IEEE P802.11
Wireless Access Methods and Physical Layer Specifications

Title:

Proposal for a
Physical Layer Draft Specification
for
2.4GHz Frequency Hopping Spread Spectrum media

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Introduction:

This paper contains the proposal for a Working Draft Standard for the Frequency Hopping Spread Spectrum Physical Layer. In this is included the Frequency Hopping Spread Spectrum PMD and PLCP.

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

1. Introduction

1.1 Scope. 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. Different physical layers are defined as part of the 802.11 standard. Each physical layer can consist of two protocol functions as follows:

(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.

Each physical medium dependent sublayer for FHSS PMDs may require the definition of a unique PLCP. If the PMD sublayer already provides the defined Physical Layer services, the physical layer convergence function might be null.

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

The FHSS Physical Layer service is provided to the Media Access Control entity at the node through a Service Access Point (SAP) as shown in Figure 1-1 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.

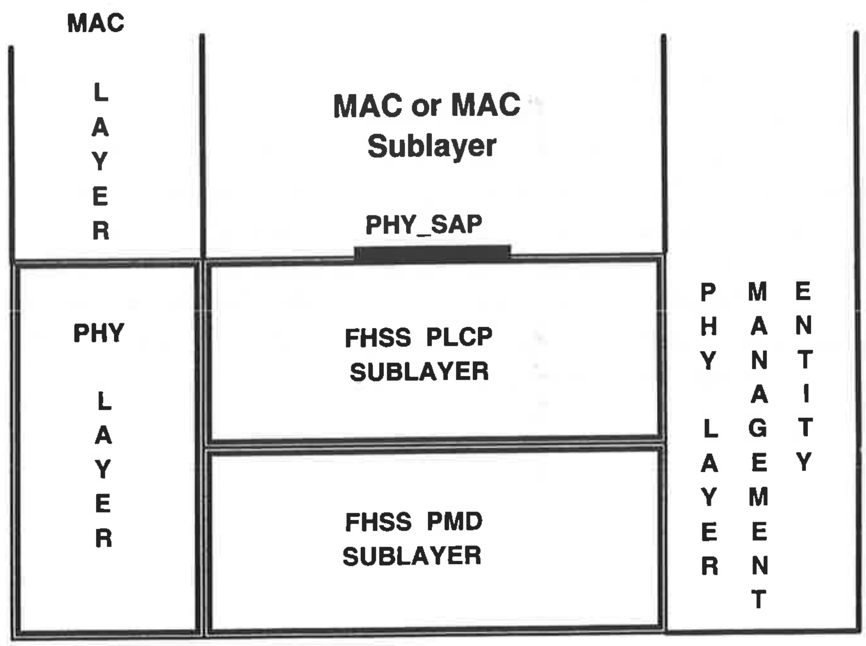

Figure 1-1 Protocol Reference Model

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.
1.2.2 Physical Medium Dependent Sublayer. The physical medium dependent sublayer provides a transmission interface used to send or receive data between two or more nodes.
1.2.3 Physical Layer Management Entity (LME). The Physical LME performs management of the local Physical Layer Functions in conjunction with the MAC Management entity.

1.3 Definitions. This section defines the terms used in this standard. Words in *italics* indicate terms that are defined elsewhere in the lists of definitions.

Physical Medium Dependent sublayer

1.4 Acronyms.

BPDU	Burst Protocol Data Unit
FHSS	Frequency Hopping Spread Spectrum
LME	Layer Management Entity
MAC	Media Access Control
MPDU	MAC Protocol Data Unit
PDU	Protocol Data Unit
PHY_SAP	Physical layer Service Access Point
PLCP	Physical Layer Convergence Procedure

PMD	Physical Medium Dependent
PMD_SAP	Physical Medium Dependent Service Access Point
SAP	Service Access Point

1.5 Service Specification Method and Notation. The models represented by state diagrams 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.

2. FHSS Physical Layer Service Specifications.

2.1 Scope and Field of Application. This section specifies the services provided by the FHSS Physical Layer to the 802.11 MAC. These services are describe in an abstract way and do not imply any particular implementation or exposed interface.

2.2 Overview of the Service. The FHSS Physical Layer function as shown in figure 1-1 is separated into to sublayers: the FHSS PLCP sublayer and the FHSS PMD sublayer. The function of the PLCP sublayer is to provide a mechanism for transferring MAC Protocol Data Units (MPDU) between two or more nodes over the FHSS PMD sublayer. This is accomplished by PLCP in the transmit direction by converting MPDUs into Burst Protocol Data Units (BPDU). The formation of the BPDU is covered in section 3. In the receive direction, the PLCP is responsible for converting BPDUs back into MPDUs. The PLCP is also responsible for adding a Preamble to the BPDU at the transmitting node which is used by the receiving nodes for recovering the BPDU. All state machines required to control the sending or receiving of data via the FHSS PMD are also included in the FHSS PLCP.

2.3 Overview of Interactions. The primitives associated with the 802.11 MAC Sublayer to the FHSS Layer falls into two basic categories:

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

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

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

2.4.1 PHY_SAP Peer-to-Peer Service Primitives. The following table (table 1) indicates the primitives for peer-to-peer interactions.

Primitive	Request	Indicate	Confirm	Response
PHY_DATA	X	X		

Table 1. PHY_SAP Peer-to-Peer Service Primitives

2.4.2 PHY_SAP Sublayer-to-Sublayer Service Primitives. The following table indicates the primitives for sublayer-to-sublayer interactions.

Primitive	Request	Indicate	Confirm	Response
PHY_TXBUSY		X		
PHY_RXBUSY		X		
PHY_RXERROR		X		
PHY_CS		X		
PHY_FREQHOP	X		X	

Table 2. PHY_SAP Sublayer-to-Sublayer Service Primitives

2.4.3 PHY_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
LENGTH	PHY_DATA.request PHY_DATA.indicate	integer 0-TBD
TXDATA	PHY_DATA.request	list of 0-TBD octets
TXPWRLVL	PHY_DATA.request	see section 4.5.6
ANTSEL	PHY_DATA.request PHY_DATA.indicate	see section 4.5.5
RXDATA	PHY_DATA.indicate	list of 0-TBD
RSSI	PHY_DATA.indicate	TBD
STATUS	PHY_TXBUSY.indicate PHY_RXBUSY.indicate PHY_CS.indicate	BUSY,IDLE
ERROR	PHY_RXERROR.indicate	HEC_Violation Length_Violation Format_Violation No_Error
CHNL_ID	PHY_FREQHOP	see section 4.5.7

Table 3. PHY_SAP Service Primitive Parameters

2.5 PHY_SAP Detailed Service Specification. The following section describes the services provided by each PHY sublayer primitive.

2.5.1 PHY_DATA.request

2.5.1.1 Function. This primitive defines the transfer of data from the MAC sublayer to the local PHY entity.

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

PHY_DATA.request (LENGTH,TXDATA,ANTSEL,TXPWRLVL)

The LENGTH parameter is an integer value of 0 to TBD. This parameter represents the number of octets in the MPDU being passed from the MAC sublayer to the local PHY entity. The TXDATA parameter is a list of octets which represent the MPDU the MAC is requesting to transmit. This list consists of 0-TBD octets as specified by the LENGTH parameter.

