MULTIBAND OFDM
PHYSICAL LAYER SPECIFICATION

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Making High-Speed Wireless A Reality ...

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Final Deliverable

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1. INTRODUCTION

This standard specifies an ultra wideband (UWB) physical layer (PHY) for a wireless personal area network (PAN), utilizing the unlicensed 3100 - 10600 MHz frequency band, supporting data rates of 53.3, 80, 106.7, 160, 200, 320, 400, and 480 Mb/s. Support for transmitting and receiving data rates of 53.3, 106.7, and 200 Mb/s shall be mandatory.

The UWB spectrum is divided into 14 bands, each with a bandwidth of 528 MHz. The first 12 bands are then grouped into 4 band groups consisting of 3 bands, and the last two bands are grouped into a fifth band group. Support for the first band group (lowest three frequency bands) shall be mandatory.

This standard specifies a MultiBand Orthogonal Frequency Division Modulation (MB-OFDM) scheme to transmit information. A total of 110 sub-carriers (100 data carriers and 10 guard carriers) are used per band to transmit the information. In addition, 12 pilot sub-carriers allow for coherent detection. Frequency-domain spreading, time-domain spreading, and forward error correction (FEC) coding are used to vary the data rates. The FEC used is a convolutional code with coding rates of 1/3, 1/2, 5/8 and 3/4.

The coded data is then spread using a time-frequency code (TFC). This standard specifies two types of time-frequency codes (TFCs): one where the coded information is interleaved over three bands, referred to as Time-Frequency Interleaving (TFI); and, one where the coded information is transmitted on a single band, referred to as Fixed Frequency Interleaving (FFI). Support for both TFI and FFI shall be mandatory.

Within each of the first four band groups, four time-frequency codes using TFI and three time-frequency codes using FFI are defined; thereby, providing support for up to seven channels per band. For the fifth band group, two time-frequency codes using FFI are defined. This standard specifies 30 channels in total.

2. Notational Conventions

The use of the word *shall* is meant to indicate a requirement which is mandated by the standard, i.e. it is required to implement that particular feature with no deviation in order to conform to the standard. The use of the word *should* is meant to recommend one particular course of action over several other possibilities, however without mentioning or excluding these others. The use of the word *may* is meant to indicate that a particular course of action is permitted. The use of the word *can* is synonymous with is able to – it is meant to indicate a capability or a possibility.

All floating-point values have been rounded to 4 decimal places.

3. ABBREVIATIONS AND ACRONYMS

BER	Bit Error Rate
BM	Burst Mode
CCA	Clear Channel Assessment
CRC	Cyclic Redundancy Code
DAC	Digital-to-Analog Converter
DCM	Dual Carrier Modulation
EIRP	Equivalent Isotropically Radiated Power
FCS	Frame Check Sequence
FDS	Frequency-Domain Spreading
FEC	Forward Error Correction
FER	Frame Error Rate
FFI	Fixed-Frequency Interleaving
FFT	Fast Fourier Transform
GF	Galois Field
HCS	Header Check Sequence
IDFT	Inverse Discrete Fourier Transform
IFFT	Inverse Fast Fourier Transform
LSB	Least Significant Bit
MAC	Medium Access Control
MIB	Management Information Base
MIFS	Minimum Interframe Spacing
MLME	MAC Layer Management Entity
MMDU	MAC Management Protocol Data Unit
MPDU	MAC Protocol Data Unit
MSB	Most Significant Bit
OFDM	Orthogonal Frequency Division Modulation
PAN	Personal Area Network
PER	Packet Error Rate
PDU	Protocol Data Unit
PHY	Physical (layer)
PHY-SAP	Physical Layer Service Access Point
PLCP	Physical Layer Convergence Protocol
PLME	Physical Layer Management Entity
PMD	Physical Medium Dependent
PMD-SAP	Physical Medium Dependent-Service Access Point
PPDU	PLCP Protocol Data Unit

PPM	Parts per Million
PRBS	Pseudo-Random Binary Sequence
PSD	Power Spectral Density
PSDU	PLCP Service Data Unit
PT	Preamble Type
QPSK	Quadrature Phase Shift Keying
RF	Radio Frequency
RS	Reed-Solomon
RSSI	Received Signal Strength Indicator
RX	Receive or Receiver
SAP	Service Access Point
SDU	Service Data Unit
SIFS	Short Interframe Spacing
SME	Station Management Entity
TDS	Time-Domain Spreading
TF	Time-Frequency
TFC	Time-Frequency Code
TFI	Time-Frequency Interleaving
TX	Transmit or Transmitter
UWB	Ultra Wideband
WPAN	Wireless Personal Area Network
ZPS	Zero Padded Suffix

4. PHY LAYER PARTITIONING

This subsection describes the PHY services provided to the MAC. The PHY layer consists of two protocol functions:

1. A PHY convergence function, which adapts the capabilities of the physical medium dependent (PMD) device to the PHY service. This function is supported by the physical layer convergence protocol (PLCP), which defines a method of mapping the PLCP service data units (PSDU) into a framing format suitable for sending and receiving user data and management information between two or more stations using the associated PMD device.
1. A PMD device whose function defines the characteristics and method of transmitting and receiving data through a wireless medium between two or more stations, each using the PHY.

4.1 PHY Function

The PHY contains three functional entities: the PMD function, the PHY convergence function, and the layer management function. The PHY service is provided to the MAC through the PHY service primitives.

4.2 PLCP Sublayer

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

4.3 PMD Sublayer

The PMD sublayer provides a means to send and receive data between two or more stations.

4.4 PHY Layer Management Entity (PLME)

The PLME performs management of the local PHY functions in conjunction with the MAC management entity.

5. Description of Signal

5.1 Mathematical Framework

The transmitted RF signal can be written in terms of the complex baseband signal as follows:

$$s_{RF}(t) = \mathrm{Re}\left\{ \sum_{n=0}^{N_{packet}-1} s_n(t - nT_{SYM}) \exp(j2\pi f_c(q(n))t) \right\}, \tag{5-1}$$

where $\mathrm{Re}(\cdot)$ represents the real part of the signal, T_{SYM} is the symbol length, N_{packet} is the number of symbols in the packet, $f_c(m)$ is the center frequency for the m^{th} frequency band, $q(n)$ is a function that maps the n^{th} symbol to the appropriate frequency band and $s_n(t)$ is the complex baseband signal representation for the n^{th} symbol, which must satisfy the following property: $s_n(t) = 0$ for $t \notin [0, T_{SYM})$. The exact structure of the n^{th} symbol depends on its location within the packet:

$$s_n(t) = \begin{cases} s_{sync,n}(t) & 0 \le n < N_{sync} \\ s_{hdr,n-N_{sync}}(t) & N_{sync} \le n < N_{sync} + N_{hdr} \\ s_{frame,n-N_{sync}-N_{hdr}}(t) & N_{sync} + N_{hdr} \le n < N_{packet} \end{cases}, \tag{5-2}$$

where $s_{sync,n}(t)$ describes the n^{th} symbol of the preamble, $s_{hdr,n}(t)$ describes the n^{th} symbol of the header, $s_{frame,n}(t)$ describes the n^{th} symbol of the PSDU, N_{sync} is the number of symbols in the preamble, N_{hdr} is the number of symbols contained in the header and $N_{packet} = N_{frame} + N_{sync} + N_{hdr}$ is the number of symbols in the payload. The exact values of N_{sync}, N_{hdr}, N_{frame}, and N_{packet} will be described in more detail in Section 6.

The potentially complex time-domain signal $s_n(t)$ shall be created by passing the real and imaginary components of the discrete-time signal $s_n[k]$ through digital-to-analog converters (DACs) and anti-alias filters as shown in Fig. 5-1. When the discrete-time signal $s_n[k]$ is real, only the real digital-to-analog converter and anti-aliasing filter need to be used. Section 6 describes how to generate $s_n[k]$.

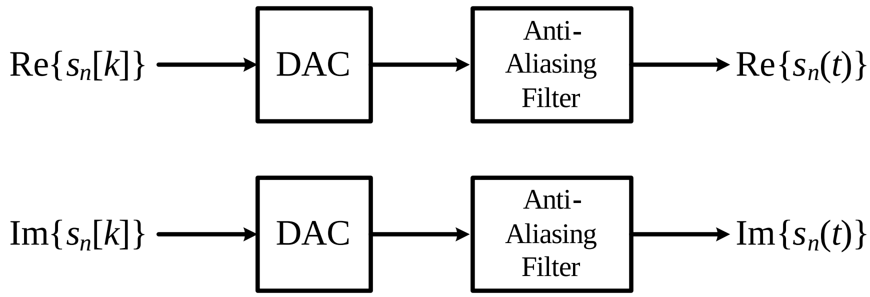

Fig. 5-1. Conversion from discrete-time signals to continuous-time signals

Fig. 5-2 shows one realization of the transmitted RF signal using three frequency bands, where the first symbol is transmitted on a center frequency of 3432 MHz, the second symbol is transmitted on a center frequency of 3960 MHz, the third symbol is transmitted on a center frequency of 4488 MHz, the fourth symbol is transmitted on a center frequency of 3432 MHz and so on. In addition, it is apparent from Fig. 5-2 that the symbol is created by appending a zero-padded suffix (ZPS) to the IFFT output, or equivalently, to the OFDM symbol. The zero-padded suffix serves two purposes: it provides a mechanism to mitigate the effects of multi-path; and, it provides a time window (a guard interval) to allow sufficient time for the transmitter and receiver to switch between the different center frequencies.

Editor's Note: A symbol is defined as an OFDM symbol (IFFT output) plus a zero-padded suffix.

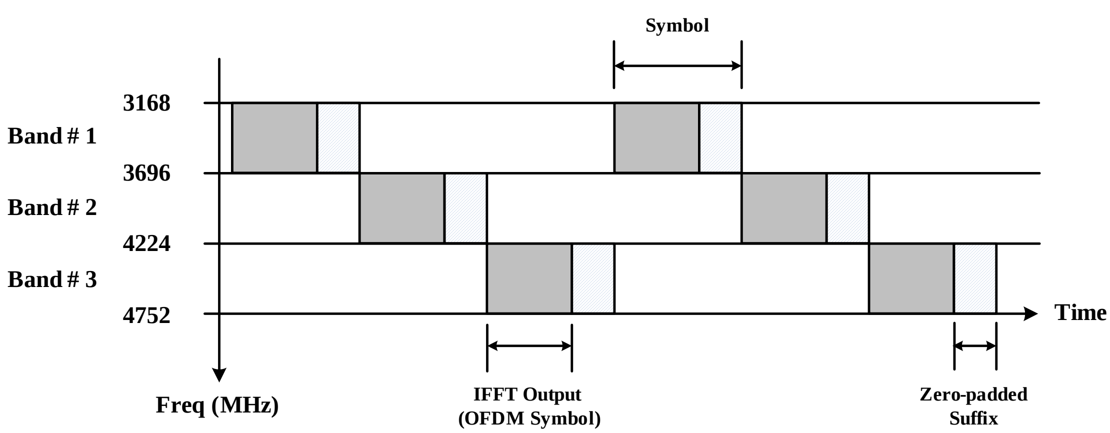

Fig. 5-2. Example realization of a transmitted RF signal using three bands.

6. PLCP SUBLAYER

This clause provides a method for converting a PSDU into a PPDU. During the transmission, the PSDU shall be pre-appended with a PLCP preamble and a PLCP header in order to create the PPDU. At the receiver, the PLCP preamble and PLCP header serve as aids in the demodulation, decoding, and delivery of the PSDU.

6.1 PPDU

Fig. 6-1 shows the format for the PPDU, which is composed of three major components: the PLCP preamble, the PLCP header and the PSDU. The components are listed in the order of transmission. The PLCP preamble is the first component of the PPDU and can be further decomposed into a packet/frame synchronization sequence, and a channel estimation sequence (see Section 6.2). The goal of the PLCP preamble is to aid the receiver in timing synchronization, carrier-offset recovery and channel estimation.

The PLCP header is the second major component of the PPDU. The goal of this component is to convey necessary information about both the PHY and the MAC to aid in decoding of the PSDU at the receiver. The PLCP header can be further decomposed into a PHY header, MAC header, header check sequence (HCS), tail bits and Reed-Solomon parity bits (see Section 6.3). Tail bits are added between the PHY header and MAC header, HCS and Reed-Solomon parity bits, and at the end of the PLCP header in order to return the convolutional encoder to the “zero state”. The Reed-Solomon parity bits are added in order to improve the robustness of the PLCP header.

The PSDU is the last major component of the PPDU (see Section 6.4). This major component is formed by concatenating the frame payload with the frame check sequence (FCS), tail bits and finally pad bits, which are inserted in order to align the data stream on the boundary of the symbol interleaver.

When transmitting the packet, the PLCP preamble is sent first, followed by the PLCP header and finally by the PSDU. As shown in Fig. 6-1, the PLCP header is always sent at a data rate of 39.4 Mb/s, while the PSDU is sent at the desired data rate of 53.3, 80, 106.7, 160, 200, 320, 400 or 480 Mb/s.

Editor’s Note: The least significant bit (LSB) of an octet shall be the first bit transmitted.

6.1.1 PSDU RATE-dependent parameters

The PSDU data rate-dependent modulation parameters are listed in Table 6-1.

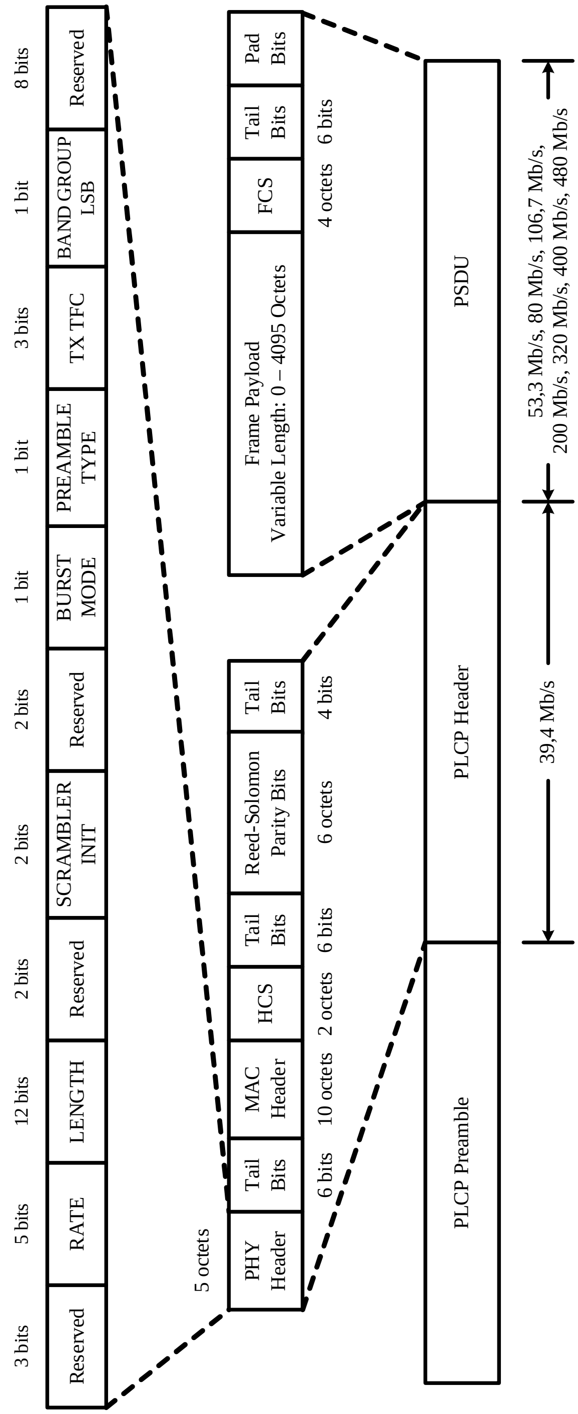

Fig. 6-1. Standard PPDU structure

TABLE 6-1. PSDU rate-dependent parameters

Data Rate (Mb/s)	Modulation	Coding Rate (R)	FDS	TDS	Coded Bits / 6 OFDM Symbol (N_{CBP6S})	Info Bits / 6 OFDM Symbol (N_{IBP6S})
53.3	QPSK	1/3	YES	YES	300	100
80	QPSK	1/2	YES	YES	300	150
106.7	QPSK	1/3	NO	YES	600	200
160	QPSK	1/2	NO	YES	600	300
200	QPSK	5/8	NO	YES	600	375
320	DCM	1/2	NO	NO	1200	600
400	DCM	5/8	NO	NO	1200	750
480	DCM	3/4	NO	NO	1200	900

6.1.2 Timing-related parameters

The timing parameters associated with the OFDM PHY are listed in Table 6-2.

