]	=	action, for example, [reset PLS functions]
	*	=	logical AND
	+	=	logical OR
	UCT	=	unconditional transition

Figure 9-2. 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 (e.g., repeaters) 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.

9.3.2 Physical Layer Convergence Procedure Frame Format. The PLCP Frame Format provides for the asynchronous transfer of MAC Layer MPDU from any transmitting node to all receiving nodes within the wireless LAN. The PLCP frame format illustrated in Figure 9-3 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 data 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 MPDU data whitener.

PLCP Preamble		**PLCP Header**			**PLCP_PDU**
Sync	Start Frame Delimiter	PLW	PSF	Header Error Check	
80 bits	16 bits	10 bits	6 bits	16 bits	Variable number of octets

Figure 9-3. PLCP Frame Format

9.3.2.1 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.

9.3.2.1.1 Sync. The preamble sync field is a 10-octet field containing an alternating zero-one pattern, 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.

9.3.2.1.2 Start Frame Delimiter. The start frame delimiter (SFD) consists of the 16-bit binary pattern 0000 1100 1011 1101 (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.

9.3.2.2 PLCP Header. The PLCP Header field contains three separate sub-fields: a 10-bit PLCP_PDU Length Word (PLW), a 6-bit PLCP Signaling Field (PSF), and a 16-bit PLCP Header Error Check (HEC) field.

9.3.2.2.1 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 - 3FFh, representing counts of zero to 1023 bytes. 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.

9.3.2.2.2 PLCP Signaling Field. The 6-bit PLCP Signaling Field (PSF) is defined in Table 9.2. The PSF is transmitted LSB (bit 0) first and MSB (bit 5) last.

Bit	Parameter Name	Parameter Values	Description
0	Reserved	Reserved	Reserved
1	Reserved	Reserved	Reserved
2	Reserved	Reserved	Reserved
3	Reserved	Reserved	Reserved
4	Reserved	Reserved	Reserved
5	Reserved	Reserved	Reserved

Table 9.2. PLCP Signaling Field Bit Descriptions

9.3.2.2.3 Header Error Check Field. The Header Error Check (HEC) field is a 16-bit BCH type error detection and correction field. The HEC uses the CCITT 16-bit CRC 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 $x^k \bullet (x^{16} + x^{15} + x^{14} + ... + x^2 + x^1 + 1)$ 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 inserted 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):

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

9.3.2.3 PLCP_PDU Data Whitener. The PLCP_PDU data whitener uses a length-127 frame synchronous scrambling followed by a 32/33 Bias Suppression Encoding to randomize the data from highly redundant patterns and to minimize the data DC bias and maximum run lengths. Data bytes 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 9-4. 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 method used is defined in Figure 9-7a. The format of the packet after data whitening is as shown in Figure 9-5.

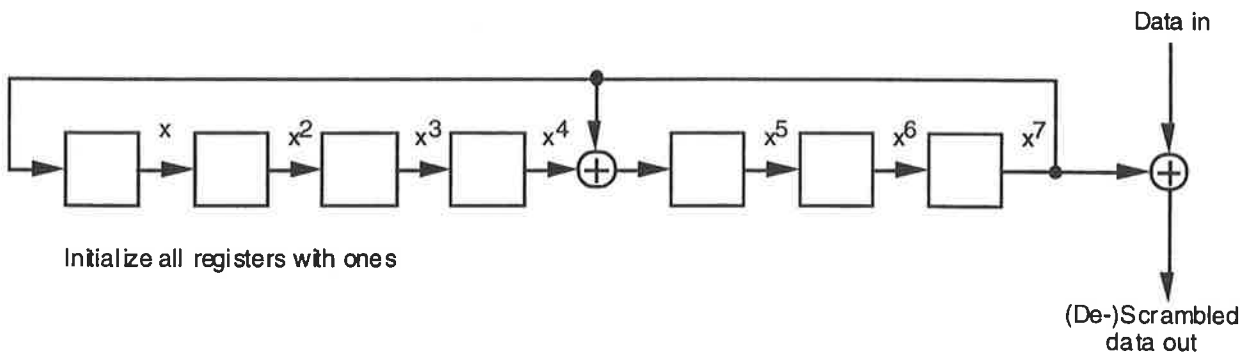


Figure 9-4 Frame Synchronous Scrambler/Descrambler.

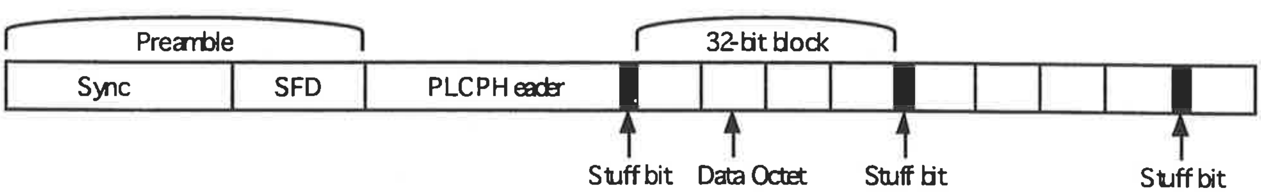


Figure 9-5 PLCP_PDU Data Whitener Format.

9.3.3 PLCP State Machines. The PLCP consists of three state machines as illustrated in Figure 9-6: the transmit (TX), carrier sense/clear channel assessment (CS/CCA), and receive (RX) state machines. 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.

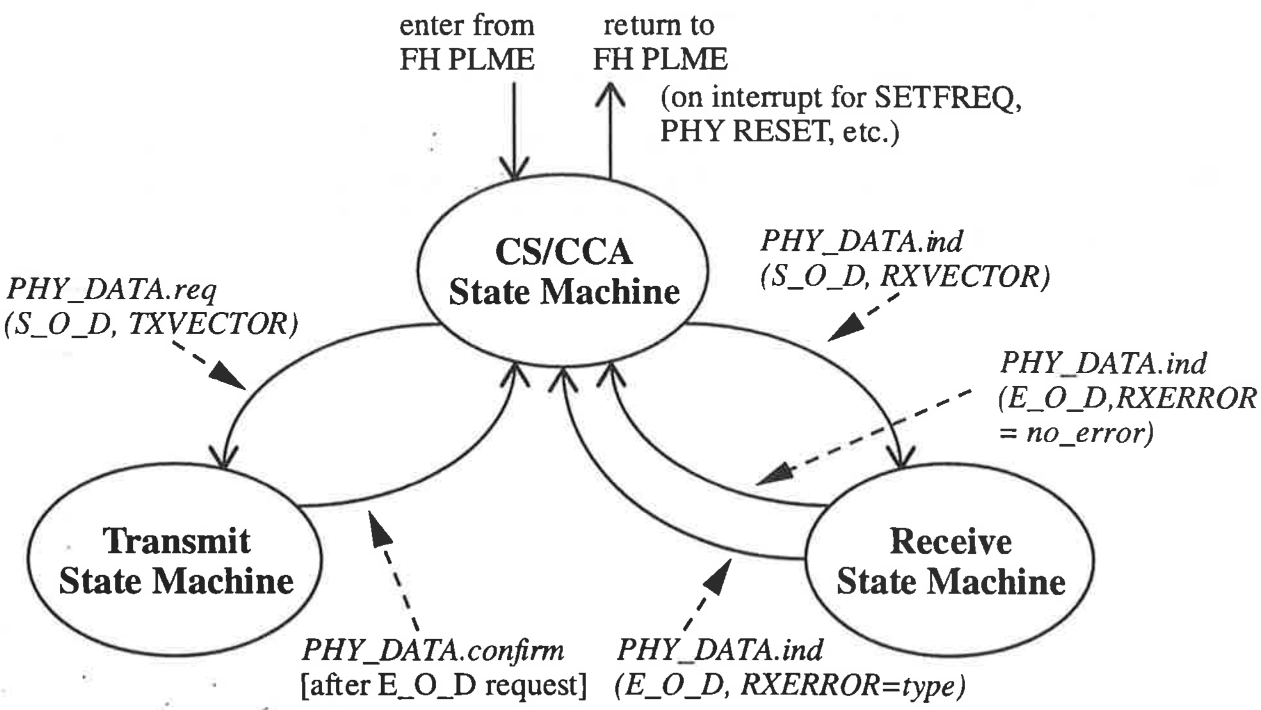


Figure 9-6 PLCP Top Level State Diagram.

9.3.3.1 PLCP Transmit Procedure. The PLCP transmit procedure is invoked by the CS/CCA procedure immediately upon receiving a *PHY_DATA.request(Start_of_Data ~~Activity~~, 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.

9.3.3.1.1 Transmit State Machine. The PLCP transmit state machine illustrated in Figure 9-7 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 ~~Activity~~, 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 9.6 (PMD specification); and transmit the preamble sync pattern and start frame delimiter. The PLCP shall generate the PLCP header as defined in Section 9.3.2.2 (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 9-7a and described in section 9.3.2.3 (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 ~~and_Activity~~, 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 9.6 (PMD), and switch the PHY PMD circuitry from transmit to receive state~~, and complete the transmit procedure by sending a *PHY_DATA.confirm* to the MAC layer~~. The execution shall ~~will~~ then return to the CS/CCA procedure.