ANTSEL (optional) The ANTSEL parameter is an optional parameter and is defined by the PMD_ANTSEL primitive in section 4.5.5 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 4.5.6 of the PMD sublayer specification. This parameter allows the MAC entity to specify the transmit power level on a per MPDU basis.

2.5.1.3 When Generated. This primitive is generated by the MAC sublayer to request the transmission of an MPDU.

2.5.1.4 Effect of Receipt. The receipt of this primitive by the PHY entity will cause the PLCP transmit state machine within the PHY layer to begin the process of data transmission.

2.5.2 PHY_DATA.indicate

2.5.2.1 Function. This primitive indicates to the local MAC entity that the PHY sublayer has completed receiving an MPDU. In addition, this primitive also defines the transfer of data from the PHY sublayer to the local Mac entity.

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

PHY_DATA.indicate (LENGTH,RXDATA,ANTSEL,RSSI)

The LENGTH parameter is an integer value of 0 to TBD. This parameter represents the number of octets in the MPDU being passed from the PHY sublayer to the local MAC entity. The RXDATA parameter is a list of octets which represent the MPDU the PHY sublayer received and is transferring to the Mac entity. This list consists of 0-800 octets as specified by the LENGTH parameter.

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.

RSSI (optional). The RSSI parameter is an optional parameter and can be a value of TBD. This parameter is an indication by the PHY sublayer the value of the energy observed on the antenna used to receive the as to the antenna it used to receive the current MPDU it is transferring to the MAC sublayer.
2.5.2.3 When Generated. The PHY_DATA.indicate is generated to by all receiving PHY sublayers to the local MAC entities in the network after a PHY_DATA.request is issued.
2.5.2.4 Effect of Receipt. The effect of receipt of this primitive by the MAC is unspecified.

2.5.3 PHY_TXBUSY.indicate
2.5.3.1 Function. This primitive is an indication by the PHY sublayer to the local Mac entity that the transmission of a MPDU has been started or completed by the PHY PLCP entity.
2.5.3.2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

PHY_TXBUSY.indicate (STATUS)

The STATUS parameter can be one of two values: IDLE or BUSY. The value is IDLE whenever the PLCP's transmit state machine is not transmitting. The BUSY value indicates that the PLCP's transmit state machine is currently running.
2.5.3.3 When Generated. This primitive is issued by the PHY sublayer to the MAC entity whenever the PLCP's transmit state machine starts or ends a transmit cycle. A BUSY indication can be used by the MAC entity to confirm the reception of a PHY_DATA.request by the PHY sublayer and as a indication that the transmission of an MPDU has begun. An IDLE indication can be used by the MAC entity to determine when the transmission of an MPDU has been completed and as an indication when to start the Inter Frame Space timers.
2.5.3.4 Effect of Receipt. The effect of receipt of this primitive by the MAC is unspecified.

2.5.4 PHY_RXBUSY.indicate
2.5.4.1 Function. This primitive is an indication by the PHY sublayer to the local MAC entity that the reception of an MPDU has been started or completed by the PHY PLCP entity.
2.5.4.2 Semantics of the Service Primitive. The primitive shall provide the following parameters:

PHY_RXBUSY.indicate (STATUS)

The STATUS parameter can be one of two values: IDLE or BUSY. The value is IDLE whenever the PLCP's receive state machine is not running. The BUSY value indicates that the PLCP's receive state machine is currently receiving a BPDU.
2.5.4.3 When Generated. This primitive is issued by the PHY sublayer to the MAC entity whenever the PLCP's receive state machine starts or ends a receive cycle. A BUSY indication is issued by the PHY sublayer to the local MAC entity whenever the PHY PLCP identifies, synchronizes, and detect a valid FRAME symbol in the preamble of a BPDU. An IDLE parameter is issued whenever the PLCP's receive state machine stops receiving due to the end of a valid BPDU or an error.
2.5.4.4 Effect of Receipt. The effect of receipt of this primitive by the MAC is unspecified.

2.5.5 PHY_RXERROR.indicate

2.5.5.1 Function. This primitive is an indication by the PHY sublayer to the local MAC entity of a receiver error.

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

PHY_RXERROR.indicate (ERROR)

The ERROR parameter can be one or more of the following values: HEC_Violation, Length_Violation, Format_Violation, or No_Error. A number of error conditions may occur after the PLCP's receive state machine has detected what it thought may be a valid preamble and issued an PHY_RXBUSY indication. The following describes the parameter returned for each of those error conditions.

HEC_Violation. This value is used to indicate that the Header Error Check field in the BPDU header can not resolve the correct BPDU header.

Length_Violation. This value is used to indicate that the Length Field in the BPDU header is not within the boundary of possible lengths.

Format_Violation. This value is used to indicate that the format of the BPDU was in error. The error condition is a run length violation.

No_Error. This value is used to indicate that no error occurred during the receive process in the PLCP.

2.5.5.3 When Generated. This primitive is generated whenever a PHY_RXBUSY.indicate (IDLE) primitive is issued to indicate the error status of the RXBUSY state change from BUSY to IDLE.

2.5.5.4 Effect of Receipt. The effect of receipt of this primitive by the MAC is unspecified.

2.5.6 PHY_CS.indicate

2.5.6.1 Function. This primitive is an indication by the PHY sublayer to the MAC entity of the current state of the medium.

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

PHY_CS.indicate (STATE)

The STATE parameter can be one of two values: BUSY,IDLE. The parameter value will be BUSY if the channel assessment by the PHY sublayer results in the medium not being available. If the channel assessment by the PHY sublayer determines that the channel is not busy, the value of the parameter is IDLE.

2.5.6.3 When Generated. This primitive is generated every time the status of the channel changes from channel clear to carrier present or from carrier present to channel clear. This includes the period of time when the PHY sublayer is receiving or transmitting data.

2.5.6.4 Effect of Receipt. The effect of receipt of this primitive by the MAC is unspecified.

2.5.7 PHY_FREQHOP.request

2.5.7.1 Function. This primitive is a request by the MAC sublayer to the local PHY entity to change or hop to a new frequency.

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

PHY_FREQHOP.request (CHNL_ID)

The CHNL_ID parameter can be one of the values listed in table x. (See section 4.5.7)

2.5.7.3 When Generated. This primitive is generated by the local MAC entity to the PHY sublayer whenever a frequency change is required

2.5.7.4 Effect of Receipt. Upon receipt of this primitive, the PHY sublayer via the PLCP will start and complete a frequency hop.

2.5.8 PHY_FREQHOP.confirm

2.5.8.1 Function. This primitive is a confirmation by the PHY sublayer to the local MAC entity that the change or hop to a new frequency was completed.

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

PHY_FREQHOP.request (CHNL_ID)

The CHNL_ID parameter can be one of the values listed in table 9. (See section 4.5.7). It is identical to the CHNL_ID that was requested in the PHY_FREQHOP primitive used to initiate the frequency change.

2.5.8.3 When Generated. This primitive is generated by the PHY sublayer for the local MAC entity to confirm that a frequency change was completed.