TABLE 6-2. Timing-related parameters

Parameter	Description	Value
f_s	Sampling frequency	528 MHz
N_{FFT}	Total number of subcarriers (FFT size)	128
N_D	Number of data subcarriers	100
N_P	Number of pilot subcarriers	12
N_G	Number of guard subcarriers	10
N_T	Total number of subcarriers used	122 (= $N_D + N_P + N_G$)
Δ_f	Subcarrier frequency spacing	4.125 MHz (= f_s / N_{FFT})
T_{FFT}	IFFT and FFT period	242.42 ns (Δ_f^{-1})
N_{ZPS}	Number of samples in zero-padded suffix	37
T_{ZPS}	Zero-padded suffix duration in time	70.08 ns (= N_{ZPS} / f_s)
T_{SYM}	Symbol interval	312.5 ns (= $T_{FFT} + T_{ZPS}$)
F_{SYM}	Symbol rate	3.2 MHz (= T_{SYM}^{-1})
N_{SYM}	Total number of samples per symbol	165 (= $N_{FFT} + N_{ZPS}$)

6.1.3 Frame-related parameters

The frame parameters associated with the PHY are listed in Table 6-3, where $\lceil\cdot\rceil$ is the ceiling function, which returns the smallest integer value greater than or equal to its argument.

TABLE 6-3. Frame-related parameters

Parameter	Description	Value
N_{pf}	Number of symbols in the packet/frame synchronization sequence	Standard Preamble: 24 Burst Preamble: 12
T_{pf}	Duration of the packet/frame synchronization sequence	Standard Preamble: 7.5 µs Burst Preamble: 3.75 µs
N_{ce}	Number of symbols in the channel estimation sequence	6
T_{ce}	Duration of the channel estimation sequence	1.875 µs
N_{sync}	Number of symbols in the PLCP Preamble	Standard Preamble: 30 Burst Preamble: 18
T_{sync}	Duration of the PLCP Preamble	Standard Preamble: 9.375 µs Burst Preamble: 5.625 µs
N_{hdr}	Number of symbols in the PLCP Header	12
T_{hdr}	Duration of the PLCP Header	3.75 µs
N_{frame}	Number of symbols in the PSDU	$6 \times \left\lceil \frac{8 \times \text{LENGTH} + 38}{N_{IBP6S}} \right\rceil$
T_{frame}	Duration for the PSDU	$6 \times \left\lceil \frac{8 \times \text{LENGTH} + 38}{N_{IBP6S}} \right\rceil \times T_{SYM}$
N_{packet}	Total number of symbols in the packet	$N_{sync} + N_{hdr} + N_{frame}$
T_{packet}	Duration of the packet	$(N_{sync} + N_{hdr} + N_{frame}) \times T_{SYM}$

6.2 PLCP Preamble

A PLCP preamble shall be added prior to the PLCP header to aid the receiver in timing synchronization, carrier-offset recovery, and channel estimation. In this section both a standard PLCP preamble and a burst PLCP preamble are defined. A unique preamble sequence shall be assigned to each time-frequency code (TFC).

The preamble is defined to be a real baseband signal. For the lowest data rate modes (53.3 and 80 Mb/s), the data type of the preamble is the same as the payload, i.e. both signals are real. For the higher data rate modes (106.7 Mb/s and higher), the preamble shall be inserted into the real portion of the complex baseband signal. The PLCP preamble consists of two portions: a time-domain portion (packet ⁄ frame synchronization sequence) followed by a frequency-domain portion (channel estimation sequence).

In this section two preambles are defined: a standard PLCP preamble and a burst PLCP preamble. The burst preamble shall only be used in the streaming mode when a burst of packets is transmitted, separated by a minimum inter-frame separation time (pMIFSTime). For data rates of 200 Mb/s and lower, all the packets in the burst shall use the standard PLCP preamble. However, for data rates higher than 200 Mb/s, the first packet shall use the standard PLCP preamble, while the remaining packets may use either the standard PLCP preamble or the burst PLCP preamble. Support for reception of burst PLCP preamble is mandatory for all supported data rates above 200Mbps. The preamble type (PT) bit in the PHY header (see Section 6.3.1.5) describes the type of preamble that shall be used in the next packet.

6.2.1 Standard PLCP Preamble

Fig. 6-2 shows the structure of the standard PLCP preamble. The preamble can be sub-divided into two distinct portions: a packet/frame synchronization sequence and a channel estimation sequence. The packet/frame synchronization sequence shall be constructed as shown in Fig. 6-3:

1. For a given time-frequency code, select the appropriate base time-domain sequence $s_{base}[l]$ from Table 6-4 through Table 6-10 and the appropriate standard cover sequence $s_{cover}[m]$ from Table 6-11.
2. Form an extended time-domain sequence $s_{ext}[l]$ by appending N_{ZPS} “zero samples” to the length N_{FFT} sequence $s_{base}[l]$.
3. The k^{th} sample of the n^{th} symbol in the standard preamble $s_{sync,n}[k]$, corresponding to the packet/frame synchronization sequence, is given by:

$$s_{sync,n}[k] = s_{cover}[n] \times s_{ext}[k], \tag{6-1}$$

where $n \in [0, N_{pf} - 1]$, $k \in [0, N_{SYM} - 1]$, N_{pf} is defined in Table 6-3 and N_{SYM} is defined in Table 6-2.

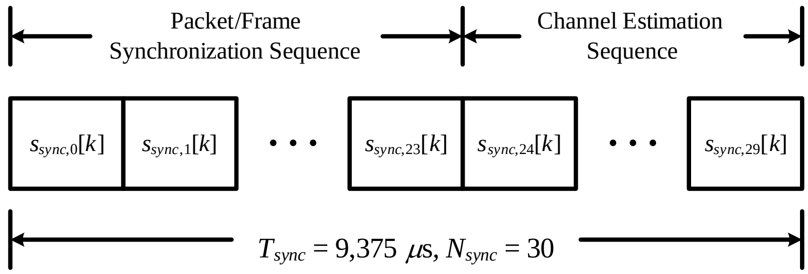

Fig. 6-2. Block diagram of the standard PLCP preamble

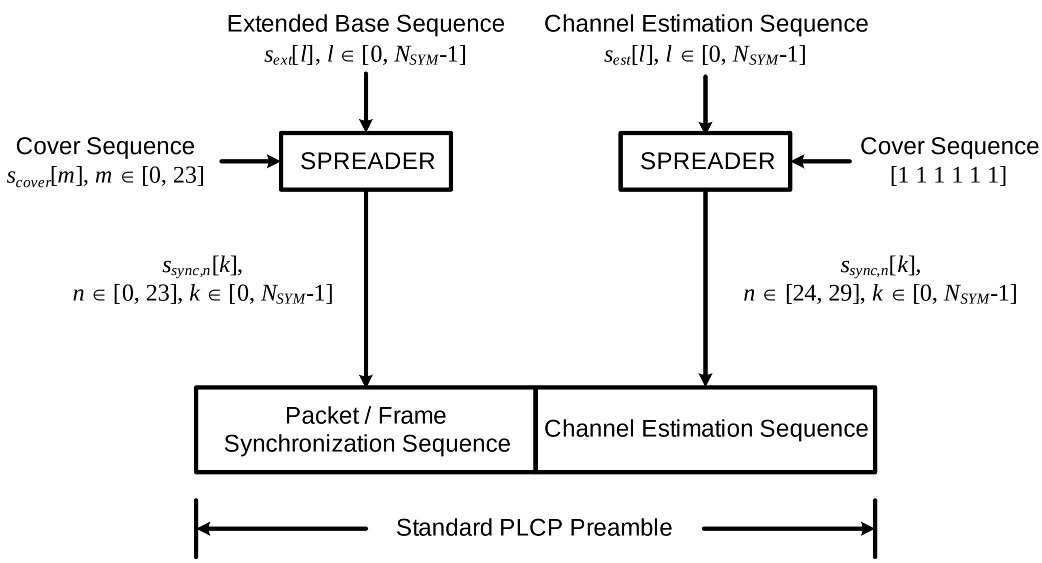

Fig. 6-3. Block diagram of standard PLCP preamble construction

The channel estimation sequence shall also be constructed as shown in Fig. 6-3. A base channel estimation sequence $s_{est}[l]$ is created by taking the inverse discrete Fourier transform (IDFT) of the frequency-domain sequence defined in Table 6-13, and appending a zero-padded suffix consisting of N_{ZPS} “zero samples” to the resulting time-domain output. The channel estimation sequence portion of the standard preamble is created by successively appending N_{ce} periods of the base estimation sequence, or equivalently, spreading the base channel estimation sequence with a sequence of $[1\ 1\ 1\ 1\ 1\ 1]$. Mathematically, the channel estimation sequence portion of the standard preamble can be written as:

$$s_{sync,n}[k] = s_{est}[k], \tag{6-2}$$

where $n \in [N_{pf}, N_{sync} - 1]$, $k \in [0, N_{SYM} - 1]$, N_{pf} is defined in Table 6-3 and N_{SYM} is defined in Table 6-2.

Editor's Note: The packet/frame synchronization sequence can be used for packet acquisition and detection, coarse carrier frequency estimation, coarse symbol timing, and for synchronization within the preamble. Whereas, the channel estimation sequence can be used for estimation of the channel frequency response, fine carrier frequency estimation, and fine symbol timing. The first sample of the first channel estimation symbol, $s_{sync,\,N_{pf}}[0]$ *, should be used as the timing reference point for range measurements, as described in Section 10*.

Editor's Note: The time-domain sequences in Table 6-4 through Table 6-10 and *the frequency-domain channel estimation sequence defined in* Table 6-13 *should be normalized (as needed) to ensure that these sequences have the same average power as the PLCP header and the PSDU.*

6.2.2 Burst PLCP Preamble

The burst PLCP preamble, which is shown in Fig. 6-4, is similar in structure to the standard PLCP preamble. This preamble can also be sub-divided into two distinct portions: a packet/frame synchronization sequence and a channel estimation sequence. The packet/frame synchronization sequence shall be constructed as shown in Fig. 6-5:

1. For a given time-frequency code, select the appropriate base time-domain sequence $s_{base}[l]$ from Table 6-4 through Table 6-10 and the appropriate burst cover sequence $s_{cover}[m]$ from Table 6-12.
2. Form an extended time-domain sequence $s_{ext}[l]$ by appending N_{ZPS} "zero samples" to the length N_{FFT} sequence $s_{base}[l]$.
3. The k^{th} sample of the n^{th} symbol in the burst preamble $s_{sync,n}[k]$, corresponding to the packet/frame synchronization sequence, is given by:

$$s_{sync,n}[k] = s_{cover}[n] \times s_{ext}[k], \tag{6-3}$$

where $n \in [0, N_{pf} - 1]$, $k \in [0, N_{SYM} - 1]$, N_{pf} is defined in Table 6-3 and N_{SYM} is defined in Table 6-2.

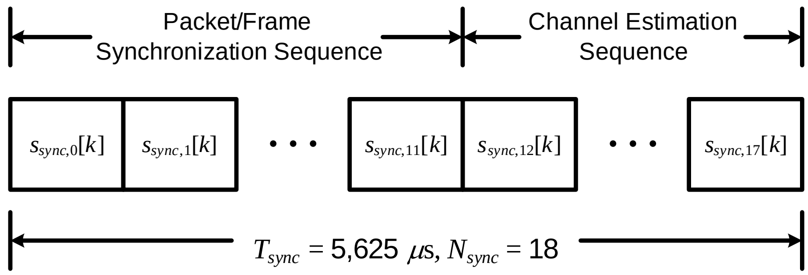

Fig. 6-4. Block diagram of the burst PLCP preamble

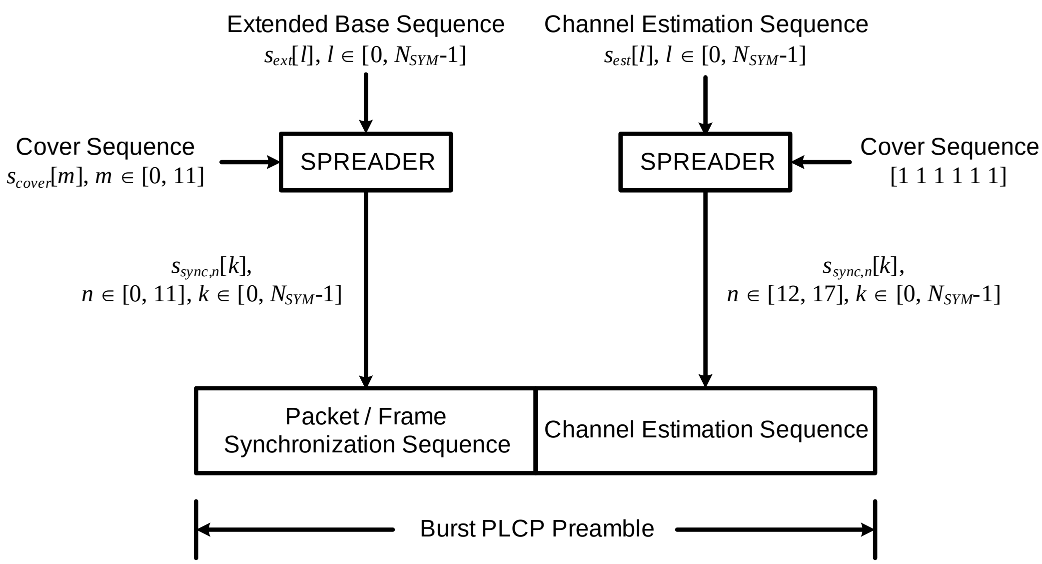

Fig. 6-5. Blo

The construction method used to create the channel estimation sequence portion of the burst preamble is identical to the method used to construct the channel estimation sequence portion of the standard preamble. Mathematically, the channel estimation sequence portion of the burst preamble can be written as:

$$s_{sync,n}[k] = s_{est}[k], \qquad (6\text{-}4)$$

where $n \in [N_{pf}, N_{sync} - 1]$, $k \in [0, N_{SYM} - 1]$, N_{pf} is defined in Table 6-3 and N_{SYM} is defined in Table 6-2.