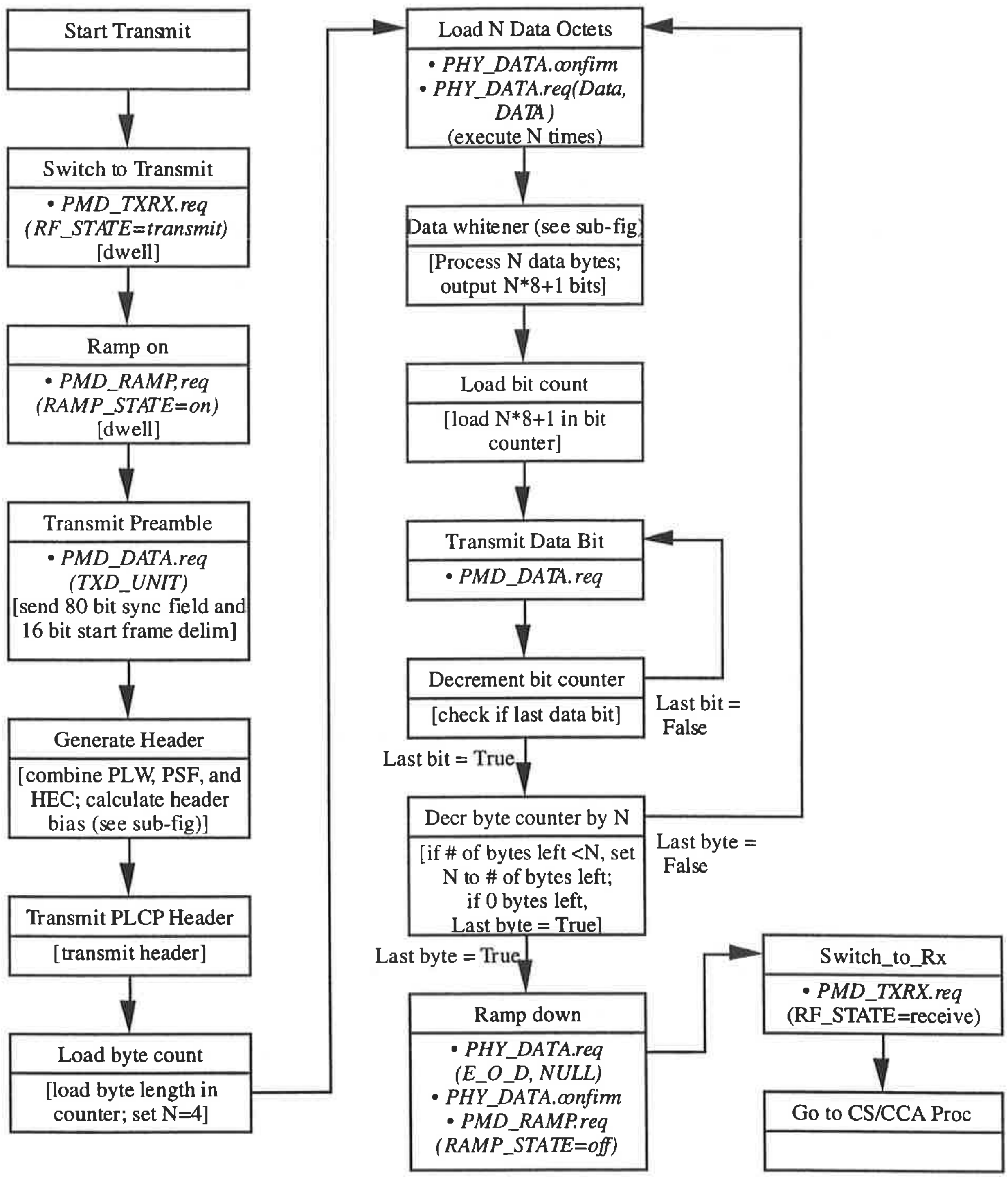


Figure 9-7 Transmit State Machine

```
Data Whitener Encoding Algorithm:
/*      If stuff bit = 1 = next block is inverted; 0 = not inverted */
/*      Accumulate PLCP Header; begin stuffing on first bit of the PLCP_PDU */

/********* Calculate number of 32-bit BSE blocks required to send MPDU;
             no padding is necessary for number of bytes not multiple of 4 *********/
Input parameter: number_of_MPDU_bytes;
number_of_blocks_in_packet = truncate{(number_of_MPDU_bytes + 3) / 4 };

/********* 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 = 2 [Sum{b(1),...,b(32)}] - (32);          /* calculate bias in header */
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;                                       /* b(0) is the stuff bit */
      N = min(4, # of bytes remaining) * 8;           /* N= block size in bits */
      Read in next block {b(1),...,b(N)};             /* b(n) = 0, 1 */
      Scramble{b(1),...,b(N)};                        /* see section 9.3.2.3 */
      bias_next_block = 2 [Sum{b(0),...,b(N)}] - (N+1); /* calculate bias with b(0)=0 */

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

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

Figure 9-7a Data Whitener Encoding Procedure

9.3.3.1.2 Transmit State Timing. The transmit timing illustrated in Figure 9-8 is defined from the instant that the *PHY_DATA.request(Start_of_Data ~~Activity~~, TXVECTOR)* is received from the MAC layer. The PMD circuitry shall be switched from receive to transmit and the power amplifier shall be turned on and settled within the limits about the final transmit power level as specified in section 9.6 (PMD) within 20 µs of receipt of the *PHY_DATA.request.* The PLCP preamble shall be transmitted at 1 Mbps and be completed ~~with~~ in 96 µs. The PLCP header shall be transmitted at 1 Mbps and be completed ~~with~~ in 32 µs. 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 ~~in 8 µs~~ within the time specified in section 9.6. At the end of the power amplifier ramp down period, the PLCP shall ~~send the last *PHY_DATA.confirm* to the MAC layer and~~ 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.

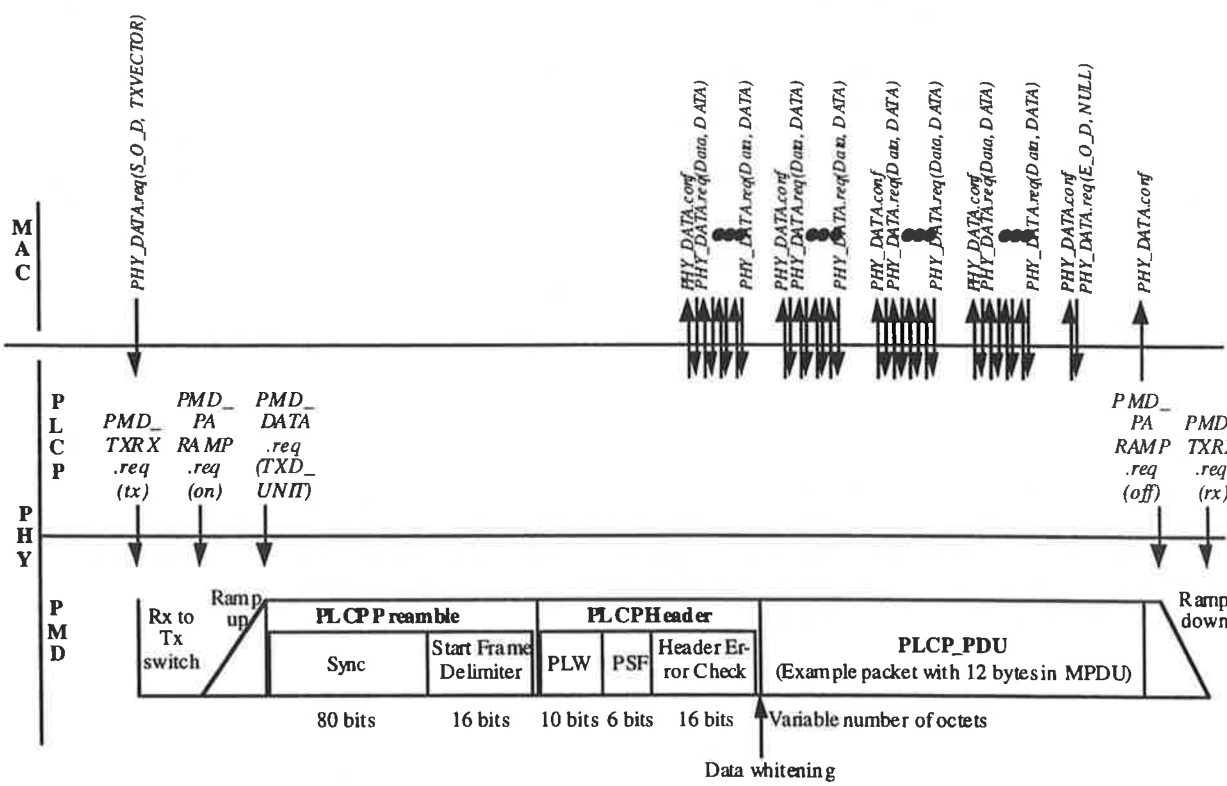


Figure 9-8 Transmit State Timing

9.3.3.2 Carrier Sense/Clear Channel Assessment Procedure (OPEN). The PLCP carrier sense/clear channel assesment (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).

9.3.3.2.1 Carrier Sense/Clear Channel Assessment State Machine (OPEN). The carrier sense/clear channel assessment (CS/CCA) state machine is shown in Figure 9-9. The PLCP shall perform a CS/CCA assessment at on a minimum of one antenna within a contention backoff slot time of 50 µs. The PLCP shall provide a CS/CCA indication to the MAC at each slot time boundary which included in the assessment the data up to the end of the slot time and a minimum of 16 µs prior to the end of the slot time. 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 performance specified in section 9.6(PMD). The CCA indication immediately prior to transmission shall must 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 undefined except for the performance of a conformant method as specified in section 9.6 (PMD).

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 relevent CS/CCA assessment timers to the state appropriate for the end of a complete received packet. 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 *PHY_DATA.request (Start_of_Data, TXVECTOR)* is received after a channel idle assessment, the CS/CCA procedure shall exit to the transmit procedure.

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 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 reception of a packet.

Upon exiting the CS/CCA procedure to receive a packet, 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. If the MAC is sending an ACK following a valid received packet, the MAC should ignore the CS/CCA busy indication immediately following the end of the received packet.

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 packet regardless of actual

CS/CCA indications. However, if the CS/CCA procedure indicates the start of a new packet 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 relevent CS/CCA assessment timers to the state appropriate for the end of a complete received packet. The initial value of the countdown timer upon entry of the CS/CCA procedure from power up or PHY reset is unspecified.

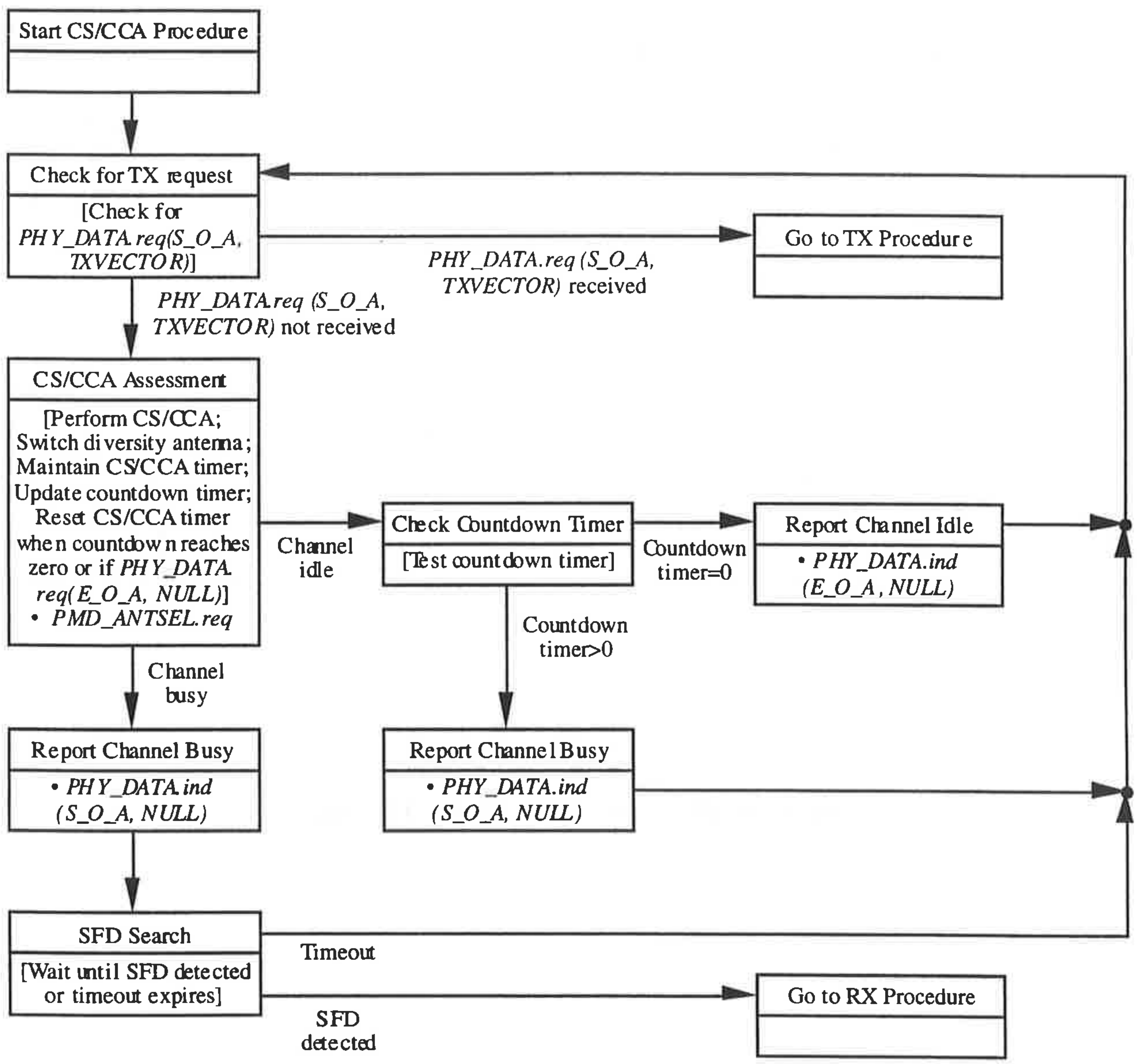


Figure 9-9 CS/CCA State Machine.

9.3.3.2.2 Carrier Sense/Clear Channel Assessment State Timing (OPEN). Timing for priority (PIFS, DIFS), contention backoff (slot times), and CS/CCA assessment windows are defined relative to the end of the last packet on the air. The PLCP shall perform a CS/CCA assessment on a minimum of one antenna ~~at the end of each~~ within a slot time including the PIFS and DIFS windows. The appropriate CS/CCA indication shall be generated ~~within 1 µs of~~ prior to the end of each 50 µs slot time with the performance specified in section 9.6 (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.

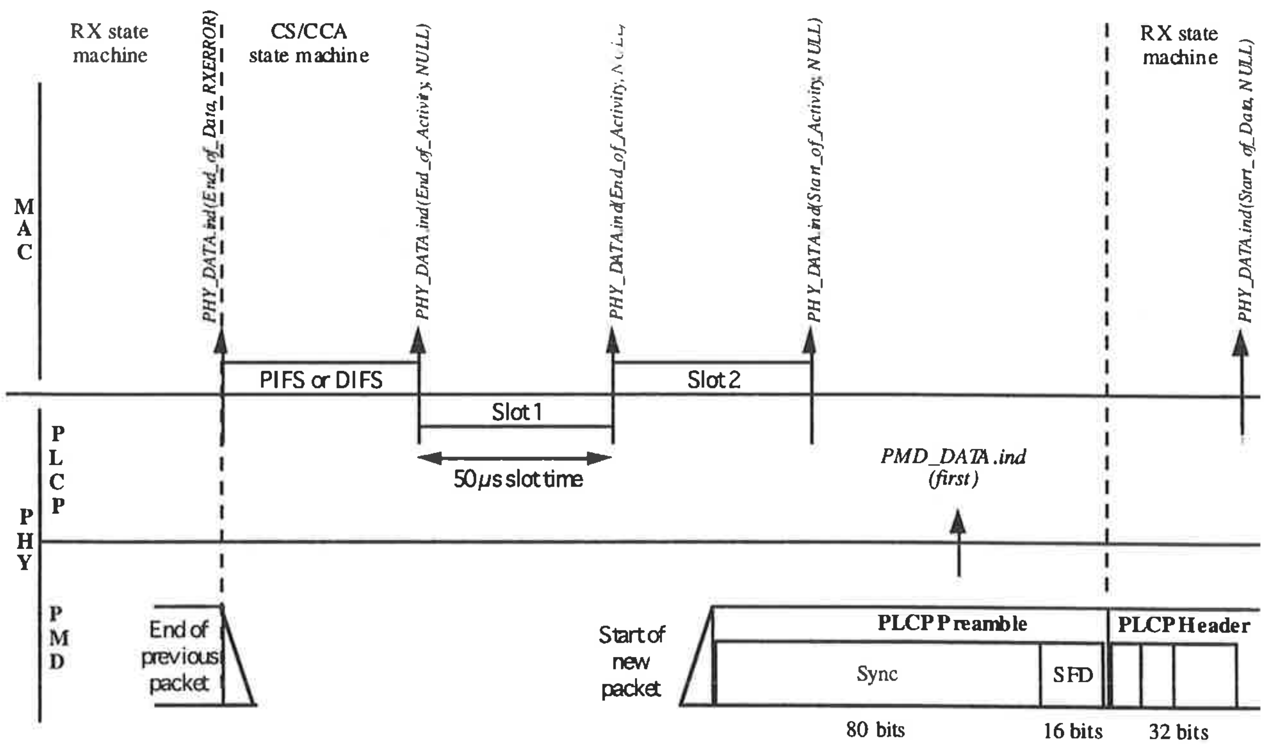


Figure 9-10 CS/CCA State Timing

9.3.3.3 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.

9.3.3.3.1 Receive State Machine (OPEN). The PLCP receive procedure shown in Figure 9-11 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 9-11a 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 uncorrectable 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 ~~error~~ violation)* to the MAC, and return to the CS/CCA procedure with TIME_REMAINING=0. If after receiving a valid PLCP header, the signal is interrupted for any reason, the PLCP shall immediately complete the receive procedure with a *PHY_DATA.indicate (End_of_Data, RXERROR=carrier lost)* to the MAC, and return to the CS/CCA procedure with TIME_REMAINING= byte/bit count remaining. 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.

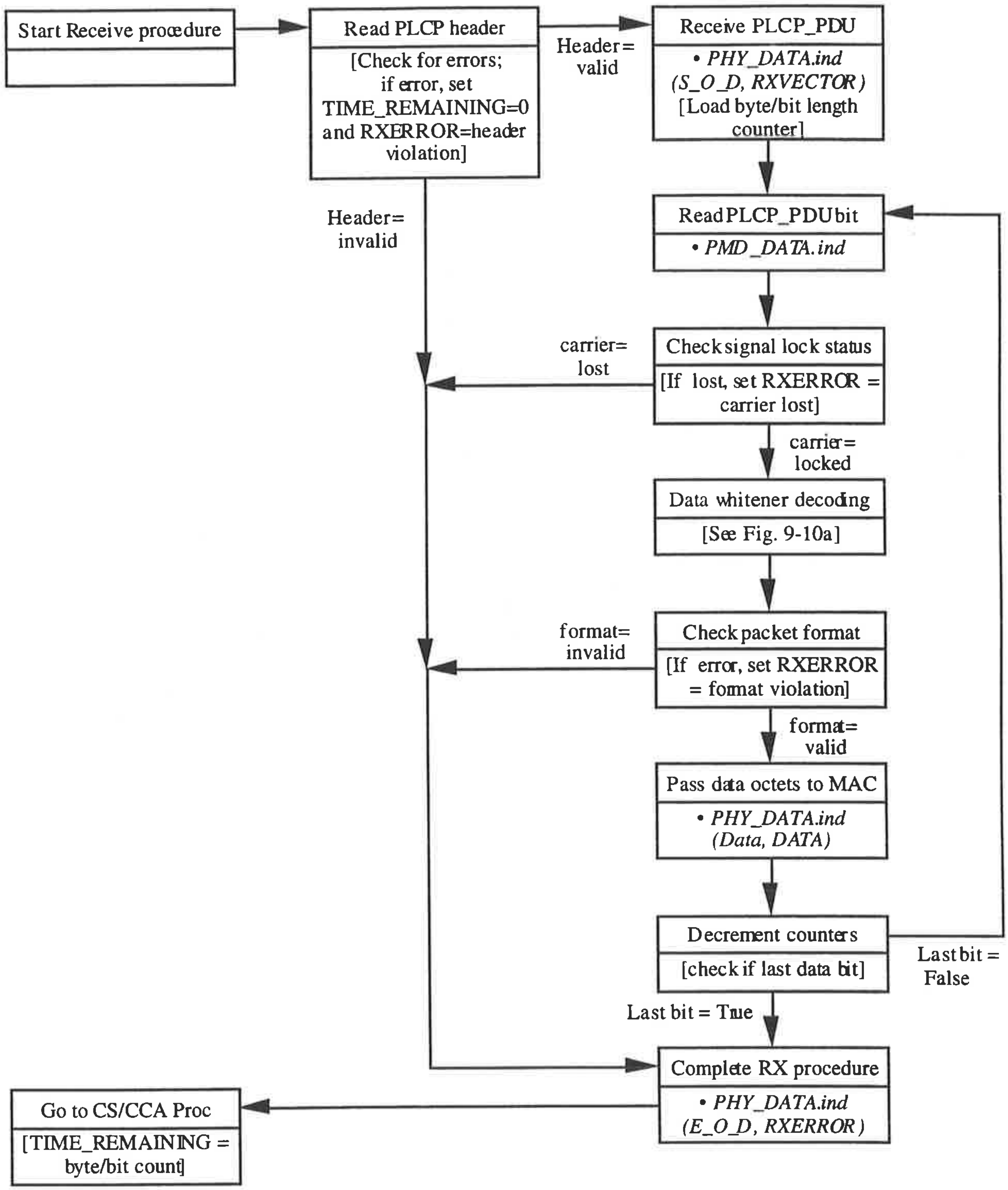


Figure 9-11 Receive State Machine