2.5.8.4 Effect of Receipt. The effect of receipt of this primitive by the MAC is unspecified.

2.6 MPHY_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
MPHY_RXRESET	X		X	
MPHY_TXRESET	X		X	

Table 4. MPHY_SAP Sublayer Management Primitives

2.6.1 MPHY_SAP Management Service Primitive Parameters. The following table shows the parameters used by one or more of the MPHY_SAP Sublayer Management Primitives.

Parameter	Associate Primitive	Value
none at this time		

Table 5. PHY_SAP Service Primitive Parameters

2.7 MPHY_SAP Detailed Service Specifications. The following section describes the services provided by each MPHY_SAP Service Primitive.

2.7.1 MPHY_RXRESET.request

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

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

MPHY_RXRESET.request

There are no parameters associated with this primitive.

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

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

2.7.2 MPHY_RXRESET.confirm

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

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

MPHY_RXRESET.confirm

There are no parameters associated with this primitive.

2.7.2.3 When Generated. This primitive will be generated as a response to a MPHY_RXRESET.request primitive once the PLCP has successfully completed the receive state machine reset.

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

2.7.3 MPHY_TXRESET.request

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

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

MPHY_TXRESET.request

There are no parameters associated with this primitive.

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

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

2.7.4 MPHY_TXRESET.confirm

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

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

MPHY_TXRESET.confirm

There are no parameters associated with this primitive.

2.7.4.3 When Generated. This primitive will be generated as a response to a MPHY_TXRESET.request primitive once the PLCP has successfully completed the transmit state machine reset.

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

3. FHSS Physical Layer Convergence Procedure Sublayer

3.1 Introduction. This section provides a convergence procedure in which the MAC PDUs are mapped into a framing format designed for FHSS radio transceivers. The physical layer convergence procedure describes in how MPDUs are

3.2 Physical Layer Convergence Procedure Frame Format.

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3.3 PLCP Field Definitions. The PLCP packet illustrated in Figure 3-1 contains three distinct fields: PLCP Preamble, PLCP Header, and the MPDU.

PLCP Preamble		PLCP Header	MPDU
Sync	Start Frame Delimiter		
80 bits	16 bits	TBD bits	Variable number of octets

Figure 3-1. PLCP Frame Format

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

3.3.1.1 Sync Field. The preamble sync field is a 10-octet field containing an alternating zero-one pattern, starting with zero, 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.

3.3.1.2 Start Frame Delimiter. The start frame delimiter consists of the 16 bit word 09AFh. The MSB of the frame pattern follows the last bit of the sync pattern and indicates the start of the MPDU. The first bit following the frame field is the first bit included in the scrambling.

3.3.2 PLCP Header Field Format. The PLCP Header field contains three separate sub-fields: a TBD MPDU length word, a TBD PLCP signaling field, and a TBD PLCP header error check/correction field.

3.3.2.1 PLCP Header. The MPDU length word is used by the receiving terminal to determine the last bit in the packet. The length is passed down from the MAC as a parameter within the PHY_DATA.request primitive. The length represents the TBD (octet/16 bit word) count of the MPDU packet including the HEC check field.

3.3.2.2 PLCP Signaling Field. The PLCP Signaling field is TBD bits and indicates TBD.

3.3.2.3 PLCP Header Error Check Field. The PLCP header error check field is a TBD bit field generated by TBD method.

3.3.3 PLCP MPDU Data Whitener. TBD scrambling/stuffing is used to randomize the data from highly redundant patterns and to minimize the data DC bias and maximum run lengths. The specific method used is TBD.

3.4 PLCP Transmit Procedure. The PLCP transmit procedure is executed immediately upon receiving a PHY_DATA.request from the MAC layer. The CSMA/CA protocol is performed by the MAC with the PHY PLCP in the carrier sense mode.

3.4.1 Transmit State Machine. The PLCP transmit procedure illustrated in Figure 3-2 includes functions that must be performed prior to, during, and after MPDU data transmission. Before transmitting the first MPDU data bit, the PLCP shall switch the PHY PMD circuitry from receive to transmit state, turn on the transmit power amplifier in the manner prescribed in Section 4 (PMD specification), and transmit the preamble sync pattern, start frame delimiter, and PLCP header. The PLCP shall generate the PLCP header as defined in Section 3.3.2 (PLCP Header) in sufficient time to send the bits at their designated bit slot time. During transmission of the MPDU data, each bit shall be processed by the TBD scrambling/stuffing operation and a counter shall be maintained to indicate the last bit of the MPDU. After the last bit of the MPDU is sent, the PLCP shall turn off the power amplifier in the manner prescribed in the PMD section and send a PHY_TXBUSY.indicate message to the MAC layer.