TABLE 6-4. Base time-domain sequence for TF code 1

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	0.6564	32	-0.0844	64	-0.2095	96	0.4232
1	-1.3671	33	1.1974	65	1.1640	97	-1.2684
2	-0.9958	34	1.2261	66	1.2334	98	-1.8151
3	-1.3981	35	1.4401	67	1.5338	99	-1.4829
4	0.8481	36	-0.5988	68	-0.8844	100	1.0302
5	1.0892	37	-0.4675	69	-0.3857	101	0.9419
6	-0.8621	38	0.8520	70	0.7730	102	-1.1472
7	1.1512	39	-0.8922	71	-0.9754	103	1.4858
8	0.9602	40	-0.5603	72	-0.2315	104	-0.6794
9	-1.3581	41	1.1886	73	0.5579	105	0.9573
10	-0.8354	42	1.1128	74	0.4035	106	1.0807
11	-1.3249	43	1.0833	75	0.4248	107	1.1445
12	1.0964	44	-0.9073	76	-0.3359	108	-1.2312
13	1.3334	45	-1.6227	77	-0.9914	109	-0.6643
14	-0.7378	46	1.0013	78	0.5975	110	0.3836
15	1.3565	47	-1.6067	79	-0.8408	111	-1.1482
16	0.9361	48	0.3360	80	0.3587	112	-0.0353
17	-0.8212	49	-1.3136	81	-0.9604	113	-0.6747
18	-0.2662	50	-1.4447	82	-1.0002	114	-1.1653
19	-0.6866	51	-1.7238	83	-1.1636	115	-0.8896
20	0.8437	52	1.0287	84	0.9590	116	0.2414
21	1.1237	53	0.6100	85	0.7137	117	0.1160
22	-0.3265	54	-0.9237	86	-0.6776	118	-0.6987
23	1.0511	55	1.2618	87	0.9824	119	0.4781
24	0.7927	56	0.5974	88	-0.5454	120	0.1821
25	-0.3363	57	-1.0976	89	1.1022	121	-1.0672
26	-0.1342	58	-0.9776	90	1.6485	122	-0.9676
27	-0.1546	59	-0.9982	91	1.3307	123	-1.2321
28	0.6955	60	0.8967	92	-1.2852	124	0.5003
29	1.0608	61	1.7640	93	-1.2659	125	0.7419
30	-0.1600	62	-1.0211	94	0.9435	126	-0.8934
31	0.9442	63	1.6913	95	-1.6809	127	0.8391

TABLE 6-5. Base time-domain sequence for TF code 2

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	0.9679	32	-1.2905	64	1.5280	96	0.5193
1	-1.0186	33	1.1040	65	-0.9193	97	-0.3439
2	0.4883	34	-1.2408	66	1.1246	98	0.1428
3	0.5432	35	-0.8062	67	1.2622	99	0.6251
4	-1.4702	36	1.5425	68	-1.4406	100	-1.0468
5	-1.4507	37	1.0955	69	-1.4929	101	-0.5798
6	-1.1752	38	1.4284	70	-1.1508	102	-0.8237
7	-0.0730	39	-0.4593	71	0.4126	103	0.2667
8	-1.2445	40	-1.0408	72	-1.0462	104	-0.9564
9	0.3143	41	1.0542	73	0.7232	105	0.6016
10	-1.3951	42	-0.4446	74	-1.1574	106	-0.9964
11	-0.9694	43	-0.7929	75	-0.7102	107	-0.3541
12	0.4563	44	1.6733	76	0.8502	108	0.3965
13	0.3073	45	1.7568	77	0.6260	109	0.5201
14	0.6408	46	1.3273	78	0.9530	110	0.4733
15	-0.9798	47	-0.2465	79	-0.4971	111	-0.2362
16	-1.4116	48	1.6850	80	-0.8633	112	-0.6892
17	0.6038	49	-0.7091	81	0.6910	113	0.4787
18	-1.3860	50	1.1396	82	-0.3639	114	-0.2605
19	-1.0888	51	1.5114	83	-0.8874	115	-0.5887
20	1.1036	52	-1.4343	84	1.5311	116	0.9411
21	0.7067	53	-1.5005	85	1.1546	117	0.7364
22	1.1667	54	-1.2572	86	1.1935	118	0.6714
23	-1.0225	55	0.8274	87	-0.2930	119	-0.1746
24	-1.2471	56	-1.5140	88	1.3285	120	1.1776
25	0.7788	57	1.1421	89	-0.7231	121	-0.8803
26	-1.2716	58	-1.0135	90	1.2832	122	1.2542
27	-0.8745	59	-1.0657	91	0.7878	123	0.5111
28	1.2175	60	1.4073	92	-0.8095	124	-0.8209
29	0.8419	61	1.8196	93	-0.7463	125	-0.8975
30	1.2881	62	1.1679	94	-0.8973	126	-0.9091
31	-0.8210	63	-0.4131	95	0.5560	127	0.2562

TABLE 6-6. Base time-domain sequence for TF code 3

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	0.4047	32	-0.9671	64	-0.7298	96	0.2424
1	0.5799	33	-0.9819	65	-0.9662	97	0.5703
2	-0.3407	34	0.7980	66	0.9694	98	-0.6381
3	0.4343	35	-0.8158	67	-0.8053	99	0.7861
4	0.0973	36	-0.9188	68	-0.9052	100	0.9175
5	-0.7637	37	1.5146	69	1.5933	101	-0.4595
6	-0.6181	38	0.8138	70	0.8418	102	-0.2201
7	-0.6539	39	1.3773	71	1.5363	103	-0.7755
8	0.3768	40	0.2108	72	0.3085	104	-0.2965
9	0.7241	41	0.9245	73	1.3016	105	-1.1220
10	-1.2095	42	-1.2138	74	-1.5546	106	1.7152
11	0.6027	43	1.1252	75	1.5347	107	-1.2756
12	0.4587	44	0.9663	76	1.0935	108	-0.7731
13	-1.3879	45	-0.8418	77	-0.8978	109	1.0724
14	-1.0592	46	-0.6811	78	-0.9712	110	1.1733
15	-1.4052	47	-1.3003	79	-1.3763	111	1.4711
16	-0.8439	48	-0.3397	80	-0.6360	112	0.4881
17	-1.5992	49	-1.1051	81	-1.2947	113	0.7528
18	1.1975	50	1.2400	82	1.6436	114	-0.6417
19	-1.9525	51	-1.3975	83	-1.6564	115	1.0363
20	-1.5141	52	-0.7467	84	-1.1981	116	0.8002
21	0.7219	53	0.2706	85	0.8719	117	-0.0077
22	0.6982	54	0.7294	86	0.9992	118	-0.2336
23	1.2924	55	0.7444	87	1.4872	119	-0.4653
24	-0.9460	56	-0.3970	88	-0.4586	120	0.6862
25	-1.2407	57	-1.0718	89	-0.8404	121	1.2716
26	0.4572	58	0.6646	90	0.6982	122	-0.8880
27	-1.2151	59	-1.1037	91	-0.7959	123	1.4011
28	-0.9869	60	-0.5716	92	-0.5692	124	0.9531
29	1.2792	61	0.9001	93	1.3528	125	-1.1210
30	0.6882	62	0.7317	94	0.9536	126	-0.9489
31	1.2586	63	0.9846	95	1.1784	127	-1.2566

TABLE 6-7. Base time-domain sequence for TF code 4

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	1.1549	32	-1.2385	64	1.3095	96	-1.0094
1	1.0079	33	-0.7883	65	0.6675	97	-0.7598
2	0.7356	34	-0.7954	66	1.2587	98	-1.0786
3	-0.7434	35	1.0874	67	-0.9993	99	0.6699
4	-1.3930	36	1.1491	68	-1.0052	100	0.9813
5	1.2818	37	-1.4780	69	0.6601	101	-0.5563
6	-1.1033	38	0.8870	70	-1.0228	102	1.0548
7	-0.2523	39	0.4694	71	-0.7489	103	0.8925
8	-0.7905	40	1.5066	72	0.5086	104	-1.3656
9	-0.4261	41	1.1266	73	0.1563	105	-0.8472
10	-0.9390	42	0.9935	74	0.0673	106	-1.3110
11	0.4345	43	-1.2462	75	-0.8375	107	1.1897
12	0.4433	44	-1.7869	76	-1.0746	108	1.5127
13	-0.3076	45	1.7462	77	0.4454	109	-0.7474
14	0.5644	46	-1.4881	78	-0.7831	110	1.4678
15	0.2571	47	-0.4090	79	-0.3623	111	1.0295
16	-1.0030	48	-1.4694	80	-1.3658	112	-0.9210
17	-0.7820	49	-0.7923	81	-1.0854	113	-0.4784
18	-0.4064	50	-1.4607	82	-1.4923	114	-0.5022
19	0.9035	51	0.9113	83	0.4233	115	1.2153
20	1.5406	52	0.8454	84	0.6741	116	1.5783
21	-1.4613	53	-0.8866	85	-1.0157	117	-0.7718
22	1.2745	54	0.8852	86	0.8304	118	1.2384
23	0.3715	55	0.4918	87	0.4878	119	0.6695
24	1.8134	56	-0.6096	88	-1.4992	120	0.8821
25	0.9438	57	-0.4322	89	-1.1884	121	0.7808
26	1.3130	58	-0.1327	90	-1.4008	122	1.0537
27	-1.3070	59	0.4953	91	0.7795	123	-0.0791
28	-1.3462	60	0.9702	92	1.2926	124	-0.2845
29	1.6868	61	-0.8667	93	-1.2049	125	0.5790
30	-1.2153	62	0.6803	94	1.2934	126	-0.4664
31	-0.6778	63	-0.0244	95	0.8123	127	-0.1097

TABLE 6-8. Base time-domain sequence for TF code 5

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	0.9574	32	0.8400	64	0.5859	96	-0.8528
1	0.5270	33	1.3980	65	0.3053	97	-0.6973
2	1.5929	34	1.1147	66	0.8948	98	-1.2477
3	-0.2500	35	-0.4732	67	-0.6744	99	0.6246
4	-0.2536	36	-1.7178	68	-0.8901	100	0.7687
5	-0.3023	37	-0.8477	69	-0.8133	101	0.7966
6	1.2907	38	1.5083	70	0.9201	102	-1.2809
7	-0.4258	39	-1.4364	71	-1.0841	103	1.1023
8	1.0012	40	0.3853	72	-0.8036	104	0.4250
9	1.7704	41	1.5673	73	-0.3105	105	-0.1614
10	0.8593	42	0.0295	74	-1.0514	106	0.7547
11	-0.3719	43	-0.4204	75	0.7644	107	-0.6696
12	-1.3465	44	-1.4856	76	0.7301	108	-0.3920
13	-0.7419	45	-0.8404	77	0.9788	109	-0.7589
14	1.5350	46	1.0111	78	-1.1305	110	0.6701
15	-1.2800	47	-1.4269	79	1.3257	111	-0.9381
16	0.6955	48	0.3033	80	0.7801	112	-0.7483
17	1.7204	49	0.7757	81	0.7867	113	-0.9659
18	0.1643	50	-0.1370	82	1.0996	114	-0.9192
19	-0.3347	51	-0.5250	83	-0.5623	115	0.3925
20	-1.7244	52	-1.1589	84	-1.2227	116	1.2864
21	-0.7447	53	-0.8324	85	-0.8223	117	0.6784
22	1.1141	54	0.6336	86	1.2074	118	-1.0909
23	-1.3541	55	-1.2698	87	-1.2338	119	1.1140
24	-0.7293	56	-0.7853	88	0.2957	120	-0.6134
25	0.2682	57	-0.7031	89	1.0999	121	-1.5467
26	-1.2401	58	-1.1106	90	-0.0201	122	-0.3031
27	1.0527	59	0.6071	91	-0.5860	123	0.9457
28	0.1199	60	0.7164	92	-1.2284	124	1.9645
29	1.1496	61	0.8305	93	-0.9215	125	1.4549
30	-1.0544	62	-1.2355	94	0.7941	126	-1.2760
31	1.3176	63	1.1754	95	-1.4128	127	2.2102

TABLE 6-9. Base time-domain sequence for TF code 6

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	1.2947	32	-0.9973	64	1.0703	96	0.9516
1	-0.8188	33	0.8548	65	-0.8625	97	-1.2593
2	0.9007	34	-0.6963	66	0.6986	98	0.4594
3	0.7786	35	-0.6874	67	1.0989	99	1.3038
4	0.6301	36	-0.5015	68	0.4600	100	0.1090
5	-0.1283	37	0.7003	69	-0.6559	101	-0.5082
6	-0.7972	38	0.3582	70	-0.6087	102	-1.8181
7	-0.3897	39	0.5772	71	-0.4206	103	-0.7747
8	1.1794	40	0.7421	72	-0.8454	104	0.7678
9	-1.2592	41	-0.6766	73	1.0317	105	-1.5342
10	0.8136	42	0.6242	74	-0.7624	106	0.4914
11	0.8872	43	0.4241	75	0.0619	107	0.7197
12	0.5797	44	0.5891	76	-0.7311	108	0.3353
13	-1.2304	45	-0.9045	77	1.3634	109	-1.5832
14	-0.5628	46	0.1625	78	-0.1379	110	-0.9947
15	-0.8272	47	-0.5105	79	0.8401	111	-1.0329
16	-1.5418	48	-1.4187	80	1.6371	112	-1.9669
17	1.2804	49	1.5169	81	-1.0201	113	0.9946
18	-1.1524	50	-0.9580	82	0.9243	114	-1.3273
19	-0.9846	51	-1.1237	83	2.0931	115	-1.5572
20	-0.9178	52	-0.6782	84	0.4511	116	-0.8746
21	1.1834	53	1.3557	85	0.0768	117	0.0579
22	0.4293	54	1.0229	86	-1.7974	118	1.2269
23	0.9021	55	0.9490	87	-0.4685	119	0.4497
24	1.1152	56	1.6308	88	1.4727	120	-1.4751
25	-0.9828	57	-0.9325	89	-1.3387	121	1.3897
26	0.7891	58	1.1461	90	0.7779	122	-0.9922
27	0.9391	59	1.1675	91	2.0080	123	-1.2950
28	0.5944	60	0.8163	92	0.3026	124	-0.6839
29	-0.8376	61	-0.1551	93	-0.4263	125	1.2113
30	-0.5320	62	-0.8657	94	-1.9751	126	1.0559
31	-0.6335	63	-0.3696	95	-0.8421	127	0.8147

TABLE 6-10. Base time-domain sequence for TF code 7

l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$	l	$s_{base}[l]$
0	0.8147	32	-0.8421	64	-0.3696	96	-0.6335
1	1.0559	33	-1.9751	65	-0.8657	97	-0.5320
2	1.2113	34	-0.4263	66	-0.1551	98	-0.8376
3	-0.6839	35	0.3026	67	0.8163	99	0.5944
4	-1.2950	36	2.0080	68	1.1675	100	0.9391
5	-0.9922	37	0.7779	69	1.1461	101	0.7891
6	1.3897	38	-1.3387	70	-0.9325	102	-0.9828
7	-1.4751	39	1.4727	71	1.6308	103	1.1152
8	0.4497	40	-0.4685	72	0.9490	104	0.9021
9	1.2269	41	-1.7974	73	1.0229	105	0.4293
10	0.0579	42	0.0768	74	1.3557	106	1.1834
11	-0.8746	43	0.4511	75	-0.6782	107	-0.9178
12	-1.5572	44	2.0931	76	-1.1237	108	-0.9846
13	-1.3273	45	0.9243	77	-0.9580	109	-1.1524
14	0.9946	46	-1.0201	78	1.5169	110	1.2804
15	-1.9669	47	1.6371	79	-1.4187	111	-1.5418
16	-1.0329	48	0.8401	80	-0.5105	112	-0.8272
17	-0.9947	49	-0.1379	81	0.1625	113	-0.5628
18	-1.5832	50	1.3634	82	-0.9045	114	-1.2304
19	0.3353	51	-0.7311	83	0.5891	115	0.5797
20	0.7197	52	0.0619	84	0.4241	116	0.8872
21	0.4914	53	-0.7624	85	0.6242	117	0.8136
22	-1.5342	54	1.0317	86	-0.6766	118	-1.2592
23	0.7678	55	-0.8454	87	0.7421	119	1.1794
24	-0.7747	56	-0.4206	88	0.5772	120	-0.3897
25	-1.8181	57	-0.6087	89	0.3582	121	-0.7972
26	-0.5082	58	-0.6559	90	0.7003	122	-0.1283
27	0.1090	59	0.4600	91	-0.5015	123	0.6301
28	1.3038	60	1.0989	92	-0.6874	124	0.7786
29	0.4594	61	0.6986	93	-0.6963	125	0.9007
30	-1.2593	62	-0.8625	94	0.8548	126	-0.8188
31	0.9516	63	1.0703	95	-0.9973	127	1.2947