```
Data Whitener Decoding Algorithm:
/*    If stuff bit = 1 = next block is inverted; 0 = not inverted */
/*    Algorithm begins on first bit of PLCP Header following the start frame delimiter; */
/*    accumulate PLCP Header; begin stuffing on first bit of the PLCP_PDU */

/********* 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 */

Verify header error check (HEC);                      /*not part of BSE algorithm*/
Get number_of_MPDU_bytes from header;
number_of_blocks_in_packet = truncate{(number_of_MPDU_bytes + 3) / 4 };
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 */
      bias_next_block = 2 [Sum{b(0),...,b(N)}] - (N+1); /* calculate bias with b(0) */
      accum = accum + bias_next_block;
      If (accum < -32 or accum > +32) send bias 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 9.3.2.3 */
      Send {b(1),...,b(N)} to MAC
}
```

Figure 9-11a Data Whitener Decoding Procedure

9.3.3.3.2 Receive State Timing (OPEN). The receive state timing shown in Figure 9-12 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 within 1 µs of 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)* within 1 µs of 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 uncorrectable error in the PLCP header, the PLCP shall terminate the receive procedure within 8 µs 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 µs of detecting the error.

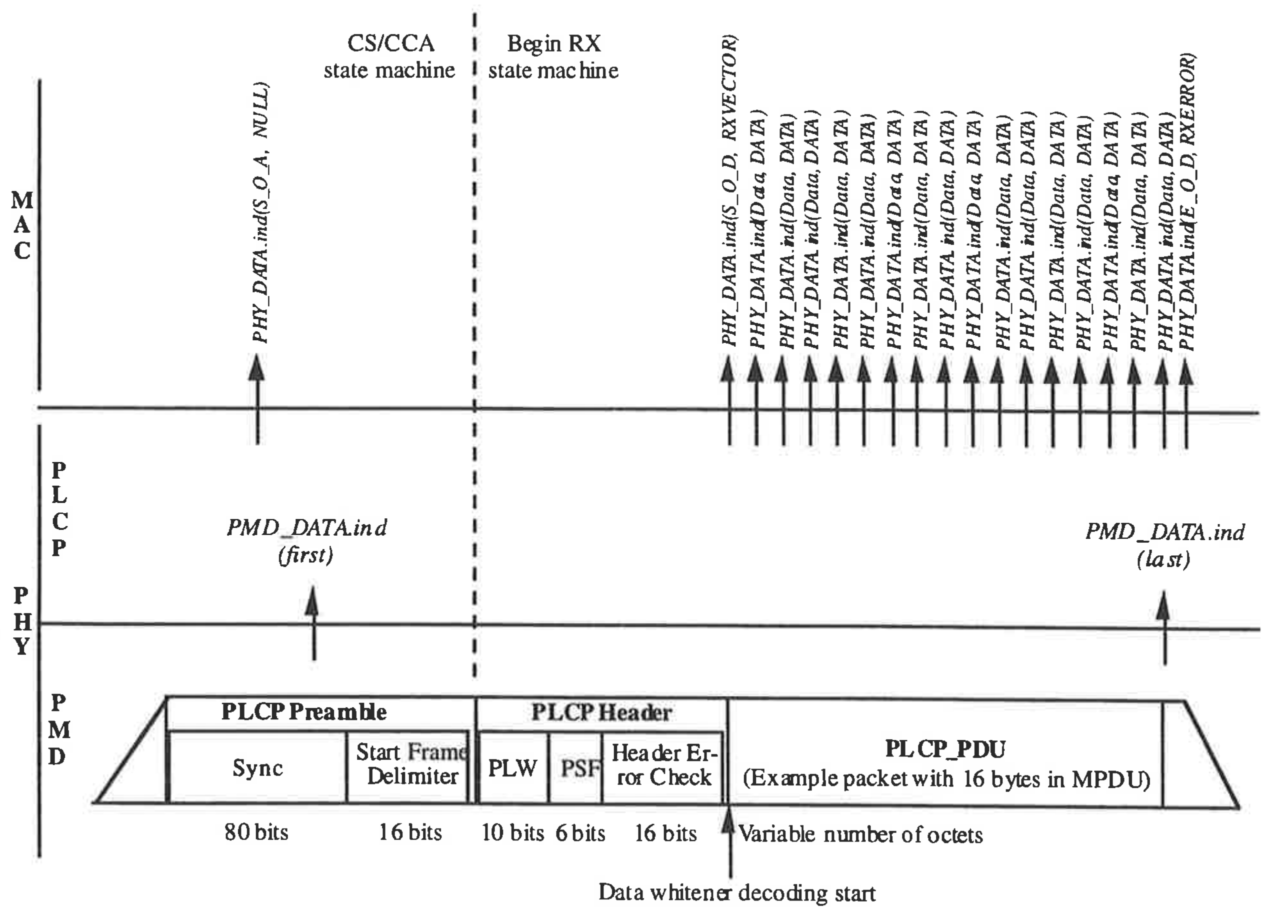


Figure 9-12 Receive Timing

9.4 PLME_SAP Layer Management.

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

9.4.2 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_~~RX~~ PLCPRESET	X		X	
PLME_~~TXRESET~~ POWER	X		X	
PLME_SETCHNL	X		X	

Table 9.3. MPHY_SAP Sublayer Management Primitives

9.4.2.1 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 9.4. PHY_SAP Service Primitive Parameters

9.4.2.2 PLME_SAP Detailed Service Specifications. The following section describes the services provided by each PLME_SAP Service Primitive.

9.4.2.3.1 PLME_PLCP~~RX~~RESET.request
9.4.2.3.1.1 Function. This primitive is a request by the LME to reset the PHY sublayer ~~receive~~ PLCP state machine.
9.4.2.3.1.2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

PLME_~~RX~~PLCPRESET.request

There are no parameters associated with this primitive.

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

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

9.4.2.3.2 PLME_~~RX~~PLCPRESET.confirm

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

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

PLME_~~RX~~PLCPRESET.confirm

There are no parameters associated with this primitive.

9.4.2.3.2.3 When Generated. This primitive will be generated as a response to a PLME_~~RX~~PLCPRESET.request primitive once the PLCP has successfully completed the ~~receive state machine~~ reset.

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

9.4.2.3.3 PLME_~~TXRESET~~POWER.request

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

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

PLME_~~TXRESET~~POWER.request(STATE)

~~There are no parameters associated with this primitive.~~ 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.

9.4.2.3.3.3 When Generated. This primitive can be generated at anytime to ~~reset the transmit state machine in the PHY sublayer~~ to control the state of the PLCP and PMD power.

9.4.2.3.3.4 Effect of Receipt. Receipt of this primitive by the PHY sublayer will cause the PHY LME entity to ~~reset the transmit state machine to its idle state~~ modifiy the state of the PLCP and PMD power.

9.4.2.3.4 PLME_~~TXRESET~~POWER.confirm

9.4.2.3.4 .1 Function. This primitive is a confirmation by the PHY sublayer to the local LME that the PLCP ~~transmit state machine was successfully reset.~~ and the PMD successfully powered up. It will not be sent to confirm a request to remove power.

9.4.2.3.4 .2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

PLME_~~TXRESET~~POWER.confirm

There are no parameters associated with this primitive.

9.4.2.3.4 .3 When Generated. This primitive will be generated as a response to a PLME_~~TXRESET~~POWER.request(ON) primitive once the PLCP and PMD has successfully ~~completed the transmit state machine reset.~~ completed power restart.

9.4.2.3.4 .4 Effect of Receipt. The effect of receipt of this primitive by the LME is unspecified.

9.4.2.3.5 PLME_SETCHNL.request

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

9.4.2.3.5.2 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.

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

9.4.2.3.5.4 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.

9.4.2.3.4 PLME_SETCHNL.confirm

9.4.2.3.4 .1 Function. This primitive is a confirmation by the PHY sublayer to the local LME that the frequency change or hop was successfully completed.

9.4.2.3.4 .2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

PLME_SETCHNL.confirm

There are no parameters associated with this primitive.

9.4.2.3.4 .3 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.

9.4.2.3.4 .4 Effect of Receipt. The effect of receipt of this primitive by the LME is unspecified.

9.4.3 FHSS PHY Management Information Base

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

9.4.3.2 FHSS PHY Management Information Base Definitions

9.4.3.2.1 FHSS PHY Attributes

9.4.3.2.1.1 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_Rcvy_Delay
aTxRx_Turnaround_Time
aRxTx_Turnaround_Time
aMAC_Ack_Delay
aTx_SIFS
aRx_SIFS
aSlot_Time
aMPDU_Maximum_Length
aMPDU_Current_Max_Length

9.4.3.2.1.2 agPhyRate_grp

aNbr_Supported_Rates
aRate_1MHz
aRate_2MHz
aCurrent_Bit_rate

9.4.3.2.1.3 agPhyAntenna_grp

aNbr_Supported_Antenna
aAntenna_One_Type
aAntenna_Two_Type

9.4.3.2.1.4 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

9.4.3.2.1.5 agPhyHopping_grp

aCurrent_Channel_ID
aCurrent_Country_Code
aHop_Time
aMax_Dwell_Time
aCurrent_Dwell_Time
aSynthesizer_Locked

9.4.3.2.2 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_Rcvy_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
        acPHY_init,
        acPHY_reset;
    NOTIFICATIONS
        none
REGISTERED AS { iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) };
```