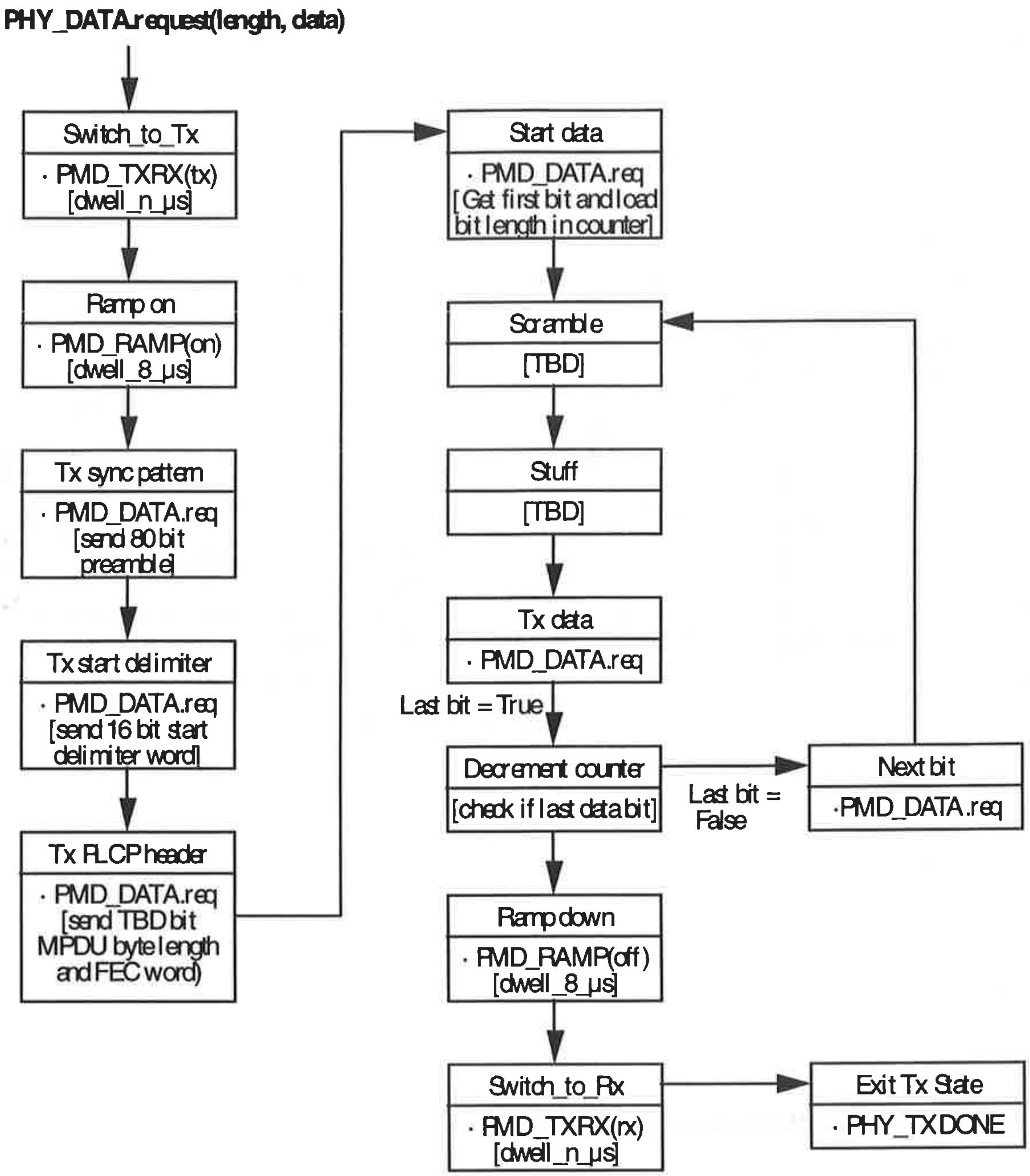

Figure 3-2 Transmit State Machine

3.4.2 Transmit State Timing. The transmit timing is defined from the instant that the PHY_DATA.request is received from the MAC layer. The PMD circuitry shall be switched from receive to transmit and settled within TBD µs. The power amplifier shall be turned on and settled within the specified range about the final transmit power level 8 µs after the receive to transmit switch time. The PLCP preamble shall be transmitted at 1 Mbps and be completed within 96 µs. The scrambling/stuffing algorithm shall be enabled with the first bit following the preamble start frame delimiter. The PLCP header shall be transmitted at 1 Mbps and be completed within TBD bit times. The variable length MPDU shall be transmitted at the selected data rate. Each byte of the MPDU data shall be sent with the most significant bit of each byte first and the least significant bit last. After the last bit of the MPDU data has been transmitted, the PLCP shall turn off the power amplifier and be less than the specified transmit power in 8 μs. At the end of the power amplifier ramp down period, the PLCP shall send a PHY_TXBUSY to the MAC layer and switch the PMD circuitry from transmit to receive.

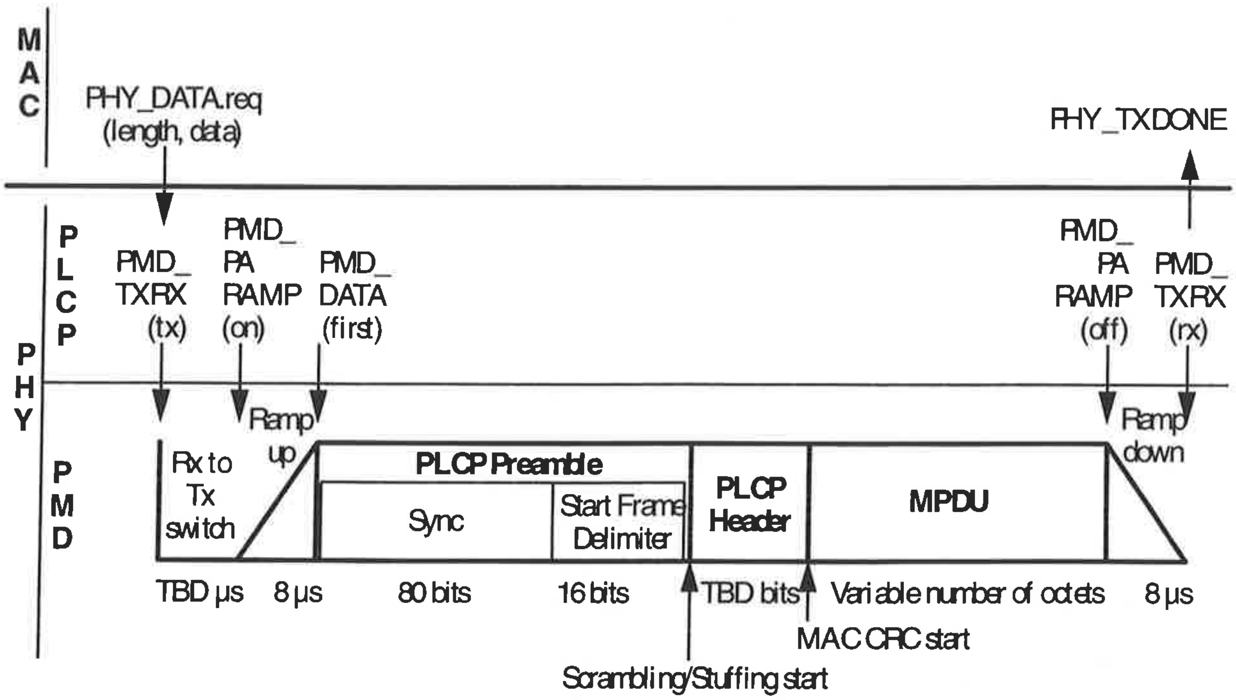

Figure 3-3 Transmit State Timing

3.5 Carrier Sense Procedure.

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3.5.1 Carrier Sense With Diversity.

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3.5.1.1 Carrier Sense With Diversity State Machine.

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3.5.1.2 Carrier Sense With Diversity State Timing.

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3.5.2 Carrier Sense Without Diversity.

Add Text

3.5.2.1 Carrier Sense Without Diversity State Machine

Add Text

3.5.2.2 Carrier Sense Without Diversity State Timing

Add Text

3.6 PLCP Receive Procedure. The PLCP receive procedure is invoked by the PHY PLCP carrier sense procedure upon detecting a portion of a preamble followed by the start frame delimiter.

3.6.1 Receive State Machine. The PLCP receive procedure includes functions that must be performed while receiving the PLCP header and the MPDU data. Immediately upon start of the PLCP receive procedure, the PLCP shall send a PHY_RXBUSY.indicate message to the MAC layer. While receiving the PLCP header, the PLCP shall read the TBD length word, TBD PHY signaling field, and TBD FEC field, and perform a TBD error check/correction. If the PLCP header is free or corrected of errors, the PLCP shall set a counter to indicate the last bit of the packet, receive the MPDU data bits and perform the TBD descrambling/unstuffing procedure on each MPDU bit. After the last MPDU bit is received, the PLCP shall send a PHY_DATA.indicate(length, data) message to the MAC layer. If the PLCP header contains errors, the PLCP shall send a PHY_RXERROR.indicate message to the MAC layer and exit the receive procedure.