TABLE 6-11. Cover sequence for standard preamble

m	$s_{cover}[m]$ for TF codes 1,2	$s_{cover}[m]$ for TF codes 3,4	$s_{cover}[m]$ for TF codes 5,6,7
0	1	1	-1
1	1	1	-1
2	1	1	-1
3	1	1	-1
4	1	1	-1
5	1	1	-1
6	1	1	-1
7	1	1	1
8	1	1	-1
9	1	1	-1
10	1	1	1
11	1	1	-1
12	1	1	-1
13	1	1	1
14	1	1	-1
15	1	1	-1
16	1	1	1
17	1	1	-1
18	1	1	-1
19	1	-1	1
20	1	1	-1
21	-1	-1	1
22	-1	1	1
23	-1	-1	1

TABLE 6-12. Cover sequence for burst preamble

m	$s_{cover}[m]$ for TF codes 1,2	$s_{cover}[m]$ for TF codes 3,4	$s_{cover}[m]$ for TF codes 5,6,7
0	1	1	-1
1	1	1	-1
2	1	1	-1
3	1	1	1
4	1	1	1
5	1	1	-1
6	1	1	-1
7	1	-1	1
8	1	1	-1
9	-1	-1	1
10	-1	1	1
11	-1	-1	1

TABLE 6-13. Base frequency-domain channel estimation sequence

Tone	Value	Tone	Value	Tone	Value	Tone	Value
–61	$(-1+j)/\sqrt{2}$	–30	$(1-j)/\sqrt{2}$	1	$(1+j)/\sqrt{2}$	32	$(1+j)/\sqrt{2}$
–60	$(-1+j)/\sqrt{2}$	–29	$(-1+j)/\sqrt{2}$	2	$(1+j)/\sqrt{2}$	33	$(1+j)/\sqrt{2}$
–59	$(-1+j)/\sqrt{2}$	–28	$(-1+j)/\sqrt{2}$	3	$(-1-j)/\sqrt{2}$	34	$(-1-j)/\sqrt{2}$
–58	$(-1+j)/\sqrt{2}$	–27	$(1-j)/\sqrt{2}$	4	$(1+j)/\sqrt{2}$	35	$(-1-j)/\sqrt{2}$
–57	$(-1+j)/\sqrt{2}$	–26	$(1-j)/\sqrt{2}$	5	$(-1-j)/\sqrt{2}$	36	$(1+j)/\sqrt{2}$
–56	$(1-j)/\sqrt{2}$	–25	$(1-j)/\sqrt{2}$	6	$(-1-j)/\sqrt{2}$	37	$(-1-j)/\sqrt{2}$
–55	$(1-j)/\sqrt{2}$	–24	$(-1+j)/\sqrt{2}$	7	$(1+j)/\sqrt{2}$	38	$(1+j)/\sqrt{2}$
–54	$(-1+j)/\sqrt{2}$	–23	$(1-j)/\sqrt{2}$	8	$(-1-j)/\sqrt{2}$	39	$(1+j)/\sqrt{2}$
–53	$(1-j)/\sqrt{2}$	–22	$(1-j)/\sqrt{2}$	9	$(1+j)/\sqrt{2}$	40	$(1+j)/\sqrt{2}$
–52	$(1-j)/\sqrt{2}$	–21	$(1-j)/\sqrt{2}$	10	$(-1-j)/\sqrt{2}$	41	$(-1-j)/\sqrt{2}$
–51	$(1-j)/\sqrt{2}$	–20	$(-1+j)/\sqrt{2}$	11	$(1+j)/\sqrt{2}$	42	$(-1-j)/\sqrt{2}$
–50	$(1-j)/\sqrt{2}$	–19	$(1-j)/\sqrt{2}$	12	$(1+j)/\sqrt{2}$	43	$(1+j)/\sqrt{2}$
–49	$(1-j)/\sqrt{2}$	–18	$(-1+j)/\sqrt{2}$	13	$(-1-j)/\sqrt{2}$	44	$(1+j)/\sqrt{2}$
–48	$(-1+j)/\sqrt{2}$	–17	$(1-j)/\sqrt{2}$	14	$(-1-j)/\sqrt{2}$	45	$(-1-j)/\sqrt{2}$
–47	$(1-j)/\sqrt{2}$	–16	$(1-j)/\sqrt{2}$	15	$(-1-j)/\sqrt{2}$	46	$(-1-j)/\sqrt{2}$
–46	$(-1+j)/\sqrt{2}$	–15	$(-1+j)/\sqrt{2}$	16	$(1+j)/\sqrt{2}$	47	$(1+j)/\sqrt{2}$
–45	$(-1+j)/\sqrt{2}$	–14	$(-1+j)/\sqrt{2}$	17	$(1+j)/\sqrt{2}$	48	$(-1-j)/\sqrt{2}$
–44	$(1-j)/\sqrt{2}$	–13	$(-1+j)/\sqrt{2}$	18	$(-1-j)/\sqrt{2}$	49	$(1+j)/\sqrt{2}$
–43	$(1-j)/\sqrt{2}$	–12	$(1-j)/\sqrt{2}$	19	$(1+j)/\sqrt{2}$	50	$(1+j)/\sqrt{2}$
–42	$(-1+j)/\sqrt{2}$	–11	$(1-j)/\sqrt{2}$	20	$(-1-j)/\sqrt{2}$	51	$(1+j)/\sqrt{2}$
–41	$(-1+j)/\sqrt{2}$	–10	$(-1+j)/\sqrt{2}$	21	$(1+j)/\sqrt{2}$	52	$(1+j)/\sqrt{2}$
–40	$(1-j)/\sqrt{2}$	–9	$(1-j)/\sqrt{2}$	22	$(1+j)/\sqrt{2}$	53	$(1+j)/\sqrt{2}$
–39	$(1-j)/\sqrt{2}$	–8	$(-1+j)/\sqrt{2}$	23	$(1+j)/\sqrt{2}$	54	$(-1-j)/\sqrt{2}$
–38	$(1-j)/\sqrt{2}$	–7	$(1-j)/\sqrt{2}$	24	$(-1-j)/\sqrt{2}$	55	$(1+j)/\sqrt{2}$
–37	$(-1+j)/\sqrt{2}$	–6	$(-1+j)/\sqrt{2}$	25	$(1+j)/\sqrt{2}$	56	$(1+j)/\sqrt{2}$
–36	$(1-j)/\sqrt{2}$	–5	$(-1+j)/\sqrt{2}$	26	$(1+j)/\sqrt{2}$	57	$(-1-j)/\sqrt{2}$
–35	$(-1+j)/\sqrt{2}$	–4	$(1-j)/\sqrt{2}$	27	$(1+j)/\sqrt{2}$	58	$(-1-j)/\sqrt{2}$
–34	$(-1+j)/\sqrt{2}$	–3	$(-1+j)/\sqrt{2}$	28	$(-1-j)/\sqrt{2}$	59	$(-1-j)/\sqrt{2}$
–33	$(1-j)/\sqrt{2}$	–2	$(1-j)/\sqrt{2}$	29	$(-1-j)/\sqrt{2}$	60	$(-1-j)/\sqrt{2}$
–32	$(1-j)/\sqrt{2}$	–1	$(1-j)/\sqrt{2}$	30	$(1+j)/\sqrt{2}$	61	$(-1-j)/\sqrt{2}$
–31	$(1-j)/\sqrt{2}$			31	$(1+j)/\sqrt{2}$		

6.3 PLCP Header

A PLCP header shall be added after the PLCP preamble to convey information about both the PHY and the MAC that is needed at the receiver in order to successfully decode the PSDU. The scrambled and Reed-Solomon encoded PLCP header shall be formed as shown in Fig. 6-6:

1. Format the PHY header based on information provided by the MAC.
2. Calculate the HCS value (2 octets) over the combined PHY and MAC headers.
3. The resulting HCS value is appended to the MAC header. The resulting combination (MAC Header + HCS) is scrambled according to Section 6.5.
4. Apply a shortened Reed-Solomon code (23,17) to the concatenation of the PHY header (5 octets), scrambled MAC header and HCS (12 octets).
5. Insert 6 tail bits after the PHY header, 6 tail bits after the scrambled MAC header and HCS, and append the 6 parity octets and 4 tail bits at the end to form the scrambled and Reed-Solomon encoded PLCP header.

The resulting scrambled and Reed-Solomon encoded PLCP header is encoded, as shown in Fig. 6-7, using a $R = 1/3$, $K = 7$ convolutional code (see Section 6.7), interleaved using a bit interleaver (see Section 6.8), mapped onto a QPSK constellation (see Section 6.9) and finally, the resulting complex values are loaded onto the data subcarriers for the IDFT (see Section 6.10) in order to create the real baseband signal.

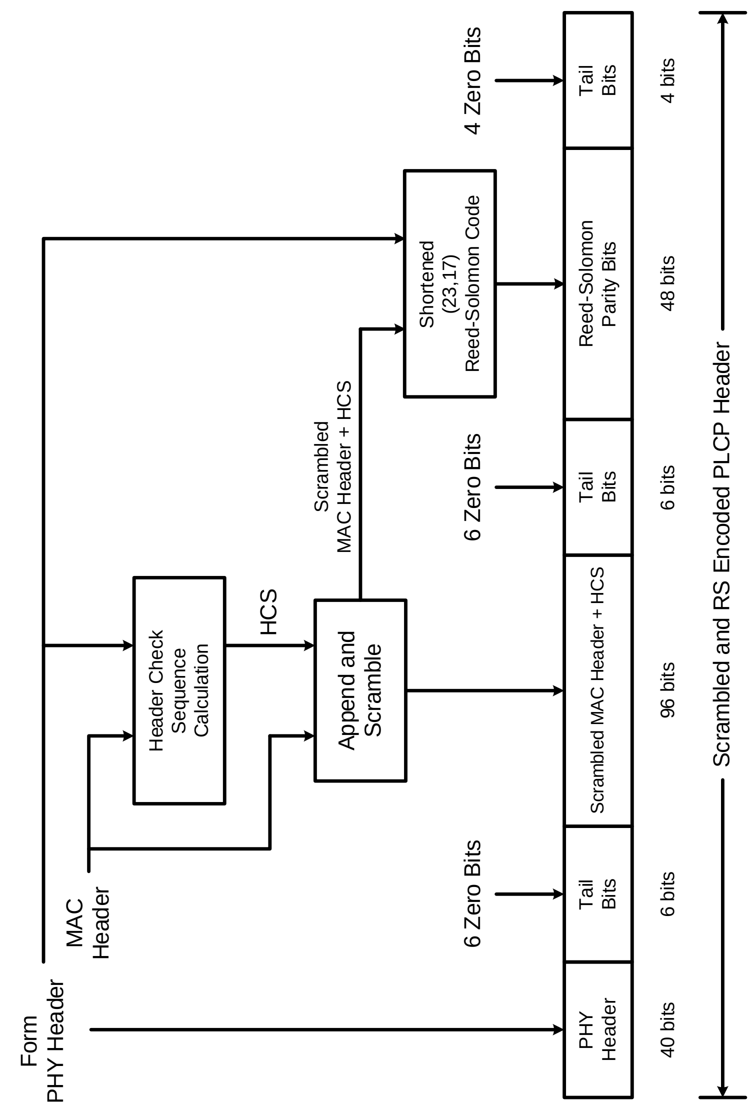

Fig. 6-6. Block diagram of PLCP header construction

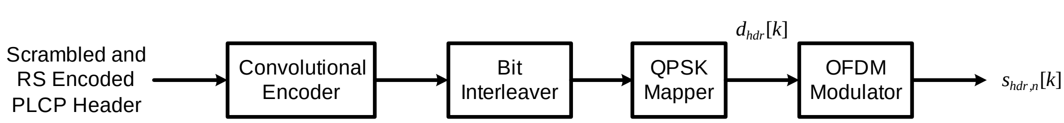

Fig. 6-7. Encoding process for the scrambled, Reed-Solomon encoded PLCP header

6.3.1 PHY Header

The PHY header contains information about the data rate of the MAC frame body, the length of the frame payload (which does not include the FCS), the seed identifier for the data scrambler, and information about the next packet – whether it is being sent in burst mode and whether it employs a burst preamble or not.

The PHY header field shall be composed of 40 bits, numbered from 0 to 39 as illustrated in Fig. 6-8. Bits 3-7 shall encode the RATE field, which conveys the information about the type of modulation, the coding rate and the spreading factor used to transmit the MAC frame body. Bits 8-19 shall encode the LENGTH field, with the least significant bit being transmitted first. Bits 22-23 shall encode the seed value for the initial state of the scrambler, which is used to synchronize the descrambler of the receiver. Bit 26 shall encode whether or not the packet is being transmitted in the burst (streaming) mode. Bit 27 shall encode the preamble type (standard or burst preamble) used in the next packet if in burst mode. Bits 28-30 shall be used to indicate the TF code used at the transmitter. Bit 31 shall be used to indicate the LSB of the band group used at the transmitter. All other bits which are not defined in this section shall be understood to be reserved for future use and shall be set to zero.

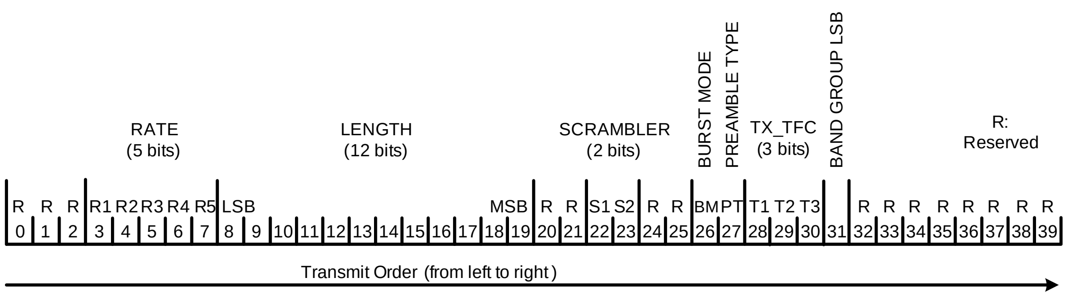

Fig. 6-8. PHY Header bit assignment

6.3.1.1 Data rate field (RATE)

Depending on the data rate (RATE), bits R1-R5 shall be set according to the values in Table 6-14.

TABLE 6-14. Rate-dependent parameters

Rate (Mb/s)	R1-R5
53.3	00000
80	00001
106.7	00010
160	00011
200	00100
320	00101
400	00110
480	00111
Reserved	01000 - 11111

6.3.1.2 PLCP length field (LENGTH)

The PLCP length field shall be an unsigned 12-bit integer that indicates the number of octets in the frame payload (which does not include the FCS, the tail bits, or the pad bits).

6.3.1.3 PLCP scrambler field (SCRAMBLER)

The MAC shall set bits S1-S2 according to the scrambler seed identifier value. This two-bit value corresponds to the seed value chosen for the data scrambler.

6.3.1.4 Burst Mode (BM) field

The MAC shall set the burst mode (BM) bit, as defined in Table 6-15, to indicate whether the next packet is part of a packet “burst”, i.e. burst mode transmission. Support for reception of burst mode is mandatory. In burst mode, the inter-frame spacing shall be equal to a pMIFSTime (see Section 7.3).