9.4.3.2.3 FHSS PHY Attribute Group Templates

9.4.3.2.3.1 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_Rcvy_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)
};
```

9.4.3.2.3.2 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)
};
```

9.4.3.2.3.3 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)
};
```

9.4.3.2.3.4 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)
};
```

9.4.3.2.3.5 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)
};
```

9.4.3.2.4 FHSS PHY Attribute Templates

9.4.3.2.4.1 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) };

9.4.3.2.4.2 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) };

9.4.3.2.4.3 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) };

9.4.3.2.4.4 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) };

9.4.3.2.4.5 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) };

9.4.3.2.4.6 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) };

9.4.3.2.4.7 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) };

9.4.3.2.4.8 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) };

9.4.3.2.4.9 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) };

9.4.3.2.4.10 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) };

9.4.3.2.4.11 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) };

9.4.3.2.4.12 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 Amplifer (PA) on";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) TxRamp_On_Time(12) };

9.4.3.2.4.13 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) };

9.4.3.2.4.14 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) };

9.4.3.2.4.15 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) };

9.4.3.2.4.16 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 tranmit data path of the PMD";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)
Tx_PLCP_Delay(16) };

9.4.3.2.4.17 aRx_Clk_Rcvy_Delay

Rx_Clk_Rcvy_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_Rcvy_Delay(17) };

9.4.3.2.4.18 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 perpared 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) };

9.4.3.2.4.19 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 transmittimg 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) };

9.4.3.2.4.20 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) };

9.4.3.2.4.21 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 node transmitting the data requiring the acknowledge ";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Tx_SIFS (21) };

9.4.3.2.4.22 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 node transmitting the data requiring the acknowledge ";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7) Rx_SIFS (22) };

9.4.3.2.4.23 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) };

9.4.3.2.4.24 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) };

9.4.3.2.4.25 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) };

9.4.3.2.4.26 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) };

9.4.3.2.4.27 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) };

9.4.3.2.4.28 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) };

9.4.3.2.4.29 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) };

9.4.3.2.4.30 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) };

9.4.3.2.4.31 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) };

9.4.3.2.4.32 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) };

9.4.3.2.4.33 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) };

9.4.3.2.4.34 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) };

9.4.3.2.4.35 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) };

9.4.3.2.4.36 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) };

9.4.3.2.4.37 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) };

9.4.3.2.4.38 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) };

9.4.3.2.4.39 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) };

9.4.3.2.4.40 aCurrent_Country_Code

Current_Country_Code ATTRIBUTE
WITH APPROPRIATE SYNTAX
Integer;
BEHAVIOR DEFINED AS
"This defines the current country implementation the PMD is supportting";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)
Current_Country_Code (40) };

9.4.3.2.4.41 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)
};

9.4.3.2.4.42 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) };

9.4.3.2.4.43 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) };

9.4.3.2.4.44 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 speciifed in the Current_Channel_ID";
REGISTERED AS
{ iso(1) member-body(2) us(840) ieee802dot11(xxxx) PHY(1) attribute(7)
Synthesizer_Locked (44) };

9.4.3.3 FH PHY Managed Objects The following section defines the managed objects for the FHSS MIB. Table 9-w lists these managed objects and the default values. Preceeding the table is a description of each managed object.

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	Implementaion 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_Rcvy_Delay	2 usec	Static	Implementation Dep.
TxRx_Turnaround_Time	Implementaion Dep.	Static	Implementation Dep.
RxTx_Turnaround_Time	20 usec	Static	Identical for all PHYs
MAC_Ack_Delay	0	Static	Set by LME
Tx_SIFS	Implementaion Dep.	Static	Identical for all PHYs
Rx_SIFS	Implementaion 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	Implementaion 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	Implementaion Dep.	Static	Implementation Dep.
Antenna_One_Type	Implementaion Dep.	Static	Implementation Dep.
Antenna_Two_Type	Implementaion 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	0	Dynamic	Set by LME
Synthesizer_Locked	0	Dynamic	Set by PLME

9.4.3.4 FH PHY Managed Objects Definitions

9.4.3.4.1 PHY_Type. The PHY_Type is Frequency Hopping Spread Spectrum. The LME uses this oject 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.

9.4.3.4.2 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.

9.4.3.4.3 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.

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

9.4.3.4.5 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.

9.4.3.4.6 CCA_Method.
add Text

9.4.3.4.7 CCA_MaxP_Det_Time.
add Text

9.4.3.4.8 CCA_Asmnt_Time.
add Text

9.4.3.4.9 CCA_Decay_Time.
add Text

9.4.3.4.10 RxTx_Switch_Time.
add Text

9.4.3.4.11 TxRx_Switch_Time.
add Text

9.4.3.4.12 TxRamp_On_Time.
add Text

9.4.3.4.13 TxRamp_Off_Time.
add Text

9.4.3.4.14 Tx_RF_Delay.
add Text

9.4.3.4.15 Rx_RF_Delay.
add Text

9.4.3.4.16 Tx_PLCP_Delay.
add Text

9.4.3.4.17 Rx_Clk_Rcvy_Delay.
add Text

9.4.3.4.18 TxRx_Turnaround_Time.
add Text

9.4.3.4.19 RxTx_Turnaround_Time.
add Text

9.4.3.4.20 MAC_Ack_Delay.
add Text

9.4.3.4.21 TX_SIFS.
add Text

9.4.3.4.22 RX_SIFS.
add Text

9.4.3.4.23 Slot_Time.
add Text

9.4.3.4.24 MPDU_MAximum_Length.
add Text

9.4.3.4.25 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.

9.4.3.4.26 Nbr_Supported_Rates.
add Text

9.4.3.4.27 Rate 1MHz.
add Text

9.4.3.4.28 Rate 2MHz.
add Text

9.4.3.4.29 Current_Bit_Rate.
add Text

9.4.3.4.30 Nbr_Supported_Antenna.
add Text

9.4.3.4.31 Antenna_One_Type.
add Text

9.4.3.4.32 Antenna_Two_Type.
add Text

9.4.3.4.33 Nbr_Supported_Power_Levels.
add Text

9.4.3.4.34 Tx_Pwr_Lvl_1.
add Text

9.4.3.4.35 Tx_Pwr_Lvl_2.
add Text

9.4.3.4.36 Tx_Pwr_Lvl_3.
add Text

9.4.3.4.37 Tx_Pwr_Lvl_4.
add Text

9.4.3.4.38 Current_Tx_PwrLvl.

add Text

9.4.3.4.39 Current_Channel_ID.
add Text

9.4.3.4.40 Current_Country_Code.
add Text

9.4.3.4.41 Hop_Time.
add Text

9.4.3.4.42 Max_Dwell_Time.
add Text

9.4.3.4.43 Current_Dwell_Time.
add Text

9.4.3.4.44 Synthesizer_Locked.
add Text

9.4.3.2.1 Introduction

9.4.3.3 FH PHY Specific MAC Layer Management State Machines

9.4.3.3.1 Introduction This section identifies the specific MAC Management state machines required for such things as frequency hopping. The relationship between the MAC Management and FH PLME state machines are also described.

9.4.4 FH PHY Layer Management Entity State Machines

9.4.4.1 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. ~~required for such things as changing to a new frequency, reseting the transmitter, reseting the receiver.~~