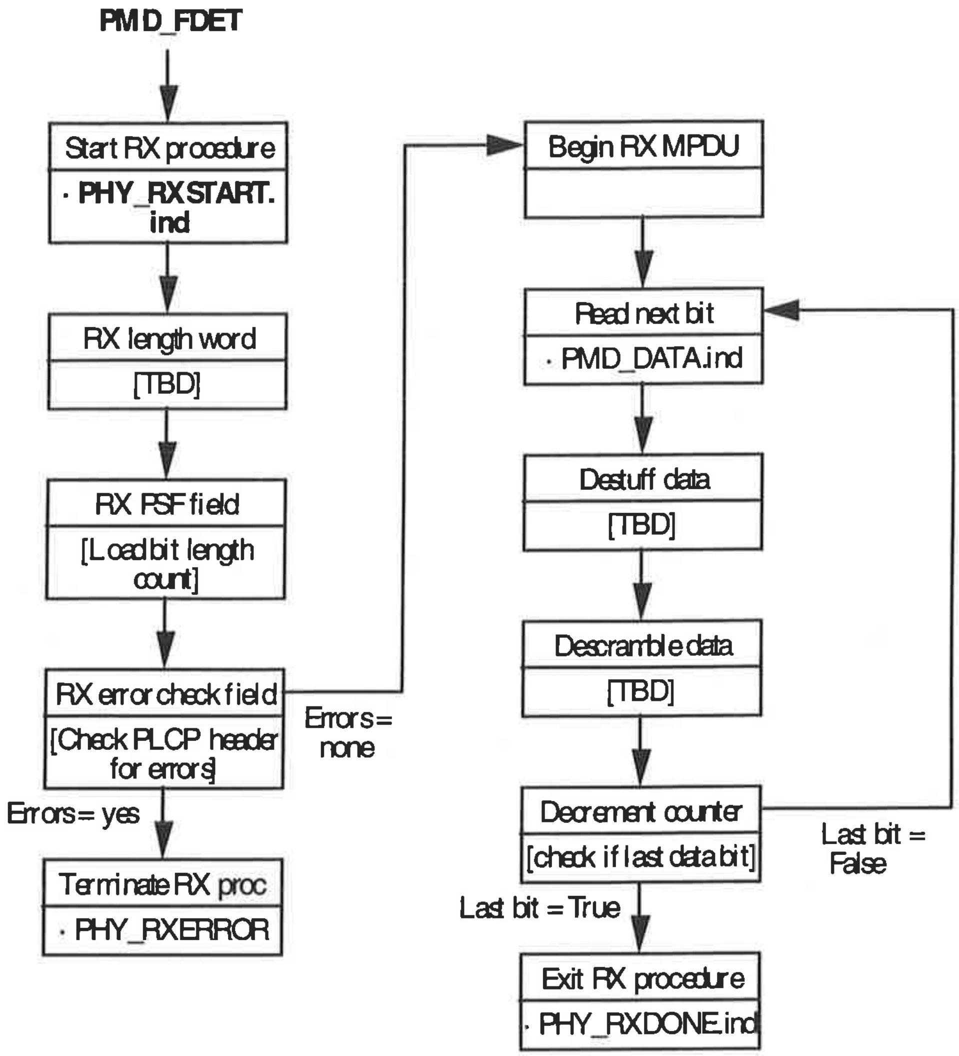

Figure 3-4 Receive State Machine

3.6.2 Receive State Timing. The receive state timing is defined at the end of the last bit of the start frame delimiter when the PMD_FDET is generated. The PLCP shall generate a PHY_RXBUSY.indicate message to the MAC layer. The PLCP shall read in the TBD MPDU length indicator and TBD PHY signaling field of the PLCP header and calculate and preload the bit count in the counter within TBD µs of the last bit of the length indicator. The PLCP shall read in the TBD header error check field and perform the check within TBD µs of the last bit of the error check field. The PLCP shall begin receiving the variable length MPDU immediately after the end of the last bit of the PLCP header. If there was an uncorrectable error in the PLCP header, the PLCP shall terminate the receive procedure within TBD µs of the start of the MPDU.

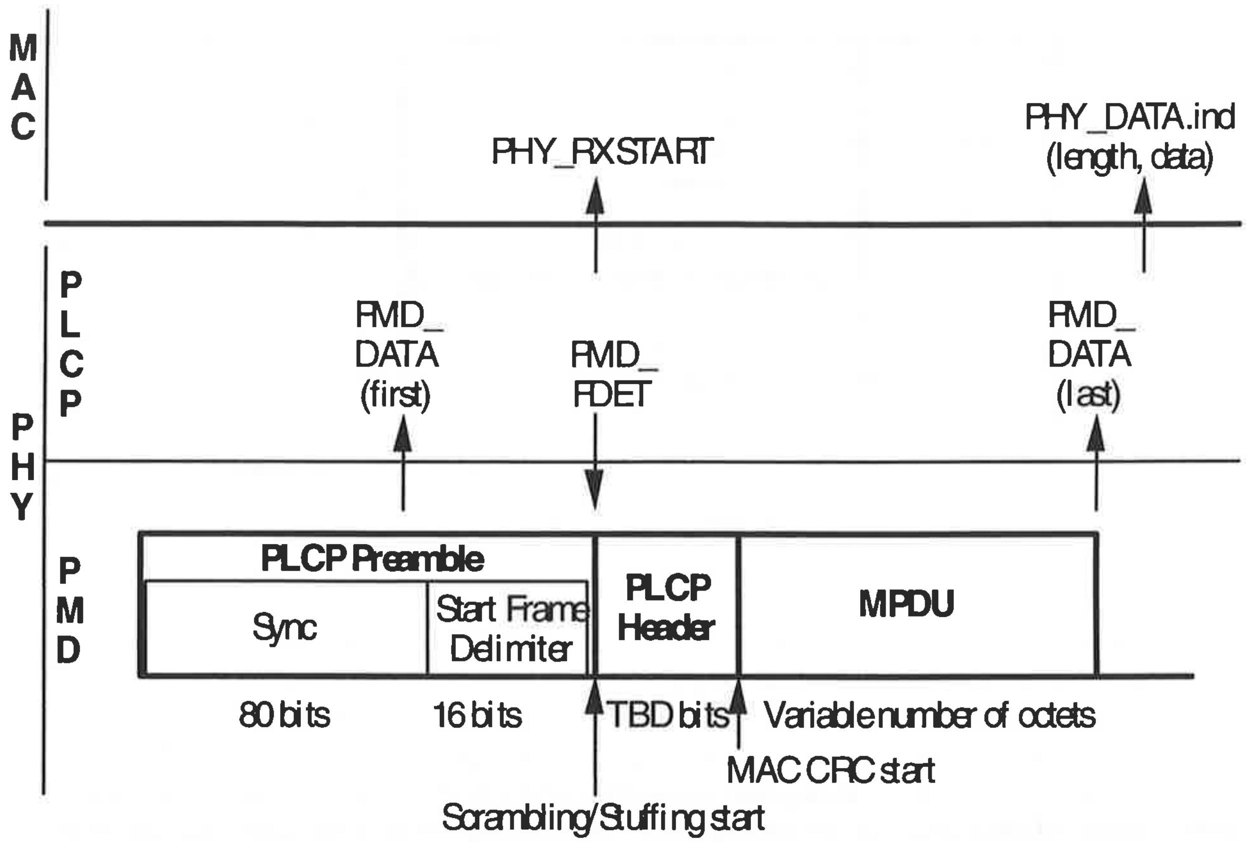

Figure 3-5 Receive Timing

4. FHSS Physical Medium Dependent Sublayer

4.1 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 4.1.