Editor’s Note: In burst mode, the minimum value of LENGTH = 1; *while, in standard mode, the minimum value of* LENGTH = 0*.*

TABLE 6-15. Burst Mode field

Burst Mode (BM) bit	Next Packet Status
0	Next packet *is not* part of burst
1	Next packet *is* part of burst

6.3.1.5 Preamble Type (PT) field

The MAC shall set the preamble type (PT) bit in burst mode to indicate the type of PLCP preamble (standard or burst) used in the next packet according to Table 6-16. For data rates of 200 Mb/s and below, the PT bit shall be always set to zero (consistent with Section 6.2).

Editor's Note: The preamble type bit only has meaning during a burst mode transmission. When devices are not in a burst mode transmission, the value of the preamble type bit shall be set to zero.

TABLE 6-16. Preamble Type field

Preamble Type (PT) bit	Type of Preamble Used for Next Packet
0	Standard Preamble
1	Burst Preamble

6.3.1.6 TF Code Used at the Transmitter (TX_TFC) field

The MAC shall configure the TX_TFC field to indicate the time-frequency code used at the transmitter for the current packet. Depending on the time-frequency code used, bits T1-T3 shall be set according to the values in Table 6-17.

TABLE 6-17. Encoding of the TX_TFC field

TF Code	T1 - T3
1	100
2	010
3	110
4	001
5	101
6	011
7	111
Reserved	000

6.3.1.7 LSB of Band Group Used at the Transmitter (BG_LSB) field

The MAC shall configure the BG_LSB field to indicate the LSB of the band group used at the transmitter for the current packet. Depending on the band group used at the transmitter, bit BG_LSB shall be set according to the values in Table 6-18.

TABLE 6-18. Encoding of the BG_LSB field

Band Group	Band Group LSB (BG_LSB)
1, 3, 5	1
2, 4	0

6.3.2 Reed-Solomon Outer Code for the PLCP header

The PLCP header shall use a systematic (23, 17) Reed-Solomon outer code to improve upon the robustness of the $R = 1/3$, $K = 7$ inner convolutional code. The Reed-Solomon code is defined over $GF(2^8)$ with a primitive polynomial $p(z) = z^8 + z^4 + z^3 + z^2 + 1$, where α is the root of the polynomial $p(z)$. For brevity, this Galois field is denoted as F. As notation, the element $M = b_7z^7 + b_6z^6 + b_5z^5 + b_4z^4 + b_3z^3 + b_2z^2 + b_1z + b_0$, where $M \in F$, has the following binary representation $b_7b_6b_5b_4b_3b_2b_1b_0$, where b_7 is the MSB and b_0 is the LSB.

The generator polynomial is obtained by shortening a systematic (255, 249) Reed-Solomon code, which is specified by the generator polynomial:

$$g(x) = \prod_{i=1}^{6} (x - \alpha^i) = x^6 + 126x^5 + 4x^4 + 158x^3 + 58x^2 + 49x + 117, \qquad (6\text{-}5)$$

where $g(x)$ is the generator polynomial over F, $x \in F$ and the coefficients are given in decimal notation.

The mapping of the information bytes $\boldsymbol{m} = (m_{248}, m_{247}, \ldots, m_0)$ to codeword bytes $\boldsymbol{c} = (m_{248}, m_{247}, \ldots, m_0, r_5, r_4, \ldots, r_0)$ is achieved by computing the remainder polynomial $r(x)$,

$$r(x) = \sum_{i=0}^{5} r_i x^i = x^6 m(x) \bmod g(x), \tag{6-6}$$

where $m(x)$ is the information polynomial:

$$m(x) = \sum_{i=0}^{248} m_i x^i, \tag{6-7}$$

and r_i, $i = 0, \ldots, 5$, and m_i, $i = 0, \ldots, 248$, are elements of F.

The shortening operation pre-appends 232 zero elements to the incoming 17 octet message as follows:

$$m_i = 0,\ i = 17, \ldots, 248, \tag{6-8}$$

where the 17 bytes message is formed by concatenating the 5 octets from the PHY header to the 12 octets from the scrambled MAC header and HCS. The message order is as follows: m_{16} is the first octet of the PHY header, m_{15} is the second octet of the PHY, m_{12} is the last octet of the PHY, m_{11} is the first octet of the scrambled MAC header and HCS, m_{10} is the first octet of the scrambled MAC header and HCS and m_0 is the last octet of the scrambled MAC header and HCS. The bit mapping within the PLCP header is LSB first, such that the first bit of the PLCP header (or PHY header) is mapped to the LSB of m_{16}, the 9th bit of the PLCP header is mapped to the LSB of m_{15} and so on. The order of parity octets is as follows: r_5 is the first octet, r_4 is the second octet and r_0 is the last octet of the Reed-Solomon parity section. Again, the mapping within the Reed-Solomon parity section of the PLCP header is LSB first, such that the first bit of the Reed-Solomon parity is mapped to the LSB of r_5, the 9th bit of the Reed-Solomon parity is mapped to the LSB of r_4 and so on. A shift-register implementation of this operation is shown in Fig. 6-9, with additions and multiplications over F. After m_0 has been inserted into the shift register, the switch shall be moved from the message polynomial input connection to the shift register output connection (right-to-left).

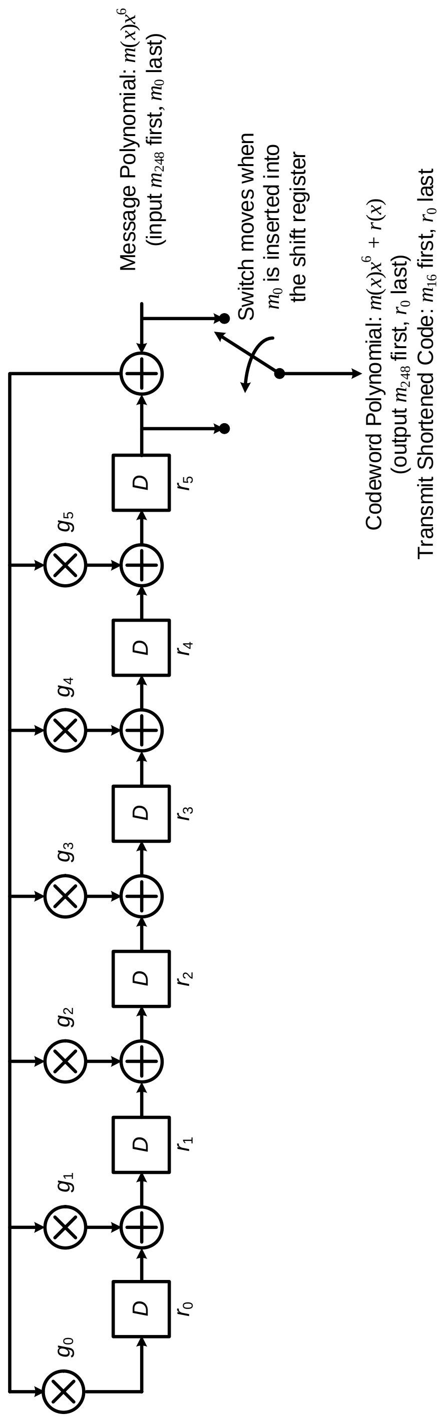

Fig. 6-9. Shift-register implementation of systematic Reed-Solomon encoder

6.3.3 Header Check Sequence

The combination of PHY header and the MAC header shall be protected with a 2 octet CCITT CRC-16 header check sequence (HCS). The CCITT CRC-16 HCS shall be the ones complement of the remainder generated by the modulo-2 division of the combined PHY and MAC headers by the polynomial: $x^{16} + x^{12} + x^5 + 1$. The HCS bits shall be processed in the transmit order. All HCS calculations shall be made prior to data scrambling. A schematic of the processing order is shown in Fig. 6-10. The registers shall be initialized to all ones.

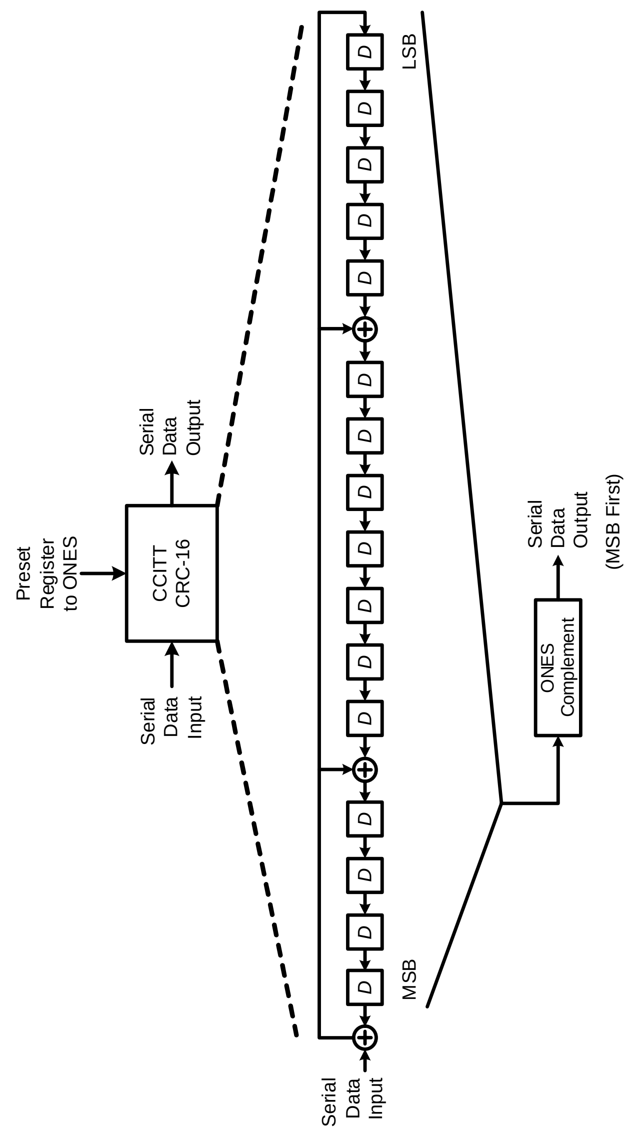

Fig. 6-10. CCITT CRC-16 block diagram

6.4 PSDU

The PSDU is the last major component of the PPDU and shall be constructed as shown in Fig. 6-11:

1. Form the non-scrambled PSDU by appending the frame payload with the 4-octet FCS, six tail bits, and a sufficient number of pad bits (see Section 6.4.1) in order to ensure that the PSDU is aligned on the interleaver boundary.
2. The resulting combination is scrambled according to Section 6.5.
3. The six tail bits in the PSDU shall be produced by replacing the six scrambled "zero" bits with six non-scrambled "zero" bits (see Section 6.6).

The resulting scrambled PSDU is encoded, as shown in Fig. 6-12, using a $R = 1/3$, $K = 7$ convolutional code and punctured to achieve the appropriate coding rate (see Section 6.7), interleaved using a bit interleaver (see Section 6.8), mapped onto either a QPSK or DCM constellation (see Section 6.9) and finally, the resulting complex values are loaded onto the data subcarriers of the OFDM symbol (see Section 6.10) in order to create the real or complex baseband signal, depending on the desired data rate.

Editor's Note: When the PLCP length field (i.e., the length of the frame payload) is zero, the length of the PSDU shall also be zero.

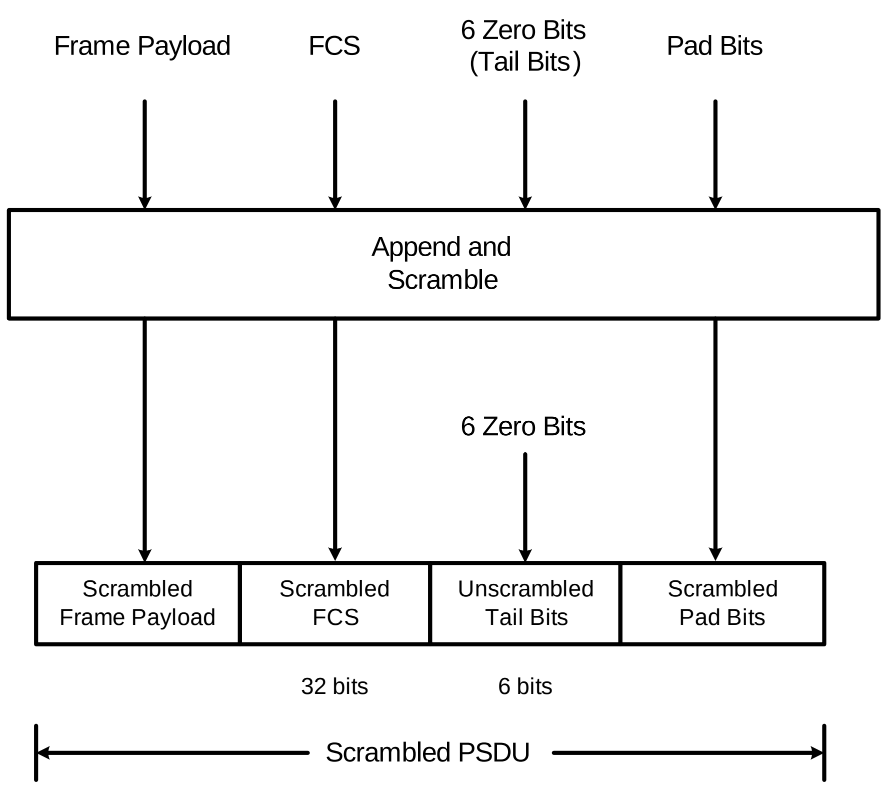

Fig. 6-11. Block diagram of PSDU construction

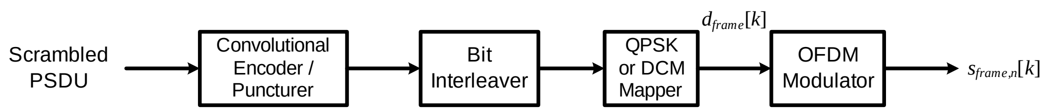

Fig. 6-12. Block diagram of the encoding process for the scrambled PSDU

6.4.1 Pad bits

Pad bits shall be appended after the 6 tail bits prior to scrambling and encoding in order to ensure that the resulting PSDU is aligned with the boundaries of the bit interleaver defined in Section 6.8. The number of pad bits, N_{pad}, that shall be inserted is a function of the number of information bits per 6 OFDM symbols N_{IBP6S}, and the number of bytes in the frame payload:

$$N_{pad} = N_{IBP6S} \times \left\lceil \frac{8 \times \text{LENGTH} + 38}{N_{IBP6S}} \right\rceil - (8 \times \text{LENGTH} + 38), \tag{6-9}$$

where LENGTH specifies the number of octets in the frame payload and is defined according to Section 6.3.1.2, and where the value 38 represents the length in bits of the FCS and tail bits section when the length of the PLCP length field is non-zero (LENGTH > 0). The appended pad bits shall be set to “zeros” and scrambled with the rest of the PSDU.

6.5 Data Scrambler

A side-stream scrambler shall be used to whiten only portions of the PLCP header, i.e., the MAC header and HCS and the entire PSDU. In addition, the scrambler shall be initialized to a seed value specified by the MAC at the beginning of the MAC header and then re-initialized to the same seed value at the beginning of the PSDU.

The polynomial generator, $g(D)$, for the pseudo-random binary sequence (PRBS) generator shall be: $g(D) = 1 + D^{14} + D^{15}$, where D is a single bit delay element. Using this generator polynomial, the corresponding PRBS, $x[n]$, is generated as:

$$x[n] = x[n-14] \oplus x[n-15],\ n = 0, 1, 2, \ldots \tag{6-10}$$

where “$\oplus$” denotes modulo-2 addition. The following sequence defines the initialization vector, x_{init}, which is specified by the parameter “seed value” in Table 6-19:

$$x_{init} = \begin{bmatrix} x_i[-1] & x_i[-2] & \ldots & x_i[-14] & x_i[-15] \end{bmatrix}, \tag{6-11}$$

where $x_i[-k]$ represents the binary initial value at the output of the k^{th} delay element. The scrambled data bits, v_m, are obtained as shown in Fig. 6-13:

$$v[m] = s[m] \oplus x[m],\ m = 0, 1, 2, \ldots \tag{6-12}$$

where $s[m]$ represents the non-scrambled data bits. The side-stream de-scrambler at the receiver shall be initialized with the same initialization vector, x_{init}, used in the transmitter scrambler. The initialization vector is determined from the seed identifier contained in the PLCP header of the received frame.