9.4.4.2 PLME State Machine The PLME state machine in Figure 9-13 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 9.3.3. 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.

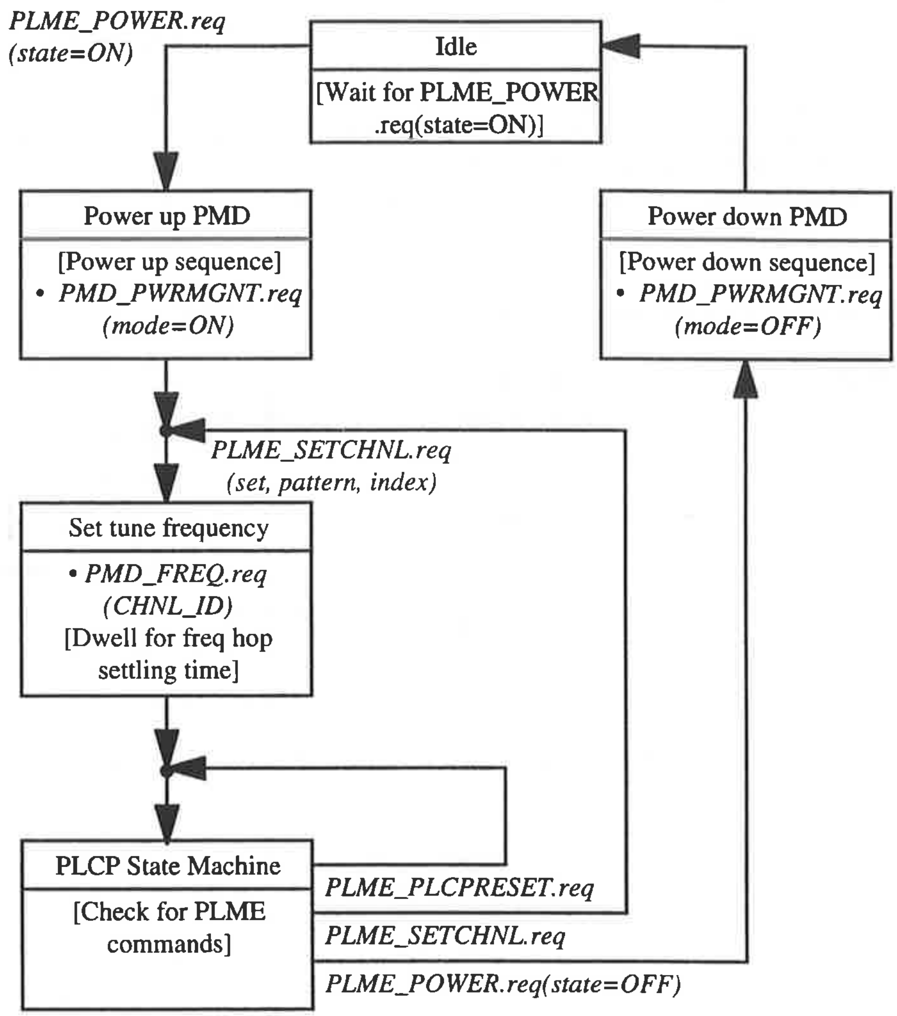


Figure 9-13 PLME State Machine

9.5 FHSS Physical Medium Dependent Sublayer ~~1.0M Bit~~ Services

9.5.1 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 9-14.

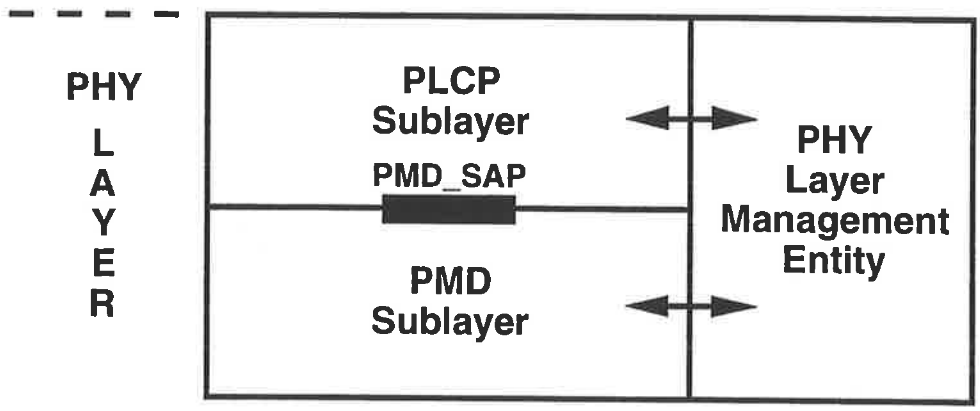


Figure 9-14 PMD layer Reference Model

9.5.2 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.

9.5.3 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.

9.5.4 Basic Service and Options. All of the service primitives described in this section are considered mandatory unless otherwise specified.

9.5.4.1 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 9.5. PMD_SAP Peer-to-Peer Service Primitives

9.5.4.2 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		
~~M~~PMD_PWRMGNT	X			
~~M~~PMD_SYNLOCK		X		

Table 9.6. PMD_SAP Sublayer-to-Sublayer Service Primitives

9.5.4.3 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	ONE, ZERO,
RXD_UNIT	PMD_DATA.indicate	ONE, ZERO
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
CHNL_ID	PMD_FREQ.request	~~1~~2 through 80 inclusive
STRENGTH	PMD_RSSI.indicate	TBD
MODE	~~M~~PMD_PWRMGNT.request	ON, OFF
STATUS	~~M~~PMD_SYNLOCK.indicate	LOCKED, UNLOCKED

Table 9.7. List of Parameters for PMD Primitives.

9.5.5 PMD_SAP Detailed Service Specification. The following section describes the services provided by each PMD primitive.

9.5.5.1 PMD_DATA.request
9.5.5.1.1 Function. This primitive defines the transfer of data from the PLCP sublayer to the PMD entity.
9.5.5.1.2 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.
9.5.5.1.3 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.

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

9.5.5.2 PMD_DATA.indicate

9.5.5.2.1 Function. This primitive defines the transfer of data from the PMD entity to the PLCP sublayer.
9.5.5.2.2 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.
9.5.5.2.3 When Generated. The PMD_DATA.indicate is generate to all receiving PLCP entities in the network after a PMD_DATA.request is issued.
9.5.5.2.4 Effect of Receipt. The effect of receipt of this primitive by the PLCP is unspecified.

9.5.5.3 PMD_TXRX.request

9.5.5.3.1 Function. This primitive is used to place the PMD entity into the transmit or receive function.
9.5.5.3.2 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.
9.5.5.3.3 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.
9.5.5.3.4 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.

9.5.5.4 PMD_PARAMP.request

9.5.5.4.1 Function. This primitive defines the start of the ramp up or ramp down of the radio transmitter's Power Amplifier.
9.5.5.4.2 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".

9.5.5.4.3 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".
9.5.5.4.4 Effect of Receipt. The receipt of this primitive by the PMD entity will cause the transmit power amplifier to be on or off.

9.5.5.5 PMD_ANTSEL.request

9.5.5.5.1 Function. This primitive is used to select which antenna the PMD entity will use to transmit or receive data.
9.5.5.5.2 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.
9.5.5.5.3 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.
9.5.5.5.4 Effect of Receipt. The receipt of this primitive by the PMD entity will cause the radio to select the antenna specified.

9.5.5.6 PMD_TXPWRLVL.request

9.5.5.6.1 Function. This primitive defines the power level the PMD entity will use to transmit data.
9.5.5.6.2 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 9.8 below.

TXPWR_LEVEL	Level Description
LEVEL1	Defined as TXPWR1 in MIB
LEVEL2	Defined as TXPWR2 in MIB
LEVEL3	Defined as TXPWR3 in MIB
LEVEL4	Defined as TXPWR4 in MIB

Table 9.8. Transmit Power Levels

9.5.5.6.3 When Generated. This primitive is generated as part of the transmit sequence.
9.5.5.6.4 Effect of Receipt. The receipt of this primitive by the PMD entity will cause the transmit power level to be modify.

9.5.5.7 PMD_FREQ.request

9.5.5.7.1 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.
9.5.5.7.2 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 9.11.

9.5.5.7.3 When Generated. This primitive is generated by the PLCP whenever a change to a new frequency is required.
9.5.5.7.4 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.

9.5.5.8 PMD_RSSI.indicate

9.5.5.8.1 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.
9.5.5.8.2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

PMD_RSSI.~~request~~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 might be used by diversity functions or other MAC or management sublayers. 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.
9.5.5.8.3 When Generated. This primitive is generated constantly by the PMD entity to transfer a receive signal strength indication to the PLCP.
9.5.5.8.4 Effect of Receipt. The effect of receipt of this primitive by the PLCP is unspecified.

9.5.5.9 MPMD_PWRMGNT.request

9.5.5.9.1 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.
9.5.5.9.2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

MPMD_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.

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

9.5.5.9.4 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.

9.5.5.10 MPMD_SYNLOCK.indicate

9.5.5.10.1 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.

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

MPMD_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.

9.5.5.10.3 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.

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

9.6 FHSS Physical Medium Dependent Sublayer 1.0M Bit

9.6.1 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.

9.6.2 Operating Frequency Range. A conformant PMD implementation shall be able to select the carrier frequency (Fc) from the full country-specific set of available set of carrier frequencies. Table 9.9. summarizes these frequencies for a number of geographic locations:

Lower Limit	Upper Limit	Full Operating Range	Geography
2.402 GHz	2.482 GHz	2.400-2.483 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 9.9. Operating Frequency Range.

9.6.3 Number of Operating Channels. The number of transmit and receive frequency channels used for operating the PMD entity is 79. This is more fully defined in Table 9.11 of section 9.6.4 ~~and section 9.5.7.6 for operation in the U.S.A~~.

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

~~Hopping Set~~	~~Geography~~
~~79~~	~~USA~~

Table 9.10. Number of Operating Channels

9.6.4 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 ~~the following~~ Table 9.11. The channel centers for Japan, starting at 2.473 GHZ with 1 Mhz increments, is listed in Table 9.12.

Channel #	Value	Channel #	Value	Channel #	Value
2~~1~~	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 9.11 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 9.12. Japan Requirements: (Values specified in GHz)

9.6.5 Occupied Channel Bandwidth. (CLOSED: A.3) The occupied channel bandwidth for the PMD is 1.0 MHz wide. This 1.0 MHz must contain 99% of the emitted engery. The FCC may impose a further restriction on transmitted bandwidth requiring the 20 dB bandwidth, as measured with a sprectrum analyzer and referenced to the magnitude at the center of the transmitted bandwidth, to be less than 1 MHz.

The transmitter center frequency shall be within +/- 25ppm of one of the specified operating center frequencies listed in section 9.6.4. The following diagram illustrates the relationship of the operating transmitter center frequency to the occupied channel bandwidth.

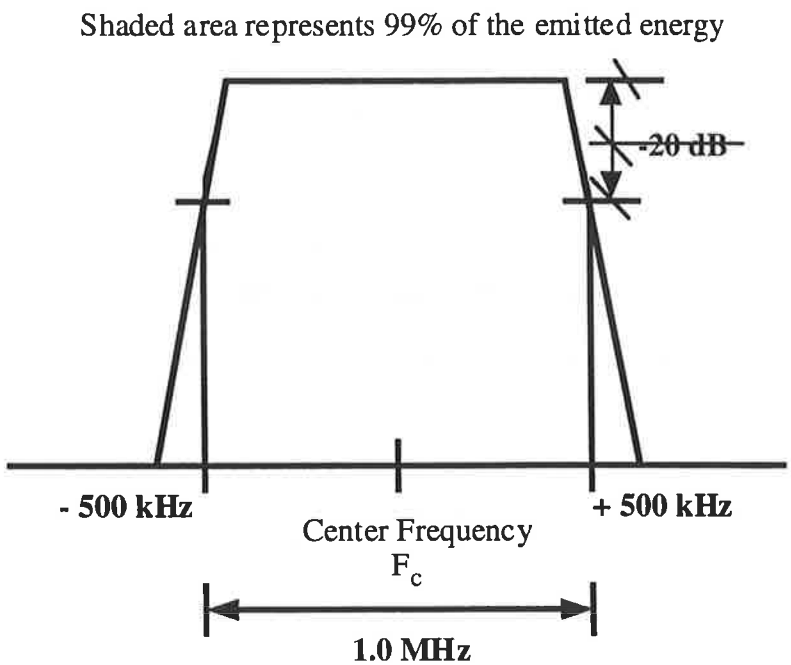


Figure 9-15. Occupied Channel Bandwidth.

9.6.7 Minimum Hop Rate. The rate at which the PMD entity is required to hop is 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. This precludes the notion of a maximum hop rate, which will most likely be determined by the transmit to receive duty cycle of the PMD.

The minimum hop rate, on the other hand, will be governed by the regulatory bodies. 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.