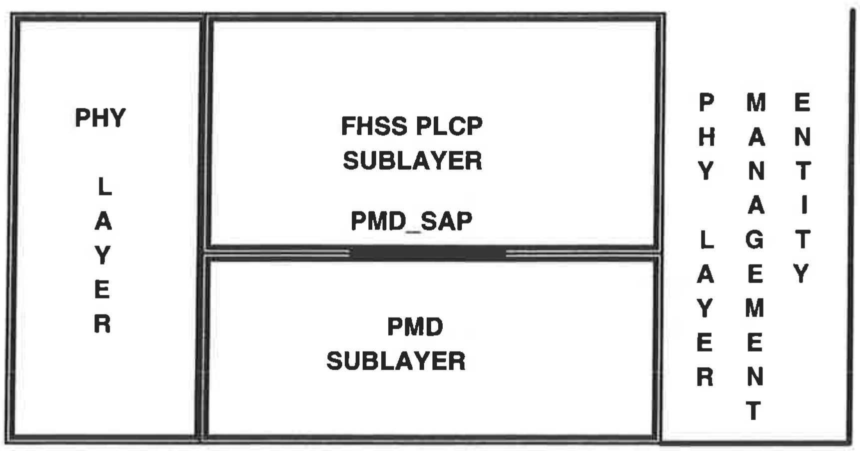

Figure 4.1 PMD layer Reference Model

4.2 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.

4.3 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.

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

4.4.1 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 6. PMD_SAP Peer-to-Peer Service Primitives

4.4.2 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		

Table 7. PMD_SAP Sublayer-to-Sublayer Service Primitives

4.4.3 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, TRISTATE
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 through 80 inclusive
STRENGTH	PMD_RSSI.indicate	TBD

Table 8. List of Parameters for PMD Primitives.

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

4.5.1 PMD_DATA.request
4.5.1.1 Function. This primitive defines the transfer of data from the PLCP sublayer to the PMD entity.
4.5.1.2 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 three values: ONE, ZERO, or TRISTATE. This parameter represents a single data bit. The effect of this parameter is ******
4.5.1.3 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.
4.5.1.4 Effect of Receipt. The receipt of this primitive will cause the PMD entity to encode and transmit a single data bit.

4.5.2 PMD_DATA.indicate
4.5.2.1 Function. This primitive defines the transfer of data from the PMD entity to the PLCP sublayer.
4.5.2.2 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 ******.
4.5.2.3 When Generated. The PMD_DATA.indicate is generate to all receiving PLCP entities in the network after a PMD_DATA.request is issued.
4.5.2.4 Effect of Receipt. The effect of receipt of this primitive by the PLCP is unspecified.

4.5.3 PMD_TXRX.request
4.5.3.1 Function. This primitive is used to place the PMD entity into the transmit or receive function.
4.5.3.2 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.
4.5.3.3 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.
4.5.3.4 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.

4.5.4 PMD_PARAMP.request
4.5.4.1 Function. This primitive defines the start of the ramp up or ramp down of the radio transmitter's Power Amplifier.
4.5.4.2 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".
4.5.4.3 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".

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

4.5.5 PMD_ANTSEL.request

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

4.5.5.2 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.

4.5.5.3 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.

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

4.5.6 PMD_TXPWRLVL.request

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

4.5.6.2 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 below.

TXPWR_LEVEL	Level Description
LEVEL1	TBD
LEVEL2	TBD
LEVEL3	TBD

Table 9. Transmit Power Levels

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

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

4.5.7 PMD_FREQ.request

4.5.7.1 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.

4.5.7.2 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 10.

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

4.5.7.4 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.

4.5.8 PMD_RSSI.indicate

4.5.8.1 Function. This primitive transfer 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 other sublayers.

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

PMD_RSSI.request (STRENGTH)

The STRENGTH parameter can be ########.

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

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

4.6 MPMD_SAP Sublayer Management Primitives. The following messages may be sent between the PMD sublayer entities and intralayer or higher layer management entities.

Primitive	Request	Indicate	Confirm	Response
MPMD_PWRMGNT	X			
MPMD_SYNLOCK		X		

Table 10. MPMD Layer Management Primitives

4.6.1 MPMD_SAP Management Service Primitives Parameters. The following table shows the parameters used by one or more of the MPMD_SAP Service Primitives.

Parameter	Associate Primitive	Value
MODE	MPMD_PWRMGNT.reques	ON, OFF
STATUS	MPMD_SYNLOCK.indicate	LOCKED, UNLOCKED

Table 11. List of Parameters for PMD
Layer Management Primitives.

4.6.1 MPMD_PWRMGNT.request
4.6.1.1 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.
4.6.1.2 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.
4.6.1.3 When Generated. This primitive is delivered by the PLCP but actually is generated by a high layer management entity
4.6.1.4 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.

4.6.2 MPMD_SYNLOCK.indicate
4.6.2.1 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.
4.6.2.2 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.

4.6.2.3 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.
4.6.2.4 Effect of Receipt. The effect of receipt of this primitive by the PLCP is unspecified.

4.7 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.

4.7.1 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. The set of carrier frequencies supported by an implementation is contained in the managed object detailing the available values of Fc. Table 12. summarizes these frequencies for a number of geographic locations:

Lower Limit	**Upper Limit**	**Full Operating Range**	**Geography**	**Status**
2.402 GHz	2.482 GHz	2.400-2.483 GHz	USA	CLOSED
2.402 GHz	2.482 GHz	2.400-2.483 GHz	Europe	**open**
2.471 GHz	2.497 GHz	2.470-2.499 GHz	Japan	**open**

Table 12. Operating Frequency Range.

4.7.2 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 14.1 of section 4.7.3 and section 4.7.6 for operation in the U.S.A.

Minimum*	**Hopping Set**	**Geography**	**Status**
75	79	USA	A.1.1
20	79	Europe	**open**
10	21	Japan	**open**

Table 13. Number of Operating Channels

*The entry in the column labeled "Minimum" is per the regulatory bodies associated with each geographic area.

4.7.3 Operating Channel Center Frequency. **(CLOSED: A.2)** 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., as listed in the following table.