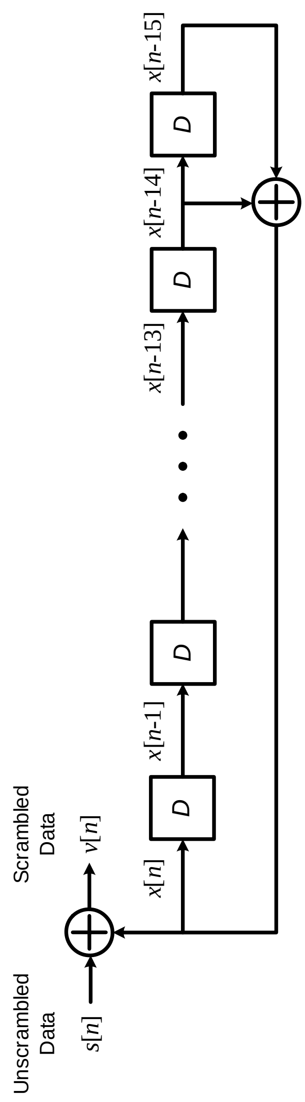

Fig. 6-13. Block diagram of the side-stream scrambler

The 15-bit initialization vector or seed value shall correspond to the seed identifier as shown in Table 6-19. The MAC shall set the seed identifier value to 00 when the PHY is initialized and this value shall be incremented in a 2-bit rollover counter for *each* frame sent by the PHY.

Editor's Note: All consecutive packets, including retransmissions, shall be sent with a different initial seed value.

TABLE 6-19. Scrambler seed selection

Seed Identifier (S1, S2)	Seed Value $x_{init} = x_i[-1]\ x_i[-2] \ldots\ x_i[-15]$	PRBS Output First 16 bits $x[0]\ x[1]\ \ldots\ x[15]$
00	0011 1111 1111 111	0000 0000 0000 1000
01	0111 1111 1111 111	0000 0000 0000 0100
10	1011 1111 1111 111	0000 0000 0000 1110
11	1111 1111 1111 111	0000 0000 0000 0010

6.6 Tail bits

The tail bit fields are required to return the convolutional encoder to the "zero state". This procedure improves the error probability of the convolutional decoder, which relies on the future bits when decoding the message stream. The tail bit fields after the PHY header and the HCS shall consist of six non-scrambled zeros, and the tail bit field after the Reed-Solomon parity bit field shall be a punctured tail bit sequence consisting of four non-scrambled zeros.

The tail bit field following the scrambled frame check sequence shall be produced by replacing the six scrambled "zero" bits with six non-scrambled "zero" bits.

6.7 Convolutional Encoder

The convolutional encoder shall use the rate $R = 1/3$ code with generator polynomials, $g_0 = 133_8$, $g_1 = 165_8$, and $g_2 = 171_8$, as shown in Fig. 6-14. The bit denoted as "A" shall be the first bit generated by the encoder, followed by the bit denoted as "B", and finally, by the bit denoted as "C". Additional coding rates are derived from the "mother" rate $R = 1/3$ convolutional code by employing "puncturing". Puncturing is a procedure for omitting some of the encoded bits at the transmitter (thus reducing the number of transmitted bits and increasing the coding rate) and inserting a dummy "zero" metric into the decoder at the receiver in place of the omitted bits. The puncturing patterns are illustrated in Fig. 6-15 through Fig. 6-17. In each of these cases, the tables shall be filled in with encoder output bits from left to right. For the last block of bits, the process shall be stopped at the point at which encoder output bits are exhausted, and the puncturing pattern applied to the partially filled block.

The PLCP header shall be encoded using a coding rate of $R = 1/3$. The encoder shall start from the all-"zero state". After the encoding process for the PLCP header has been completed, the encoder shall be reset to the all-"zero state" before the encoding starts for the PSDU; in other words, the encoding of the PSDU shall also start from the all-"zero state". The PSDU shall be encoded using the appropriate coding rate of $R = 1/3$, $1/2$, $5/8$, or $3/4$.

Editor's Note: Decoding by the Viterbi algorithm is recommended.

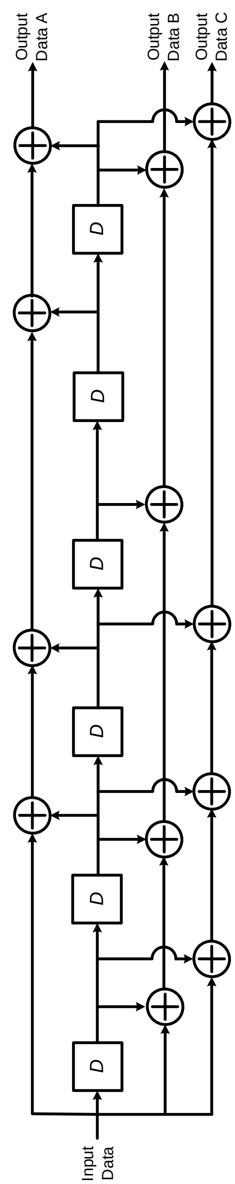

Fig. 6-14. Convolutional encoder: rate $R = 1/3$, constraint length $K = 7$

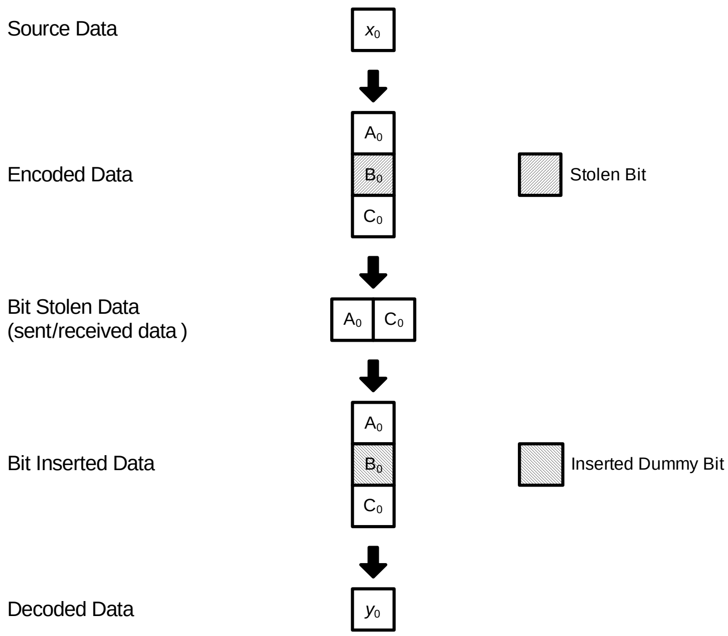

Fig. 6-15. An example of bit-stealing and bit-insertion for $R = 1/2$ code

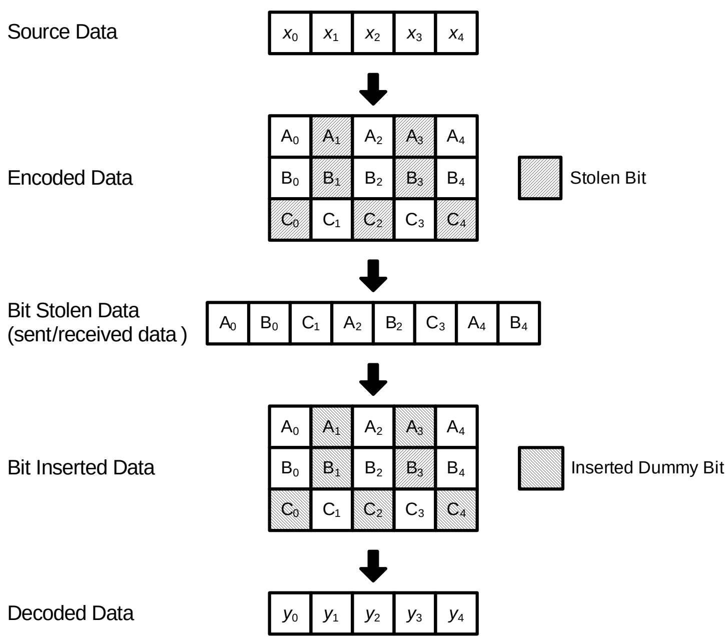

Fig. 6-16. An example of bit-stealing and bit-insertion for $R = 5/8$ code

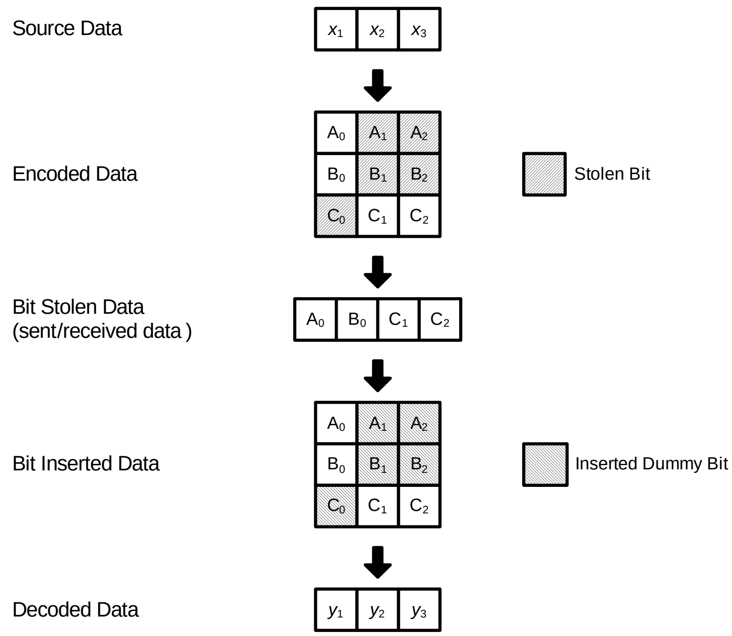

Fig. 6-17. An example of bit-stealing and bit-insertion for $R = 3/4$ code

6.8 Bit interleaving

The coded and padded bit stream shall be interleaved prior to modulation to provide robustness against burst errors. The bit interleaving operation is performed in three distinct stages, as shown in Fig. 6-18:

1. Symbol interleaving, which permutes the bits across 6 consecutive OFDM symbols, enables the PHY to exploit frequency diversity within a band group.
2. Intra-symbol tone interleaving, which permutes the bits across the data subcarriers within an OFDM symbol, exploits frequency diversity across subcarriers and provides robustness against narrow-band interferers.
3. Intra-symbol cyclic shifts, which cyclically shift the bits in successive OFDM symbols by deterministic amounts, enables modes that employ time-domain spreading and the fixed frequency interleaving (FFI) modes to better exploit frequency diversity.

The additional parameters needed by the interleaver are listed in Table 6-20 as a function of the data rate.

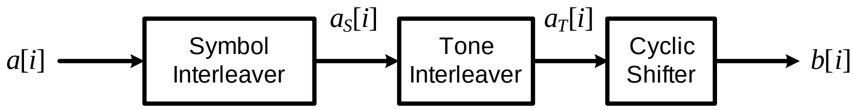

Fig. 6-18. A block diagram of the various stages of the bit interleaver

TABLE 6-20. Parameters for the interleaver

Data Rate (Mb/s)	TDS Factor (N_{TDS})	Coded Bits / OFDM Symbol (N_{CBPS})	Tone Interleaver Block Size (N_{Tint})	Cyclic Interleaver Shift (N_{cyc})
53.3	2	100	10	33
80	2	100	10	33
106.7	2	200	20	66
160	2	200	20	66
200	2	200	20	66
320	1	200	20	33
400	1	200	20	33
480	1	200	20	33

The symbol interleaving operation is performed by first grouping the coded bits into blocks of N_{CBP6S} bits (corresponding to six "on-air" OFDM symbols) and then using a block interleaver of size N_{CBPS} by $6 / N_{TDS}$ to permute the coded bits. Let the sequences $a[i]$ and $a_S[i]$, where $i = 0, \ldots, N_{CBP6S} - 1$, represent the input and output bits of the symbol block interleaver, respectively. The output of the symbol block interleaver is given by the following relationship:

$$a_S[i] = a\left[\left\lfloor \frac{i}{N_{CBPS}} \right\rfloor + \left(\frac{6}{N_{TDS}}\right) \times \mathrm{mod}(i, N_{CBPS})\right] , \tag{6-13}$$

where $\lfloor \cdot \rfloor$ is the floor function, which returns the largest integer value less than or equal to its argument value, and mod(a,b) is the modulus operator, which returns the non-negative integer remainder when a is divided by b.

The output of the symbol interleaver, which is grouped together into blocks of N_{CBPS} bits, is then permuted using a regular block intra-symbol interleaver of size $N_{Tint} \times 10$. Let the sequences $a_S[j]$ and $a_T[j]$, where $j = 0, \ldots, N_{CBPS} - 1$, represent the input and output bits of the tone interleaver, respectively. The output of the tone interleaver is given by the following relationship:

$$a_T[j] = a_S\left[\left\lfloor \frac{j}{N_{Tint}} \right\rfloor + 10 \times \mathrm{mod}(j, N_{Tint})\right] . \tag{6-14}$$

The output of the tone interleaver is then passed through an intra-symbol cyclic shifter, which consists of a different cyclic shift for each block of N_{CBPS} bits within the span of the symbol interleaver. Let the sequences $a_T[i]$ and $b[i]$, where $i = 0, \ldots, N_{CBP6S} - 1$, represent the input and output bits of the cyclic shifter, respectively. The output of the cyclic shifter is given by the following relationship:

$$b[i] = a_T\left[m(i) \times N_{CBPS} + \mathrm{mod}(i + m(i) \times N_{cyc}, N_{CBPS})\right] , \tag{6-15}$$

where $m(i) = \lfloor i / N_{CBPS} \rfloor$, where $i = 0, \ldots, N_{CBP6S} - 1$.

6.9 Constellation Mapping

The section describes the techniques for mapping the coded and interleaved binary data sequence onto a complex constellation. For data rates 200 Mb/s and lower, the binary data shall be mapped onto a QPSK constellation. For data rates 320 Mb/s and higher, the binary data shall be mapped onto a multi-dimensional constellation using a dual-carrier modulation (DCM) technique.

6.9.1 QPSK

The coded and interleaved binary serial input data, $b[i]$ where $i = 0, 1, 2, \ldots$, shall be divided into groups of two bits and converted into a complex number representing one of the four QPSK constellation points. The conversion shall be performed according to the Gray-coded constellation mapping, illustrated in Fig. 6-19, with the input bit, $b[2k]$ where $k = 0, 1, 2, \ldots$, being the earliest of the two in the stream. The output values, $d[k]$ where $k = 0, 1, 2, \ldots$, are formed by multiplying $(2\times b[2k]-1) + j(2\times b[2k+1]-1)$ value by a normalization factor of K_{MOD}, as described in the following equation:

$$d[k] = K_{MOD} \times \left[(2\times b[2k]-1) + j(2\times b[2k+1]-1)\right], \text{ where } k = 0, 1, 2, \ldots, \tag{6-16}$$

The normalization factor $K_{MOD} = 1/\sqrt{2}$ for a QPSK constellation. In practical implementations, an approximate value of the normalization factor can be used, as long as the device conforms to the modulation accuracy requirements. For QPSK, $b[2k]$ determines the I value, and $b[2k+1]$ determines the Q value, as illustrated in Table 6-21.