9.6.8 Hop Sequences. (CLOSED: A.8)

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. The sequence is defined by the hopping length, **p**, and hopping pattern, $\mathbf{F_i}$, where a family of (p-1) patterns is given by:

$F_i = \{f_i(0), f_i(1), f_i(2), \ldots f_i(p-1)\}$ ~~with $f_i(j) = (i*j \bmod(p))$~~

where $f_i(j) = i*j \bmod(p) + 2$ in USA and Europe

$f_i(j) = i*j \bmod(p) + 73$ in Japan

Each of the $\mathbf{F_i}$ contains each **p** frequency channels equally often as each $\mathbf{F_i}$ is a permutation of 0, 1, 2 ..., (p-1). 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:

$$\frac{(p-1) - (2*F)}{2k+1} = \frac{(p-13)}{2k+1} = 22\text{ patterns}$$ in U.S.A. and Europe

$= 4$ patterns / set for Japan

Where k = the number of adjacent channel interferers on each side of the channel frequency. 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 Similarly, there are three sets in Japan, except each set has four patterns as listed in Table D in the Annex.~~below in order of preference~~. ~~Set One contains patterns 24-45, set Two contains patterns 47-68 and set Three contains patterns 2-23.~~ The channel numbers listed under each pattern refer to the actual frequency values listed in Tables 9.11 and 9.12. ~~A, B & C in the Annex.~~

9.6.9 Spurious Out-of-Band Emissions. Conformant PMD implementations of this FHSS standard shall limit the spurious emissions that fall outside of the operating frequency range, defined in Table 9.9 of section 9.6.2, to the geographically applicable 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 out-of-band emissions.

9.6.10 Modulation. The minimum set of requirements for a PMD to be compliant with the 802.11 FHSS PHY shall be that it is capable of operating using 2 level Gaussian Frequency Shift Key (GFSK) modulation with a nominial ~~modulation index~~ bandwidth bit-period ~~of~~ (BT)=0.5. The PMD will accept symbols from the set {{1},{0}}from the PLCP. The symbol {1} is 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} is encoded with a peak frequency deviation of (-f), giving a peak transmit frequency of (F_c-f).

The frequency deviation, as shown in 9-16 below shall be greater than 110kHz relative to the nominal center frequency F_c. F_c is the center frequency of the last 8 bits of preamble prior to the unique word. The deviation is to be measured mid symbol.

The zero crossing error shall be less than +/-1/8 of a symbol. The zero crossing error is the time difference between the ideal symbol periods and measured crossings of F_c. This is illustrated in Figure 9-16 below.

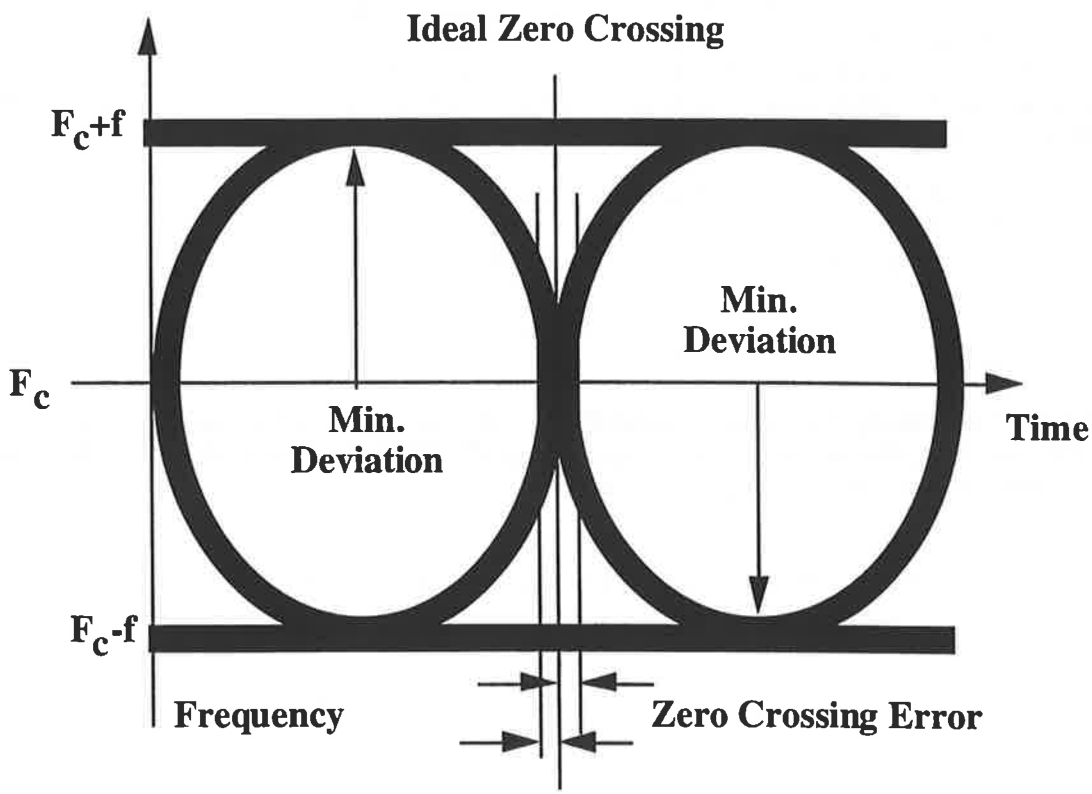


Figure 9-16. Transmit Modulation Mask

9.6.11 Channel Data Rate. A compliant 802.11 FHSS PMD will be capable of transmitting and receiving at a nominal data rate of 1.0 MBps.

9.6.12 Channel Switching/Settling Time (Closed August) The time to change from one operating channel frequency, as specified in section 9.6.4, 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 9.6.4.

9.6.13 Transmit to Receive Switch Time (OPEN) The maximum time for a conformant PMD to switch the radio from the transmit state to the receive state shall be 18 usec. This specification is composed of the following paramenters

TX_Ramp_Up	Transmitter PA ramp up time	8us
TX-RX	Transmit to Receive delay time	10us

In an actual implementation, the parameters specified above can individually be smaller or larger providing that sum of these parameters meets the overall turn-around requirements.

9.6.14 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 first bit on the air shall be 19usec. This specification provides a reference point for manufacturers to meet the Receive to Transmit turn-around time for a compliant 802.11 FHSS PMD. This specification is composed of the following paramenters

TX-RX	Transmit to Receive delay time	10us
TX_Ramp_Up	Transmitter PA ramp up time	8us
TX_Prop_Delay	Transmitter RF Propagation Delay	1us

In an actual implementation, the parameters specified above can individually be smaller or larger providing that sum of these parameters meets the overall turn-around requirements.

9.6.15 Operating Channel Availability. A conformant PMD must provide availability to each operating channel center frequency at least 99.5% of the time with no interference present in the occupied operating channel bandwidth.

9.6.16 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.

9.6.17 Transmit Power Levels. (CLOSED: A.11, A.12) In addition to the requirements imposed on the transmit signal by the baseband wave shape detailed in section 9.6.20, the signal shall also exhibit the characteristic that the maximum Equivalent Radiated Power (EIRP) of the PMD, as measured in accordance with the geographically applicable regulations, shall not exceed that listed in Table 9.12. In addition, all conformant PMD implementations shall be capable of transmitting a minimum of 1.0 mW.

Maximum EIRP [mW]	Geography
1000	USA
100	Europe
230	Japan

Table 9.12. Transmit Power Limits

9.6.18 Transmit Power Level Control. (CLOSED: A.9, A.10, A.13) 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, as measured by the geographically applicable regulations, 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 below 100 mW under the influence of said power control.

As an optional PMD implementation, additional power level control will consist of four (4) discrete levels that are to be determined by the manufacturer. These levels must exist between the minimum transmit power level of 1.0 mW and the maximum of 1000 mW.

9.6.19 Transmit Power Classes. The 802.11 compliant frequency hopping transmitters shall be labeled in four classes according to their maximum nominal EIRP.

Class	Maximum Nominal EIRP
Class 1	1mW to 10mW
Class 2	1mW to 100mW
Class 3	1mW to 500mW
Class 4	1mW to 1000mW

9.6.20 Transmit Spectrum Shape. (OPEN) Co~~nformant PMD implementations shall confine their emissions while transmitting any symbol pattern to be such that when measured by "the filter method" (EDITORS NOTE: WE WILL NEED TO DEFINE WHAT THIS IS) they will not exceed -20 dBc in any frequency range outside of Fc± 0.5 MHz, not exceed -45 dBc in the any frequency range outside of Fc± 2.0 MHz, not exceed -60 dBc in the any frequency range outside of Fc± 3.0 MHz. These are to be measured in a TBD bandwidth as specified by the following test conditions [NOTE: NEED TO SPECIFY CONDITIONS AND MEASUREMENT PROCEDURE].~~

The adjacent channel power is sum of the power measured in a 1MHz band, shall be as a function of channel offset N from the assigned transmitter channel M below the transmitter.

Power by

N=M+/-2	-40dB
N>M+/-2	-60dB

The transmitter power in the sum of the power in a 1MHz channel centred 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 100kHz, with a peak detector and the measurement device set to maximum hold.

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

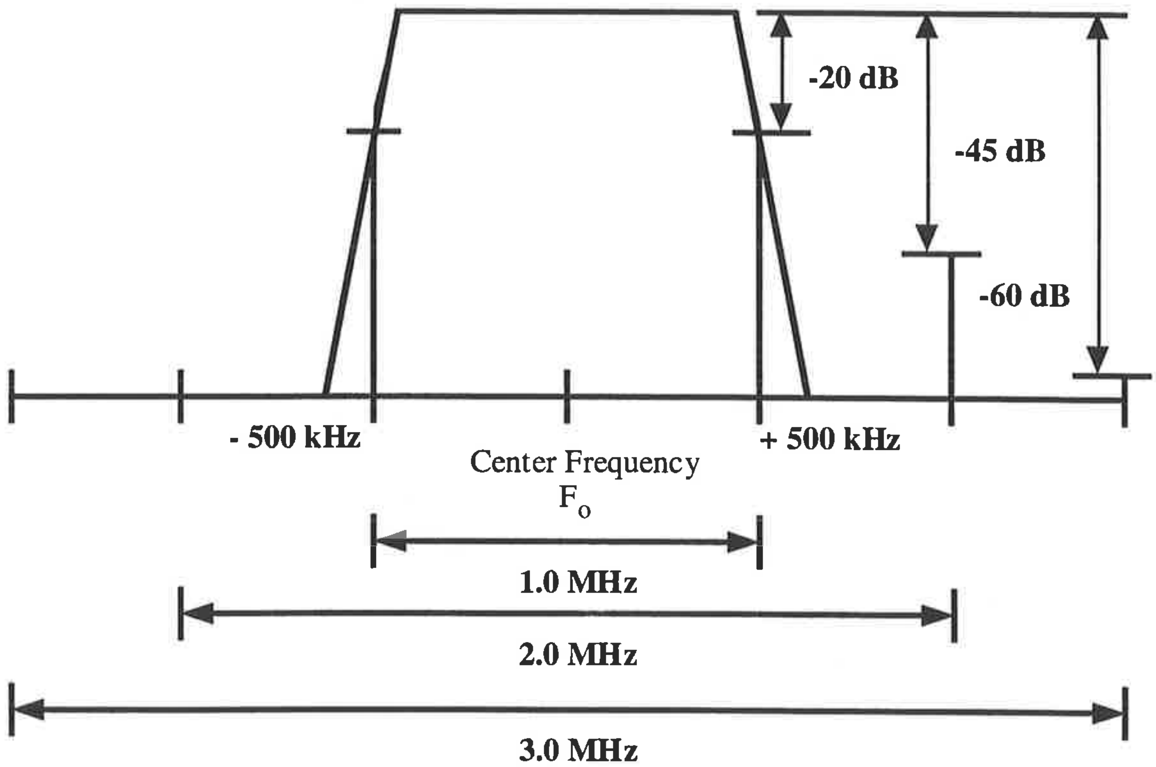


Figure 9-14. Transmit Spectrum Mask

9.6.21 Transmit Center Frequency Tolerance. (OPEN: A.16) An 802.11 FHSS compliant PMD shall have a transmit center frequency accuracy, as measured from F_c, of ±25.0 ppm. It shall maintain this stability over the stated operating temperature ranges:

9.6.22 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},{tristate}} to the PLCP Sublayer.

9.6.23 Spurious Free Dynamic Range. (OPEN) A conformant PMD implementation must be capable of recovering a conformant PMD signal from the medium, as described in related sections, whose level is between -80 dBm (defined as minimum sensitivity) and -20 dBm (defined as maximum allowable input level). The conformant PMD signal must maintain an E_b/N_o of 16.0 dB in the presence of Gaussian white noise at a BER of greater than or equal to 10^{-5}.

9.6.24 Selectivity. ***Editors Recommendation is to delete this paragraph based upon July meeting and section 9.6.32*** **(Open)** A conformant PMD implementation must be capable of recovering a conformant PMD signal from the medium, as described in related sections, when a signal is offset from the center frequency (F_c) by greater than 2.0 MHz and has a power level that is 45 dB higher than that of the desired signal.