Channel #	Value	Channel #	Value	Channel #	Value
1	2.402	27	2.428	53	2.454
2	2.403	28	2.429	54	2.455
3	2.404	29	2.430	55	2.456
4	2.405	30	2.431	56	2.457
5	2.406	31	2.432	57	2.458
6	2.407	32	2.433	58	2.459
7	2.408	33	2.434	59	2.460
8	2.409	34	2.435	60	2.461
9	2.410	35	2.436	61	2.462
10	2.411	36	2.437	62	2.463
11	2.412	37	2.438	63	2.464
12	2.413	38	2.439	64	2.465
13	2.414	39	2.440	65	2.466
14	2.415	40	2.441	66	2.467
15	2.416	41	2.442	67	2.468
16	2.417	42	2.443	68	2.469
17	2.418	43	2.444	69	2.470
18	2.419	44	2.445	70	2.471
19	2.420	45	2.446	71	2.472
20	2.421	46	2.447	72	2.473
21	2.422	47	2.448	73	2.474
22	2.423	48	2.449	74	2.475
23	2.424	49	2.450	75	2.476
24	2.425	50	2.451	76	2.477
25	2.426	51	2.452	77	2.478
26	2.427	52	2.453	78	2.479
				79	2.480

Table 14.1 USA and Europe Requirements:
(Values specified in GHz)

Channel #	Value	Channel #	Value	Channel #	Value
1	2.471	10	2.480	19	2.489
2	2.472	11	2.481	20	2.490
3	2.473	12	2.482	21	2.491
4	2.474	13	2.483	22	2.492
5	2.475	14	2.484	23	2.493
6	2.476	15	2.485	24	2.494
7	2.477	16	2.486	25	2.495
8	2.478	17	2.487	26	2.496
9	2.479	18	2.488	27	2.497

Table 14.2 Japan Requirements:
(Values specified in GHz)

4.7.4 Occupied Channel Bandwidth. **(CLOSED: A.3)** The occupied channel bandwidth for the PMD is 1.0 MHz wide as specified at the -20 dB points of the associated signal spectrum. This 1.0 MHz envelope must contain 99% of the emitted energy as measured at the ± 500 kHz frequency limits from the specified operating center frequency listed in section 4.7.3. The following diagram illustrates the relationship of the operating channel center frequency (defined as F_c) to the occupied channel bandwidth.

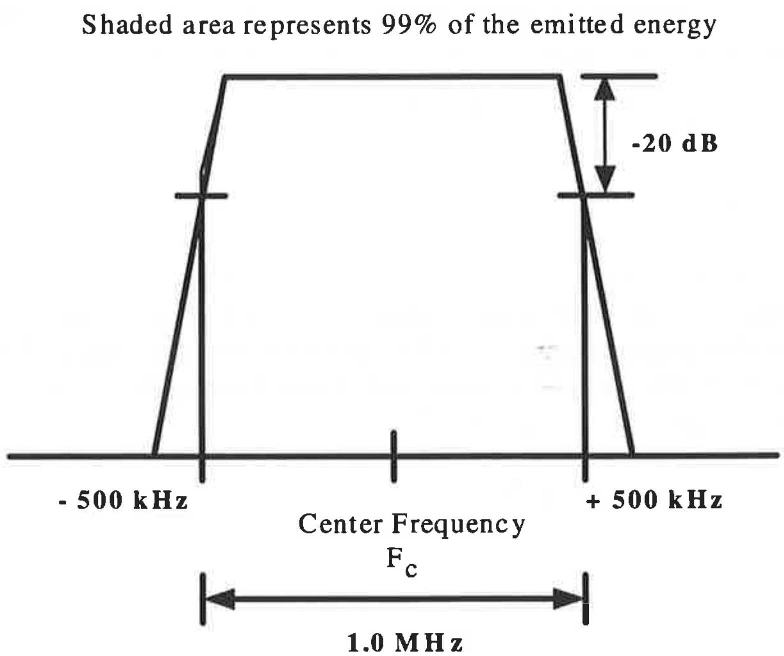

Figure 4-2. Occupied Channel Bandwidth.

4.7.5 Hop Rate. **(OPEN: A.4, A.5, A.6, A.7)** 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 in each geographic area. 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:

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

(Still need to specify this for Europe and Japan)

4.7.6 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 $f_i(j) = i*j \bmod(p)$

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 that can be derived is:

$$\frac{(p-1) - (2*F)}{2k+1} = \frac{(p-13)}{2k+1} = 22 \text{ patterns}$$

Where k = the number of adjacent channel interferers on each side of the channel frequency. For the 802.11 compliant FHSS PMD, 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 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 Table 14.1 in section 4.7.3.

Table 15.1 Hopping Sequence Set 1

Pattern 24:

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

Pattern 25:

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

Pattern 26:

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

Pattern 27:

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

Pattern 28:

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

Pattern 29:

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

Pattern 30:

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

Pattern 31:

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

Pattern 32:

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

Pattern 33:

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

Pattern 34:

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

Pattern 35:

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

Pattern 36:

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

Pattern 37

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

Pattern 38:

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

Pattern 39:

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

Pattern 40:

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

Pattern 41:

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

Pattern 42:

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

Pattern 43:

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

Pattern 44:

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

Pattern 45:

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

Table 15.2 Hopping Sequence Set 2

Pattern 47:

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

Pattern 48:

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

Pattern 49:

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

Pattern 50:

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

Pattern 51:

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

Pattern 52:

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

Pattern 53:

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

Pattern 54:

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

Pattern 55:

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

Pattern 56:

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

Pattern 57:

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

Pattern 58:

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

Pattern 59:

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

Pattern 60:

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

Pattern 61:

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

Pattern 62:

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

Pattern 63:

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

Pattern 64:

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

Pattern 65:

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

Pattern 66:

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

Pattern 67:

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

Pattern 68:

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

Table 15.3 Hopping Sequence Set 3

Pattern 2:

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

Pattern 3:

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

Pattern 4:

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

Pattern 5:

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

Pattern 6:

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

Pattern 7:

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

Pattern 8:

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

Pattern 9:

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

Pattern 10:

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

Pattern 11:

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

Pattern 12:

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

Pattern 13:

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

Pattern 14:

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

Pattern 15:

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

Pattern 16:

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

Pattern 17:

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

Pattern 18:

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

Pattern 19:

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

Pattern 20:

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

Pattern 21:

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

Pattern 22:

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

Pattern 23:

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

4.7.7 Spurious In-Band Emissions. **(CLOSED: A.25)** Conformant PMD implementations of this FHSS standard shall limit their in-band spurious emissions, while transmitting or receiving any symbol pattern, to less than -55 dBc as measured with respect to the fundamental carrier frequency (F_C) within the operating frequency range as specified in Table 12. of section 4.7.1. The following diagram is an example of this limit as related to the operating frequency range for the U.S. geographic location.

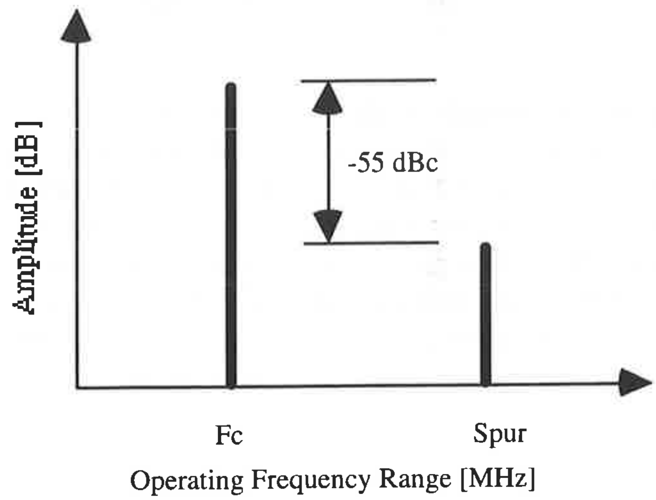

Figure 4-3. In-Band Spurious Response

4.7.8 Spurious Out-of-Band Emissions. **(CLOSED: Regulatory)** Conformant PMD implementations of this FHSS standard shall limit the spurious emissions that fall outside of the operating frequency range, defined in Table 12 of section 4.7.1, 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. For Europe, the governing regulations are ETS 300-328. {Japan TBD??}.