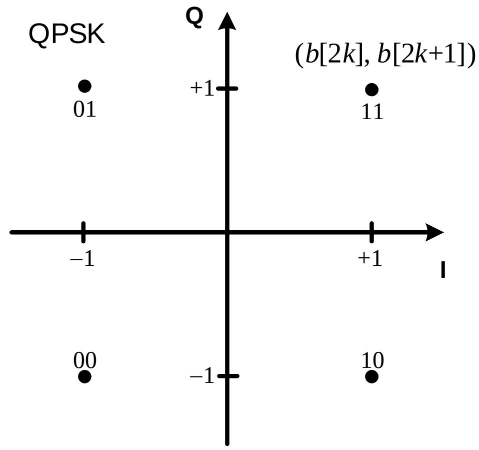

Fig. 6-19. QPSK constellation bit encoding

TABLE 6-21. QPSK encoding table

Input Bit $(b[2k], b[2k{+}1])$	*I*-out	*Q*-out
00	–1	–1
01	–1	1
10	1	–1
11	1	1

6.9.2 Dual-carrier modulation (DCM)

The coded and interleaved binary serial input data, $b[i]$ where $i = 0, 1, 2, \ldots$, shall be divided into groups of 200 bits and converted into 100 complex numbers using a technique called dual-carrier modulation. The conversion shall be performed as follows:

1. The 200 coded bits are grouped into 50 groups of 4 bits. Each group is represented as $(b[g(k)], b[g(k){+}1], b[g(k) + 50)], b[g(k) + 51])$, where $k \in [0, 49]$ and

$$g(k) = \begin{cases} 2k & k \in [0, 24] \\ 2k + 50 & k \in [25, 49] \end{cases} . \qquad (6\text{-}17)$$

2. Each group of 4 bits $(b[g(k)], b[g(k){+}1], b[g(k) + 50)], b[g(k) + 51])$ shall be mapped onto a four-dimensional constellation, as shown in Fig. 6-20, and converted into two complex numbers $(d[k], d[k + 50])$. The mapping between bits and constellation is enumerated in Table 6-22.

3. The complex numbers shall be normalized using a normalization factor K_{MOD}.

The normalization factor $K_{MOD} = 1/\sqrt{10}$ is used for the dual-carrier modulation. In practical implementations, an approximate value of the normalization factor can be used, as long as the device conforms to the modulation accuracy requirements.

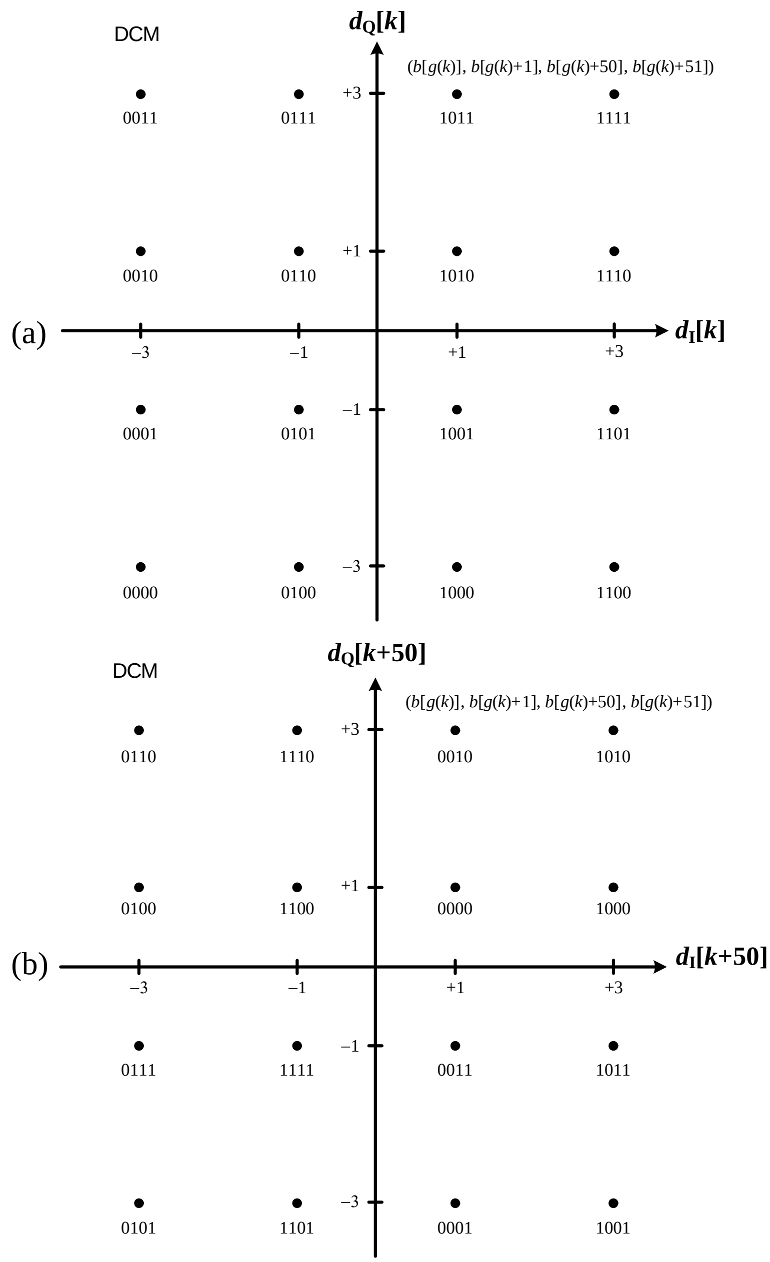

Fig. 6-20. DCM encoding: (a) mapping for $d[k]$; (b) mapping for $d[k+50]$

TABLE 6-22. Dual-carrier modulation encoding table

Input Bit $(b[g(k)], (b[g(k)+1], (b[g(k)+50)], (b[g(k)+51])$	$d[k]$ *I*-out	$d[k]$ *Q*-out	$d[k+50]$ *I*-out	$d[k+50]$ *Q*-out
0000	-3	-3	1	1
0001	-3	-1	1	-3
0010	-3	1	1	3
0011	-3	3	1	-1
0100	-1	-3	-3	1
0101	-1	-1	-3	-3
0110	-1	1	-3	3
0111	-1	3	-3	-1
1000	1	-3	3	1
1001	1	-1	3	-3
1010	1	1	3	3
1011	1	3	3	-1
1100	3	-3	-1	1
1101	3	-1	-1	-3
1110	3	1	-1	3
1111	3	3	-1	-1

6.10 OFDM Modulation

The discrete-time signal, $s_n[k]$, shall be created by taking the IDFT of the stream of complex values as follows:

$$s_n[k] = \frac{1}{\sqrt{N_{FFT}}}\left[\sum_{l=0}^{N_D} C_{D,n}[l]\exp(j2\pi M_D[l]k/N_{FFT}) + \sum_{l=0}^{N_G} C_{G,n}[l]\exp(j2\pi M_G[l]k/N_{FFT}) + \sum_{l=0}^{N_P} C_{P,n}[l]\exp(j2\pi M_P[l]k/N_{FFT})\right], \qquad (6\text{-}18)$$

where $k \in [0, N_{FFT} - 1]$, $n \in [N_{sync}, N_{packet} - 1]$, N_D is the number of data subcarriers, N_G is the number of guard subcarriers, N_P is the number of pilot subcarriers, N_{FFT} is the number of total subcarriers, and $C_{D,n}[l]$, $C_{G,n}[l]$, $C_{P,n}[l]$ are the complex numbers placed on the l^{th}

data, guard, and pilot subcarriers of the n^{th} OFDM symbol, respectively. The relationship between $C_{D,n}[l]$ and $C_{G,n}[l]$, and the stream of complex values is defined in Section 6.10.2 and Section 6.10.3. The values for $C_{P,n}[l]$ are defined in Section 6.10.4. Functions $M_D[l]$, $M_G[l]$ and $M_P[l]$ define a mapping from indices $[0, N_D - 1]$, $[0, N_G - 1]$ and $[0, N_P - 1]$ to logical frequency subcarriers $[-N_T/2, N_T/2]$ excluding 0, respectively. The exact definitions for the mapping functions $M_D[l]$, $M_G[l]$, and $M_P[l]$ are given below:

$$M_D[l] = \begin{cases} l-56 & l = 0 \\ l-55 & 1 \le l \le 9 \\ l-54 & 10 \le l \le 18 \\ l-53 & 19 \le l \le 27 \\ l-52 & 28 \le l \le 36 \\ l-51 & 37 \le l \le 45 \\ l-50 & 46 \le l \le 49 \\ l-49 & 50 \le l \le 53 \\ l-48 & 54 \le l \le 62 \\ l-47 & 63 \le l \le 71 \\ l-46 & 72 \le l \le 80 \\ l-45 & 81 \le l \le 89 \\ l-44 & 90 \le l \le 98 \\ l-43 & l = 99 \end{cases}, \tag{6-19}$$

$$M_G[l] = \begin{cases} -61 + l & l \in \left[0, \frac{N_G}{2} - 1\right] \\ 52 + l & l \in \left[\frac{N_G}{2}, N_G - 1\right] \end{cases}, \tag{6-20}$$

$$M_P[l] = \quad -55 + 10l \qquad l \in [0, N_P - 1] \quad . \tag{6-21}$$

The mapping of the data, pilot and guard subcarriers within an OFDM symbol is illustrated in Fig. 6-21.

Finally, the discrete-time signals for the PLCP header, $s_{hdr,n}[k]$, and the PSDU, $s_{frame,n}[k]$, shall be created as follows by appending a zero-padded suffix (ZPS) to every IDFT output:

$$s_{hdr,n}[k] = \begin{cases} s_n[k] & k \in [0, N_{FFT} - 1] \\ 0 & k \in [N_{FFT}, N_{SYM} - 1] \end{cases}, \tag{6-22}$$

for $n \in [N_{sync}, N_{sync} + N_{hdr} - 1]$, and

$$s_{frame,n}[k] = \begin{cases} s_n[k] & k \in [0, N_{FFT} - 1] \\ 0 & k \in [N_{FFT}, N_{SYM} - 1] \end{cases} , \qquad (6\text{-}23)$$

for $n \in [N_{sync} + N_{hdr}, N_{packet} - 1]$. The zero-padded suffix is typically used to mitigate the effects of multi-path as well as to provide a time window or guard interval to allow the transmitter and receiver sufficient time to switch between the different center frequencies.

Within the OFDM modulation process, frequency-domain spreading within a symbol and time-domain spreading across two consecutive symbols is used to obtain further bandwidth expansion, beyond that provided by the forward error correction code and the time-frequency codes. Frequency-domain spreading entails transmitting the same information (complex number) on two separate subcarriers within the same OFDM symbol. Time-domain spreading involves transmitting the same information across two consecutive OFDM symbols. This technique is used to maximize frequency-diversity and to improve the performance in the presence of other non-coordinated devices.

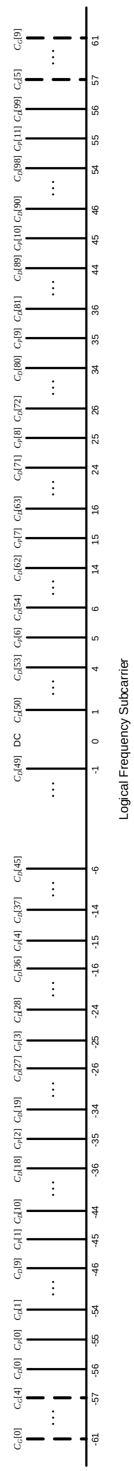

Fig. 6-21. Mapping from data, guard and pilot subcarriers to logical frequency subcarriers

6.10.1 Implementation Considerations

A common way to implement an inverse discrete Fourier transform is by using an inverse Fast Fourier Transform (IFFT) algorithm. In this example, the logical frequency subcarriers $[-N_T/2, N_T/2]$ shall be mapped according to Fig. 6-22. The logical frequency subcarriers 1 to 61 are mapped to the same numbered IFFT inputs, while the logical frequency subcarriers –61 to –1 are mapped into IFFT inputs 67 to 127, respectively. The rest of the inputs, 62 to 66 and the 0 (DC) input, are set to zero. The subcarrier falling at DC (0^{th} subcarrier) is not used to avoid difficulties in DAC and ADC offsets and carrier feed-through in the RF chain.

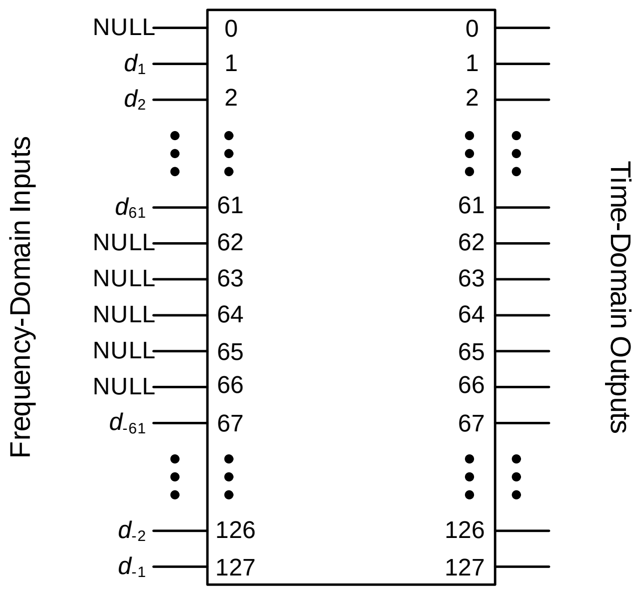

Fig. 6-22. Input and outputs relationship of the IFFT

6.10.2 Data Subcarriers

The mapping between the stream of complex values and the data subcarriers is dependent on the portion of the PPDU and the data rate. In the following subsections, a detailed mapping between the stream of complex values and the data subcarriers is provided.

6.10.2.1 Mapping for PLCP Header

Both frequency-domain and time-domain spreading techniques shall be used for the PLCP header. For this case, the stream of complex values, $d_{hdr}[k]$, where $k = 0, 1, 2, \ldots,$

shall be grouped into sets of $N_D / 2 = 50$ complex numbers. This group of complex values shall be mapped onto the l^{th} data subcarrier of the n^{th} OFDM symbol, $C_{D,n}[l]$, as follows:

$$C_{D,2n}[l] = d_{hdr}\left[\frac{N_D}{4} \times (2n - N_{sync}) + l\right] , \tag{6-24}$$

$$C_{D,2n}\left[l + \frac{N_D}{2}\right] = d_{hdr}{}^{*}\left[\frac{N_D}{4} \times (2n - N_{sync}) + \left(\frac{N_D}{2} - 1 - l\right)\right] , \tag{6-25}$$

$$C_{D,2n+1}[l] = p_{spread}[n] \times d_{hdr}\left[\frac{N_D}{4} \times (2n - N_{sync}) + l\right] , \tag{6-26}$$

$$C_{D,2n+1}\left[l + \frac{N_D}{2}\right] = p_{spread}[n] \times d_{hdr}{}^{*}\left[\frac{N_D}{4} \times (2n - N_{sync}) + \left(\frac{N_D}{2} - 1 - l\right)\right] , \tag{6-27}$$

where

$$p_{spread}[n] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2} + 6, N_{FFT} - 1\right)\right] , \tag{6-28}$$

and where $p[n]$ is a length 127 pseudo-random sequence, whose values are defined in Table 6-23, $l \in \left[0, \frac{N_D}{2} - 1\right]$, $n \in \left[\frac{N_{sync}}{2}, \frac{N_{sync} + N_{hdr}}{2} - 1\right]$, N_D is the number of data sub-carriers, N_{sync} is the number of symbols in the PLCP preamble and N_{hdr} is the number of symbols in the PLCP header.