Conformance to this section is measured by inputting an in-channel signal at a level that provides a BER of 10^{-5}. This signal is then increased in level by 1.0 dB. Simultaneously, an alternate channel signal with the same modulation characteristics, defined as $F_c \pm 2.0$ MHz, is increased in level until the resultant BER is 10^{-5}. The difference between the desired and undesired signal levels must be greater than 45 dB. This measurement is performed in a AWGN channel.

9.6.25 Channel BER. (OPEN) A conformant PMD implementation must provide a channel BER of at least 10^{-5} at an E_b/N_o of 16.0 dB in an AWGN channel for 1M bit per second data rate.

9.6.26 Receive Center Frequency Tolerance. (OPEN) An 802.11 FHSS compliant PMD shall accept an input signal have a receive with a center frequency accuracy, as measured from F_c, of ±25.0 ppm. It shall maintain this stability over the stated operating temperature ranges:

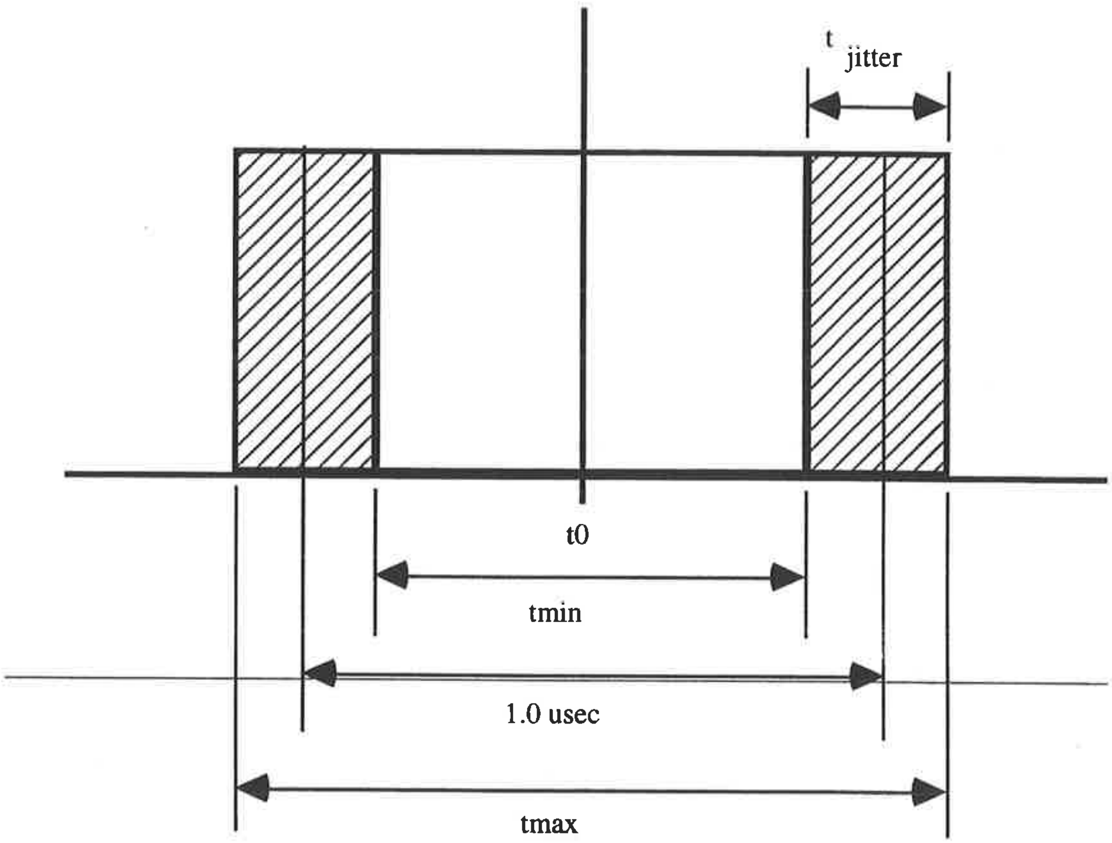
9.6.27 Carrier Detect Response Time. (OPEN) A conformant PMD implementation must be capable of providing to the PLCP within **TBD** µseconds an indication of whether the receiver has been able to determine if the channel has a carrier present on it. This will influence the time it takes for an 802.11 compliant PMD to acquire a signal that is present on the medium.

9.6.28 Clear Channel Assessment Power Threshold. A compliant FHSS PHY implementation must, 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 and a 70% probability for detection of random data within the CCA assessment window. This specification applies to a PMD operating with a nominal output power of 100mW. A compliant PMD operating at a nominal output power other than 100mW shall use the following equation to define the CCA threshold.

CCA Threshold = -65 dBm - Transmit Power in dBm.

9.6.~~2~~8 Clock Recovery Time (OPEN) A ~~conformant PMD implementation must be capable of withstanding a data pattern of up to seven (7) continuos "1's" or seven (7) continuos "0's" with no degradation in output signal to noise ratio and BER.~~

9.6.29 Receiver Data Jitter Tolerance(OPEN) A ~~conformant PMD implementation must be capable of providing to the PLCP the following bit width restrictions as applied to a single logical "one" or logical "zero" data bit that meets the maximum run length and dc balance as specified in sections 9.5.9.x and 9.5.9.y. The jitter associated with each individual data bi, as referenced from the center of a nominal dat bit period of 1.0 microsecond is outlined in Figure 9-15.~~



where t0 is the nominal center of a logical data bit

~~**Figure 9-15 Data Jitter Tolerance**~~

~~9.5.9.8 Preamble Definition~~

~~Add text~~

9.6.30 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 durign its transition to the desired steady state transmit output level. The ramp-up period is defined as a window consisting of 8-bit periods and is governed by the mask of Figure 9-16.

The following states are defined by the mask of diagram Figure 9-16. The transmitter is considered "off" (i.e. less than -50 dBm EIRP) at the start of the first bit period and is less than 0 dBm at the end of the first bit period. The output level at the end of the seventh bit period is within 3 dB of the desired steady state transmit power level and within 1 dB at the end of the eighth bit period. The maximum magnitude of the rate of change of the output power level should be one volt per microsecond as measured by a wideband detector based on the RMS output voltage into a 50-ohm load of the conformant PMD.

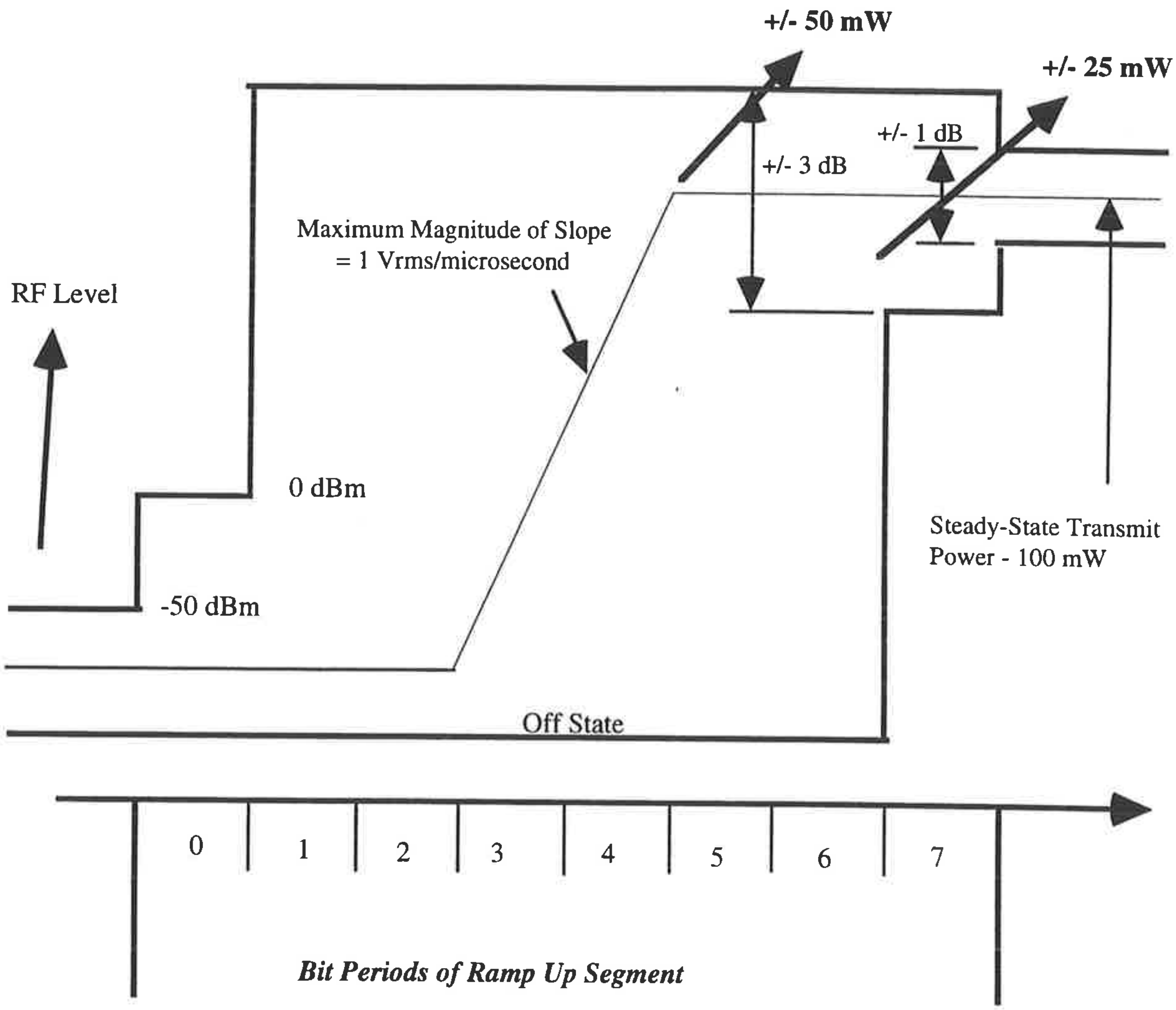


Figure 9-16 Ramp Up

9.6.31 Ramp Down Period (Closed per A19) The purpose of a conformant PMD Ramp Down Time Period is to control the rate of change of the amplitude of the transmit signal durign its transition to the desired steady state transmit output level. The ramp-down period is defined as a window consisting of an 8-~~bit~~ usec periods and is governed by the mask of Figure 9-17.

The following states are defined by the mask of Figure 9-17. The transmitter is considered "off" (i.e. less than -50 dBm EIRP) at the start of the first bit period and is less than 0 dBm at the end of the first bit period. The output level at the end of the seventh bit period is within 3 dB of the desired steady state transmit power level and within 1 dB at the end of the eighth bit period. The maximum magnitude of the rate of change of the output power level should be one volt per microsecond as measured by a wideband detector based on the RMS output voltage into a 50-ohm load of the conformant PMD.

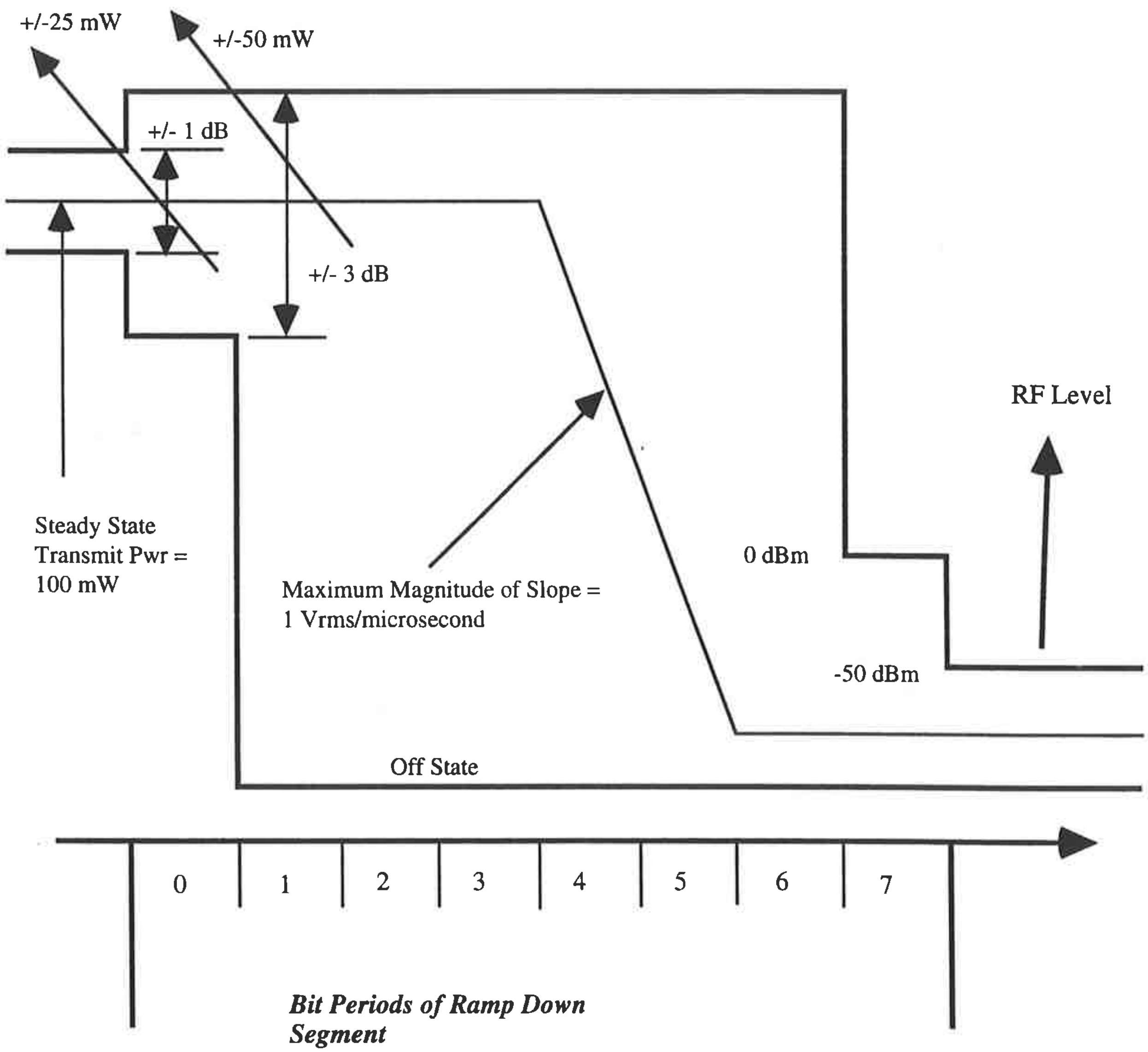


Figure 9-17 Ramp Down

~~9.6 Receive Data DC Offset (Open)~~

~~Add text~~

~~9.6 Received Data Maximum Run Length (DC Balance) (Open)~~

~~Add text~~

9.6.32 Receiver Sensitivity (CLOSED per July 1994) Sensitivity is defined as the minimum signal level required to produce a BER of 10-5. A conformant PMD shall have the minimum signal level be less than or equal to -80 dBm across the operating frequency range specified in 9.6.4.

9.6.33 Intermodulation (CLOSED per July 1994) Intermodulation protection (IMp) is defined as the ratio 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 BER of the receiver to be reduced to 10-5, when the desired signal is 3 dB above sensitivity. Each interfering signal is modulated with the FH PMD modulation uncorrolated in time to each other or the desired signal. A conformant PMD shall have the IMp for the interfering signal at 4 and 8 MHz be greater than or equal to 30 dB.

9.6.34 Desensitization (CLOSED per July 1994) Desensitization (Dp) is defined as the ratio to measured sensitivity of the minimum amplitude of an interfering signal that causes the BER of the receiver to be reduced to 10-5 when the desired signal is -77 dB (3 dB above sensitivity specified in section 9.6.32). The interfering signal shall be modulated with the FHSS PMD modulation uncorrolated in time to the desired signal.

~~Dp for Interfering Signal 2 MHz removed ———— 30 dB~~
~~Dp for Interfering Signal 3 or more MHz removed ——— 40 dB~~

Interferer Frequency	DP Minimum
M=N>+/-2	30dB
M=N>+/-3	40dB

Table 9.xx. 1M Bit Desensitization

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

9.7 FHSS Physical Medium Dependent Sublayer 2.0M Bit

9.7.1 Introduction. Many implementors believe that some FHSS wireless LAN applications may require higher throughput than the 1M bit FHSS PHY is able to provide. The FHSS 2.0M bit PMD was developed in an attempt to better meet the needs of those requiring higher data throughput. One of the requirements placed on the development of a higher bit rate PHY was that the PMDs be as similar as possible so that all FHSS PHYs might co-exist and possibly even interoperate. This requirement resulted in a decision to develop a 2.0M bit PMD using a 4 level GFSK modulation scheme.

In terms of co-existence, the 4 level GFSK symbol rate is identical to that of the 2 level GFSK rate and thus each PMD will be able to detect when the other PMD is using the channel. This is useful in avoiding collisions when operating the CSMA protocol. In keeping the modulation schemes similar, the opportunity exists for implementors to develop radios which will interoperate with both one and two megabit PMDs. It is even possible to develop radio implementations which allow dynamic rate selection on a packet basis or actually shift rates during a single transmission.

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 contatined in section 9.6.

9.7.2 - 9.7.9 See Sections 9.6.2 - 9.6.9.

9.7.10 4 Level GFSK Modulation. For a 2MB/sec conformant PMD, the modulation scheme shall be 4 level Gaussian Frequency Shift Keying (4GFSK), with a nominal bit-period bandwidth product (BT) = 0.5. The four level deviation, defined as the frequency separation of adjacent symbols, h4, shall be related to the peak to peak deviation of the 2GFSK modulation, h2, by the following equation:

$$h4/h2 = 0.45 +/- 0.01$$

The peak to peak deviation is measured at the last 8 bits of the preamble 101010 sequence prior to the unique word in the PHY header.