4.7.9 Modulation. **(CLOSED: A.18)** The process of moving from the frequency representing one medium symbol to the frequency representing another shall be implemented as a continuous phase frequency modulation in a manner that results in the signal on the medium being that which would have been generated by modulating an ideal voltage controlled oscillator with a baseband control signal that falls within the mask detailed in Figure 4-y. Alternatively, the time domain mask detailed in Figure 4-y could be interpreted as the range of permissible baseband waveforms that could emerge from an ideal limiter-discriminator demodulator with the transmitter and receiver coupled together through a perfect channel exhibiting a VSWR of 1.0. The signal shall be such that the boundaries of the mask detailed in Figure 4-y are not violated by any transmit symbol pattern.

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 GFSK modulation with a modulation index of BT=0.5 and a nominal peak deviation of 160 kHz.

The PMD will accept symbols from the set {{1},{0},{tristate}}from the PLCP. The symbol {1} is encoded with a peak deviation of (+f), giving a peak transmit frequency of (Fc+f), which is greater than the carrier center frequency (Fc). The symbol {0} is encoded with a peak frequency deviation of (-f), giving a peak transmit frequency of (Fc-f). The symbol {tristate} shall be encoded as the frequency (Fc) within the tolerance specifications detailed in section 4.7.5.

AS A SUGGESTION INSERT AN EYE-DIAGRAM MASK THAT IS BOUNDED BY GAUSSIAN FILTER IMPULSE RESPONSE OF BT=.5 and BT=.4 USING THE MAXIMUM PEAK DEVIATION THAT IS EXPECTED TO MEET THE FCC EMISSION MASK REQUIREMENTS. THIS TEMPLATE CAN ALSO BE USED TO SPECIFY ALLOWABLE BIT TIMING VARIATIONS BY LABELING NOMINAL ZERO CROSSING COORDINATES

Figure 4-4. Transmit Modulation Mask

4.7.10 Channel Data Rate. **(CLOSED: A.15)** A compliant 802.11 FHSS PMD will be capable of transmitting and receiving at a nominal data rate of 1.0 MBps as specified by the modulation parameters and criterion outlined in section 4.7.9. 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 4.9.3 is achievable at minimum receiver sensitivity as specified in section 4.9.1.

4.8 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.

4.8.1 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 4.8.9, 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 6.0. In addition, all conformant PMD implementations shall be capable of transmitting a minimum of 1.0 mW.

Maximum EIRP [mW]	**Geography**	**Status**
1000	USA	CLOSED
100	Europe	CLOSED
10 / MHz	Japan	**open**

Table 16. Transmit Power Limits

4.8.2 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 100 mW.

4.8.3 Transmit Spectrum Shape. **(OPEN)** Conformant 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].

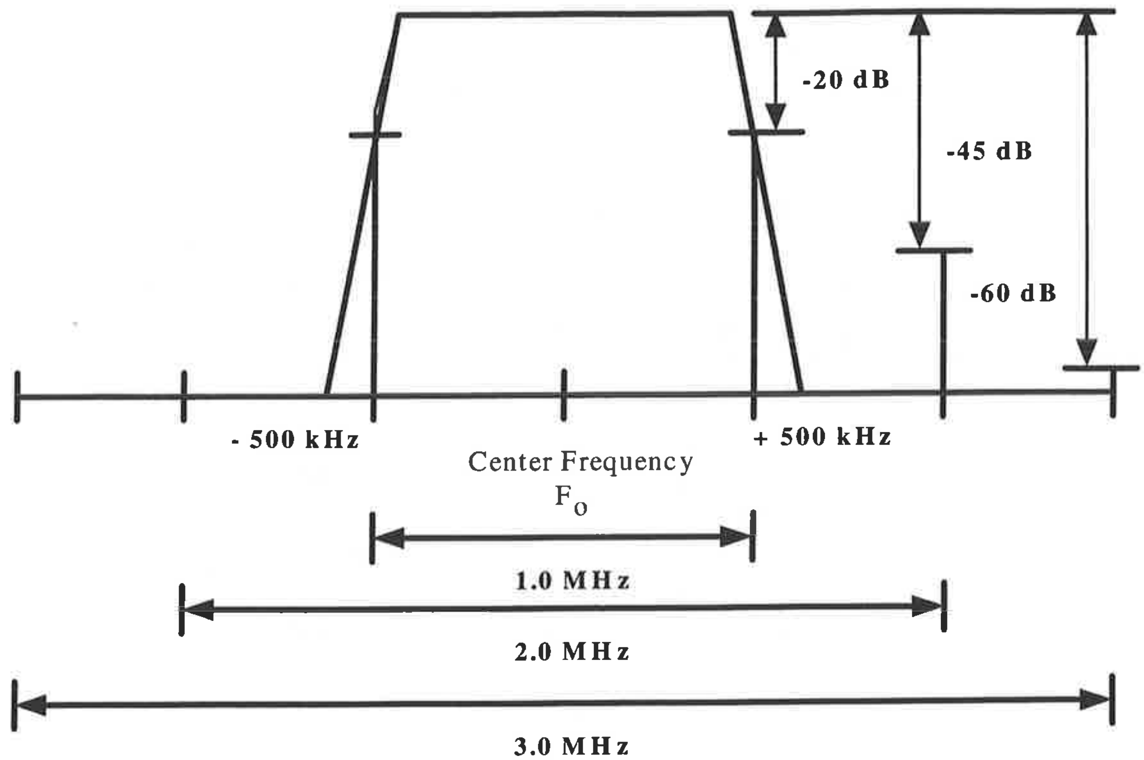

Figure 4-5. Transmit Spectrum Mask

4.8.4 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 following temperature ranges:

Minimum	Maximum	Conditions	Status
0^o C	$+40^o$ C	Indoors	**open**
-20^o C	$+55^o$ C	Outdoors	**open**
-15^o C	$+55^o$ C	Portable Equipment	**open**

Table 17. Transmit Center Frequency Tolerance

4.9 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.

4.9.1 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_0 of 16.0 dB in the presence of Gaussian white noise at a BER of greater than or equal to 10^{-5}.

4.9.2 Selectivity. **(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.

4.9.3 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.

4.9.4 Receive Center Frequency Tolerance. **(OPEN)** An 802.11 FHSS compliant PMD shall have a receive center frequency accuracy, as measured from F_c, of ±25.0 ppm. It shall maintain this stability over the following temperature ranges:

Minimum	Maximum	Conditions	Status
0^o C	$+40^o$ C	Indoors	**open**
-20^o C	$+55^o$ C	Outdoors	**open**
-15^o C	$+55^o$ C	Portable Equipment	**open**

Table 18. Operating temperature Range

4.9.5 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.

4.9.6 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.

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. <u>NOTE:</u> 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