An incoming bit stream at 2Mb/sec will be converted to 2 bit words or symbols, with a rate of 1M symbol/sec. The first received bit will be encoded as the MSB, with the notation below referring to MSB first. The symbols will be encoded as deviations on the frequency carrier as indicated in table 9.14 below:

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

Table 9.14. Symbol Encoding vs. Carrier Deviation

The deviation is relative to the nominal center frequency of the RF carrier. The modulation error shall be less than +/-15kHz at the mid symbol time, from the deviations specified above. H4 should have a minimum mean value over a slot of 140kHz. The nominal center frequency shall not vary greater than +/-10kHz/msec, from the start to end of the 4GFSK data word. For definition purposes, the nominal center frequency is the mid frequency between symbols 10 and 01. Symbols and terms used within this section are illustrated in the figure 9-12 below:

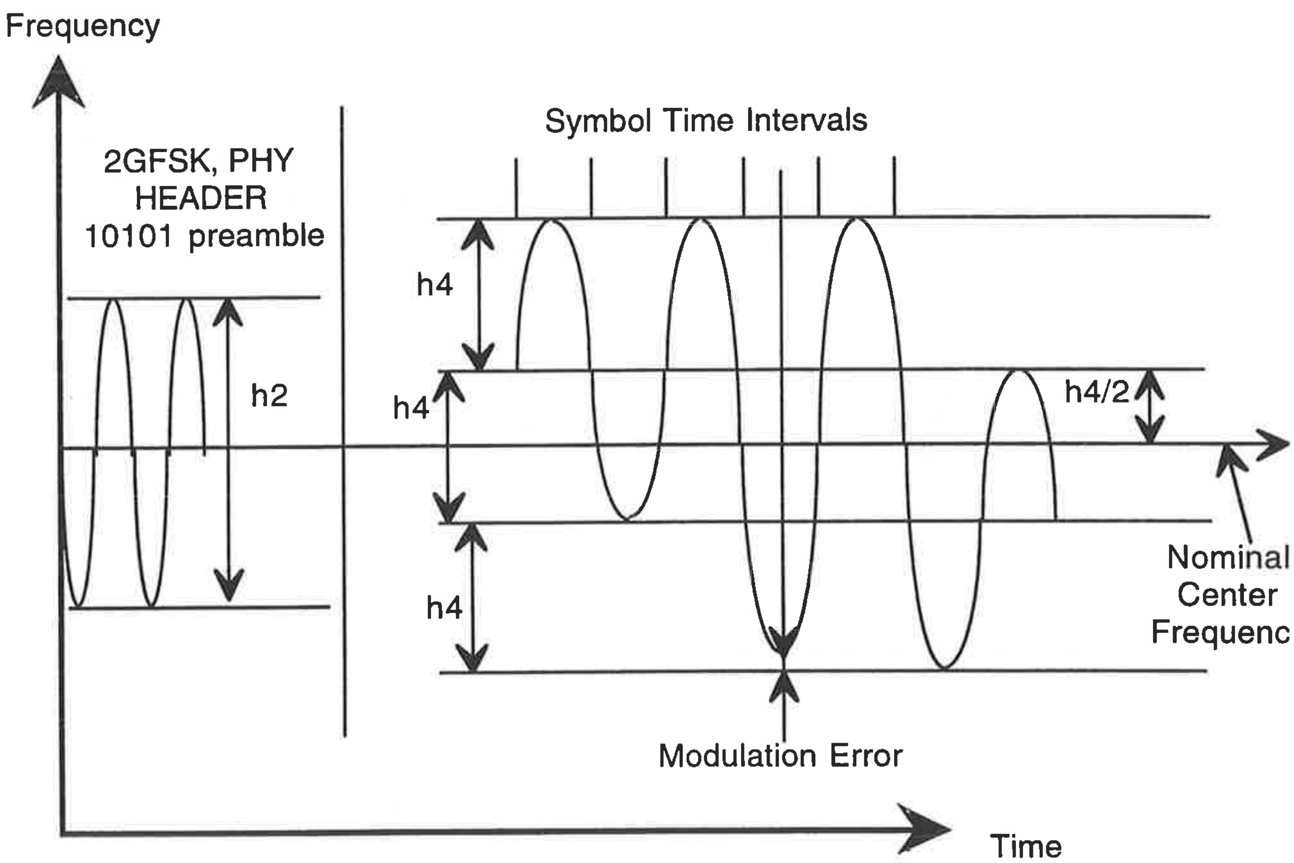


Figure 9-12. 4Level GPSK Transmit Modulation

9.7.11 Channel Data Rate. A compliant 802.11 FHSS PMD will be capable of transmitting and receiving at a nominal data rate of 2.0 MBps ~~as specified by the modulation parameters and criterion outlined in section 9.5.7.1. This data rate is considered to be the raw, over-the-air data rate as measured between the respective antenna ports of a transmitting PMD and the intended receiving PMD. This data rate is specified under clear medium conditions, where a clear medium is defined as a communication channel between a transmitting and receiving PMD that is void of interference, and where the BER specified in section 9.6.3 is achievable at minimum receiver sensitivity as specified in section 9.5.9.1.~~

9.7.12 - 9.7.24 See Sections 9.6.12 - 9.6.24.

9.7.25 Channel BER. A conformant PMD implementation must provide a channel BER of at least 10^{-5} at an E_b/N_o of 22.5 dB in an AWGN channel for 2M bit per second data rate.

9.7.26 - 9.7.28 See Sections 9.6.26 - 9.6.28.

~~**9.7.29 Receiver Data Jitter Tolerance(OPEN)**~~

~~Need some help here guys~~

9.7.30 - 9.7.31 See Sections 9.6.30 - 9.6.31.

9.7.32 Receiver Sensitivity. Sensitivity is defined as the minimum signal level required to produce a BER of 10-5. A conformant PMD shall have the minimum signal level be less than or equal to -75 dBm across the operating frequency range specified in 9.6.4.

9.7.33 Intermodulation. Intermodulation protection (IMp) is defined as the ratio 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 BER of the receiver to be reduced to 10-5, when the desired signal is 3 dB above the specified sensitivity. Each interfering signal is modulated with the FH 1Mb/sec PMD modulation uncorrolated in time to each other or the desired signal. A conformant 2Mb/sec PMD shall have the IMp for the interfering signal at 4 and 8 MHz be greater than or equal to 30 dB.

9.7.34 Desensitization. Desensitization (Dp) is defined as the ratio to measured sensitivity of the minimum amplitude of an interfering signal that causes the BER of the receiver to be reduced to 10-5 when the desired signal is -72 dB (3 dB above sensitivity specified in section 9.7.32). The interfering signal shall be modulated with the FHSS PMD modulation uncorrolated in time to the desired signal. Dp should be greater than or equal to the figures given in table 9-15 below:

Interferer Frequency	DP Minimum
M=N*	-20dB
M=N+/-1	-18dB
M=N>+/-2	24dB
M=N>+/-3	35dB

Table 9.15. 2M Bit Desensitization

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

Annex

Table A Hopping Sequence Set 1

Index	Pattern 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

Index \ Pattern	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

Index	Pattern 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

Index	Pattern 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

Index	Pattern 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

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

Appendix A

PMD Approved Motions

Item	Motion	Yes	No	Abstain
A.1	The 2.4 GHz frequency hop physical layer draft specification shall have 79 frequency channels. **(May 1993)**	26	0	6
A.2	The 2.4 GHz frequency hop physical layer draft specification shall have a channel center frequency of 1.0 MHz **(May 1993)**	26	0	6
A.3	The 2.4 GHz frequency hop physical layer draft specification shall have a maximum channel bandwidth of 1.0 MHz that contains 99% of the energy. **(May 1993)**	15	0	8
A.4	The hop rate shall be configurable in the MAC but fixed within a given BSA. It does not have to adapt. **(Jan. 1993)**	20	1	1
A.5	The 2.4 GHz frequency hop physical layer draft specification shall require the MAC to maximize the use of each hop interval. **(Jan. 1993)**	15	4	3
A.6	The 2.4 GHz frequency hop physical layer draft specification shall have the maximum hop rate restriction removed.**(May 1993)**	21	1	3
A.7	The MAC will tell the PHY when to hop **(Jan. 1993)**	13	5	0
A.8	The FHSS PHY group accepts IBM's proposed hopping sequences, in document 93/60, for 802.11 compatible FHSS WLAN's **(Jan. 1994)**	16	0	2
A.9	The 2.4 GHz frequency hop physical layer draft specification shall require transmit power level control above a TBD level of transmit power. **(Jan. 1993)**	15	6	1
A.10	The threshold level referenced in Motion 4 shall equal 100 mW. **(Jan. 1993)**	11	9	0
A.11	The 2.4 GHz frequency hop physical layer draft specification shall be able to transmit at least a TBD level of power to conform to the standard. **(Jan. 1993)**	21	1	0
A.12	The level referenced in Motion 6 shall be 1.0 mW. **(Jan. 1993)**	15	6	0

A.13	When power control is required, then the number of bits provided to specify transmit power shall be 2 bits. **(Jan. 1993)**	9	9	0
A.14	The PHY shall not fragment frames/packets supplied by the MAC. **(Jan. 1993)**	16	3	2
A.15	The 2.4 GHz frequency hop physical layer draft specification shall have a channel data rate of 1.0 Mbps. **(May 1993)**	15	0	8
A.16	The 2.4 GHz frequency hop physical layer draft specification shall have a transmitter center frequency accuracy of ±25 ppm. (NOTE: This may be revised downward in the future). **(May 1993)**	26	0	6
A.17	The 2.4 GHz frequency hop physical layer draft specification shall receive the switching time requirement (Tx-Rx) from the MAC. **(May 1993)**	10	6	-
A.18	All 802.11 FHSS PHY shall be capable of operating using GFSK with BT=0.5 and a minimum deviation of 160 kHz with a data rate of 1.0 Mbps. Modulation techniques for higher data rates are for further study by 802.11 PHY committee. A means for negotiating a switch to higher data rate from GFSK is also for further study. **(July 1993)**	39	5	5
A.19	Adopted the Jim McDonald proposal (Doc: 93/209) with language changed from dB to Watts, for both ramp up and ramp down, and modulation during the ramp is unspecified by 802.11, but must be specified by the manufacturer. **(November 1993)**	13	0	0
A.20	The training sequence will be 80 bits in length and consist of a "01" pattern. NOTE: We did not vote on the unique word, length field length, PHY signaling field length or depth of protection on the length field. Peter Chadwick gave a summary of 8 bits PHY signaling, 16 bits packet length and 8 bits protection (I'm not sure I understand this?) and nobody objected. **(November 1993)**	9	2	3

A.21	The PHY subcommittee of IEEE 802.11 will continue to work on the international standardization process. The first objective will be the release of a first-draft US standard by November 1994. **(Jan. 1994)**	29	4	5
A.22	The DS, FHSS and HSFHSS subgroups shall prepare draft standards and template documents and their chairs shall present them to the full PHY. **(Jan. 1994)**	23	2	10
A.23	We shall remove from 93/161 all reference to the subject matter of line 16 of 93/83r2 (fall back data rates below 1.0 Mbps) **(Jan. 1994)**	12	0	5
A.24	We shall remove from 93/161 all reference to lines 17 and 17a of 93/83r2 (baseband clock jitter & clock accuracy). **(Jan. 1994)**	4	1	2
A.25	In-band spurious emissions shall be -55 dBc. **(Jan. 1994)**	9	0	5