TABLE 6-23. Length 127 pseudo-random sequence

n	$p[n]$	n	$p[n]$	n	$p[n]$	n	$p[n]$
0	1	32	1	64	-1	96	-1
1	1	33	1	65	-1	97	-1
2	1	34	-1	66	1	98	-1
3	1	35	1	67	-1	99	-1
4	-1	36	1	68	1	100	-1
5	-1	37	-1	69	-1	101	1
6	-1	38	-1	70	1	102	-1
7	1	39	1	71	1	103	1
8	-1	40	1	72	-1	104	1
9	-1	41	1	73	-1	105	-1
10	-1	42	-1	74	-1	106	1
11	-1	43	1	75	1	107	-1
12	1	44	-1	76	1	108	1
13	1	45	-1	77	-1	109	1
14	-1	46	-1	78	-1	110	1
15	1	47	1	79	-1	111	-1
16	-1	48	-1	80	-1	112	-1
17	-1	49	1	81	1	113	1
18	1	50	-1	82	-1	114	-1
19	1	51	-1	83	-1	115	-1
20	-1	52	1	84	1	116	-1
21	1	53	-1	85	-1	117	1
22	1	54	-1	86	1	118	1
23	-1	55	1	87	1	119	1
24	1	56	1	88	1	120	-1
25	1	57	1	89	1	121	-1
26	1	58	1	90	-1	122	-1
27	1	59	1	91	1	123	-1
28	1	60	-1	92	-1	124	-1
29	1	61	-1	93	1	125	-1
30	-1	62	1	94	-1	126	-1
31	1	63	1	95	1		

6.10.2.2 Mapping for Data Rates of 53.3 and 80 Mb/s

Both frequency-domain and time-domain spreading techniques shall be used when the PSDU is encoded at a data rate of 53.3 or 80 Mb/s. For this case, the stream of complex values, $d_{frame}[k]$, where $k = 0, 1, 2, \ldots$, shall be grouped into sets of $N_D/2 = 50$ complex numbers. This group of complex values shall be mapped onto the l^{th} data subcarrier of the n^{th} OFDM symbol, $C_{D,n}[l]$, as follows:

$$C_{D,2n}[l] = d_{frame}\left[\frac{N_D}{4} \times (2n - N_{sync} - N_{hdr}) + l\right] , \qquad (6\text{-}29)$$

$$C_{D,2n}\left[l + \frac{N_D}{2}\right] = d_{frame}^{*}\left[\frac{N_D}{4} \times (2n - N_{sync} - N_{hdr}) + \left(\frac{N_D}{2} - 1 - l\right)\right] , \qquad (6\text{-}30)$$

$$C_{D,2n+1}[l] = p_{spread}[n] \times d_{frame}\left[\frac{N_D}{4} \times (2n - N_{sync} - N_{hdr}) + l\right] , \qquad (6\text{-}31)$$

$$C_{D,2n+1}\left[l + \frac{N_D}{2}\right] = p_{spread}[n] \times d_{frame}^{*}\left[\frac{N_D}{4} \times (2n - N_{sync} - N_{hdr}) + \left(\frac{N_D}{2} - 1 - l\right)\right] , \qquad (6\text{-}32)$$

where $p_{spread}[n]$ is defined in (6-28), $p[n]$ is defined in Table 6-23, $l \in \left[0, \frac{N_D}{2} - 1\right]$, $n \in \left[\frac{N_{sync} + N_{hdr}}{2}, \frac{N_{packet}}{2} - 1\right]$, N_D is the number of data subcarriers, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header and N_{packet} is the total number of symbols in the packet.

6.10.2.3 Mapping for Data Rates of 106.7, 160 and 200 Mb/s

Only time-domain spreading techniques shall be used when the PSDU is encoded at a data rate of 106.7, 160 or 200 Mb/s. For this case, the stream of complex values, $d_{frame}[k]$, where $k = 0, 1, 2, \ldots$, shall be grouped into sets of $N_D = 100$ complex numbers. This group of complex values shall be mapped onto the l^{th} data subcarrier of the n^{th} OFDM symbol, $C_{D,n}[l]$, as follows:

$$C_{D,2n}[l] = d_{frame}\left[\frac{N_D}{2} \times (2n - N_{sync} - N_{hdr}) + l\right] , \qquad (6\text{-}33)$$

$$C_{D,2n+1}[l] = p_{spread}[n] \times \left\{ imag\left(d_{frame}\left[\frac{N_D}{2} \times (2n - N_{sync} - N_{hdr}) + (N_D - 1 - l)\right]\right) \right.$$

$$\left. + j \quad real\left(d_{frame}\left[\frac{N_D}{2} \times (2n - N_{sync} - N_{hdr}) + (N_D - 1 - l)\right]\right) \right\} \quad , \qquad (6\text{-}34)$$

where $p_{spread}[n]$ is defined in (6-28), $p[n]$ is defined in Table 6-23, $l \in [0, N_D - 1]$, $n \in \left[\frac{N_{sync} + N_{hdr}}{2}, \frac{N_{packet}}{2} - 1\right]$, N_D is the number of data subcarriers, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header and N_{packet} is the total number of symbols in the packet.

6.10.2.4 Mapping for Data Rates of 320, 400 and 480 Mb/s

No spreading techniques shall be used when the PSDU is encoded at a data rate of 320, 400 or 480 Mb/s. For this case, the stream of complex values, $d_{frame}[k]$, where $k = 0$, $1, 2, \ldots$, shall be grouped into sets of $N_D = 100$ complex numbers. This group of complex values shall be mapped onto the l^{th} data subcarrier of the n^{th} OFDM symbol, $C_{D,n}[l]$, as follows:

$$C_{D,n}[l] = d_{frame}[N_D \times (n - N_{sync} - N_{hdr}) + l] \quad , \qquad (6\text{-}35)$$

where $l \in [0, N_D - 1]$, $n \in [N_{sync} + N_{hdr}, N_{packet} - 1]$, N_D is the number of data subcarriers, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header and N_{packet} is the total number of symbols in the packet.

6.10.3 Guard Subcarriers

For each OFDM symbol, starting with the channel estimation sequence within the PLCP preamble, there shall be ten subcarriers, 5 on each edge of the occupied frequency band, allocated as guard subcarriers. The relationship between the power levels of the guard subcarriers and that of the data subcarriers shall be implementation dependent. This relationship shall remain constant within a packet, i.e., from the start of the channel estimation sequence to the end of the packet. In addition, the power levels for the guard subcarriers shall be chosen in such a way as to ensure that the transmitted signal meets the local regulatory requirements of minimum occupied bandwidth and any other necessary regulatory conditions.

The 10 guard subcarriers are located on either edge of the OFDM symbol; at logical frequency subcarriers -61, -60, …, -57, and 57, 58, …, 61. The data on these carriers shall be created by copying over the five outermost data-bearing subcarriers from the nearest edge of the OFDM symbol as shown below:

$$C_{G,n}[l] = \begin{cases} C_{D,n}[l] & l \in \left[0, \frac{N_G}{2} - 1\right] \\ C_{D,n}[l + 90] & l \in \left[\frac{N_G}{2}, N_G - 1\right] \end{cases}, \quad (6\text{-}36)$$

where $C_{G,n}[l]$ is the l^{th} guard subcarrier of the n^{th} OFDM symbol, $n \in [N_{sync}, N_{packet}-1]$, N_{sync} is the number of symbols in the PLCP preamble and N_{packet} is the total number of symbols in the packet.

Editor's Note: Individual implementations may exploit the guard subcarriers for various purposes, including relaxing the specs on analog transmit and analog receive filters, and possibly improving the performance.

6.10.4 Pilot Subcarriers

In all of the OFDM symbols following the PLCP preamble, twelve of the subcarriers shall be dedicated to pilot signals in order to allow for coherent detection and to provide robustness against frequency offsets and phase noise. These pilot signals shall be placed in logical frequency subcarriers -55, -45, -35, -25, -15, -5, 5, 15, 25, 35, 45 and 55. The mapping between actual pilot sequence and the pilot subcarriers is dependent on the data portion of the PPDU and the information data rate. In the following subsections, a detailed mapping between the stream of complex values and the data subcarriers is provided.

6.10.4.1 Mapping for PLCP Header

During the PLCP header portion of the PPDU, the information for the l^{th} pilot subcarrier of the n^{th} OFDM symbol shall be defined as follows:

$$C_{P,2n}[l] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2}, N_{FFT} - 1\right)\right] \times d_{pilot,cs}[l], \quad (6\text{-}37)$$

$$C_{P,2n+1}[l] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2}, N_{FFT} - 1\right)\right] \times p_{spread}[n] \times d_{pilot,cs}[l], \quad (6\text{-}38)$$

where

$$d_{pilot,cs}[l] = \begin{cases} \frac{1-j}{\sqrt{2}} & l = 0, 3 \\ \frac{-1+j}{\sqrt{2}} & l = 1, 2, 4, 5 \\ \frac{1+j}{\sqrt{2}} & l = 8, 11 \\ \frac{-1-j}{\sqrt{2}} & l = 6, 7, 9, 10 \end{cases}, \qquad (6\text{-}39)$$

and where $p[n]$ is defined in Table 6-23, $p_{spread}[n]$ is defined in (6-28), $n \in \left[\frac{N_{sync}}{2}, \frac{N_{sync} + N_{hdr}}{2} - 1\right]$, N_{sync} is the number of symbols in the PLCP preamble and N_{hdr} is the number of symbols in the PLCP header.

6.10.4.2 Mapping for Data Rates of 53.3 and 80 Mb/s

When the PPDU is encoded at a data rate of 53.3 or 80 Mb/s, the information for the l^{th} pilot subcarrier of the n^{th} OFDM symbol shall be defined as follows:

$$C_{P,2n}[l] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2}, N_{FFT} - 1\right)\right] \times d_{pilot,cs}[l], \qquad (6\text{-}40)$$

$$C_{P,2n+1}[l] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2}, N_{FFT} - 1\right)\right] \times p_{spread}[n] \times d_{pilot,cs}[l], \qquad (6\text{-}41)$$

where $d_{pilot,cs}[l]$ is defined in (6-39), $p[n]$ is defined in Table 6-23, $p_{spread}[n]$ is defined in (6-28), $n \in \left[\frac{N_{sync} + N_{hdr}}{2}, \frac{N_{packet}}{2} - 1\right]$, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header and N_{packet} is the total number of symbols in the packet.

6.10.4.3 Mapping for Data Rates of 106.7, 160 and 200 Mb/s

When the PPDU is encoded at a data rate of 106.7, 160 or 200 Mb/s, the information for the l^{th} pilot subcarrier of the n^{th} OFDM symbol shall be defined as follows:

$$C_{P,2n}[l] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2}, N_{FFT} - 1\right)\right] \times d_{pilot,ncs}[l], \qquad (6\text{-}42)$$

$$C_{P,2n+1}[l] = p\left[\mathrm{mod}\left(n - \frac{N_{sync}}{2}, N_{FFT} - 1\right)\right] \times p_{spread}[n] \times d_{pilot,ncs}[l], \qquad (6\text{-}43)$$

where

$$d_{pilot,ncs}[l] = \begin{cases} \dfrac{1+j}{\sqrt{2}} & l = 0, 3, 8, 11 \\ \dfrac{-1-j}{\sqrt{2}} & l = 1, 2, 4, 5, 6, 7, 9, 10 \end{cases}, \qquad (6\text{-}44)$$

and where $p[n]$ is defined in Table 6-23, $p_{spread}[n]$ is defined in (6-28), $n \in \left[\frac{N_{sync} + N_{hdr}}{2}, \frac{N_{packet}}{2} - 1\right]$, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header and N_{packet} is the total number of symbols in the packet.

6.10.4.4 Mapping for Data Rates of 320, 400 and 480 Mb/s

When the PPDU is encoded at a data rate of 320, 400 or 480 Mb/s, the information for the l^{th} pilot subcarrier of the n^{th} OFDM symbol shall be defined as follows:

$$C_{P,n}[l] = p\left[\mathrm{mod}\left(n - N_{sync} - \frac{N_{hdr}}{2}, N_{FFT} - 1\right)\right] \times d_{pilot,ncs}[l], \qquad (6\text{-}45)$$

where $d_{pilot,ncs}[l]$ is defined in (6-44), $p[n]$ is defined in Table 6-23, $n \in [N_{sync} + N_{hdr}, N_{packet} - 1]$, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header and N_{packet} is the total number of symbols in the packet.

7. GENERAL REQUIREMENTS

7.1 Operating Band Frequencies

7.1.1 Operating Frequency Range

This PHY operates in the 3100-10600 MHz UWB band.

7.1.2 Band Numbering

The relationship between center frequency, f_c, and BAND_ID number, n_b, is given by the following equation:

$$f_c(n_b) = \quad 2904 + 528 \times n_b \ \ (\text{MHz}) \qquad n_b = 1, \ldots, 14 \quad . \tag{7-1}$$

This definition provides a unique numbering system for all channels that have a spacing of 528 MHz and lie within the band 3100-10600 MHz. As shown in Fig. 7-1, five band groups are defined, consisting of four band groups of three bands each and one band group of two bands. The band allocation is summarized in Table 7-1.

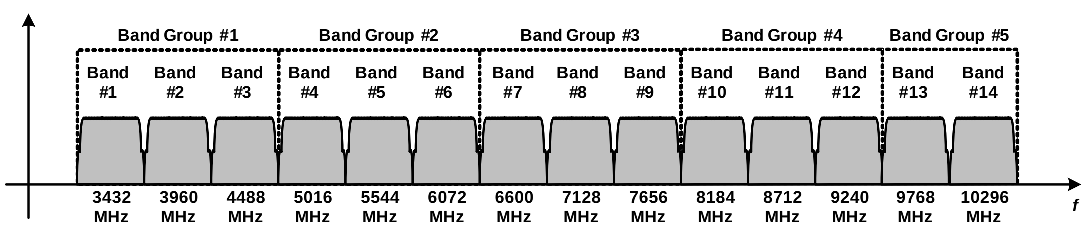

Fig. 7-1. Diagram of the band group allocation

TABLE 7-1. Band group allocation

Band Group	BAND_ID (n_b)	Lower Frequency (MHz)	Center Frequency (MHz)	Upper Frequency (MHz)
1	1	3168	3432	3696
	2	3696	3960	4224
	3	4224	4488	4752
2	4	4752	5016	5280
	5	5280	5544	5808
	6	5808	6072	6336
3	7	6336	6600	6864
	8	6864	7128	7392
	9	7392	7656	7920
4	10	7920	8184	8448
	11	8448	8712	8976
	12	8976	9240	9504
5	13	9504	9768	10032
	14	10032	10296	10560

7.2 Channelization

Unique logical channels are defined by using up to seven different time-frequency codes for each band group. The TFCs and the associated base sequences (and corresponding preambles) for band group 1 are defined in Table 7-2 as a function of BAND_ID values. Similarly, the definitions for the TFCs and the associated base sequences (and corresponding preambles) for band groups 2, 3, 4, and 5 are enumerated in Table 7-3 through Table 7-6.

Editor's Note: For band group 5, only TFC 5 and 6 shall be defined.

TABLE 7-2. Time-Frequency codes and preamble patterns for band group 1

TFC Number	Base Sequence / Preamble	BAND_ID (n_b) for TFC					
1	1	1	2	3	1	2	3
2	2	1	3	2	1	3	2
3	3	1	1	2	2	3	3
4	4	1	1	3	3	2	2
5	5	1	1	1	1	1	1
6	6	2	2	2	2	2	2
7	7	3	3	3	3	3	3

TABLE 7-3. Time-Frequency codes and preamble patterns for band group 2

TFC Number	Base Sequence / Preamble	BAND_ID (n_b) for TFC					
1	1	4	5	6	4	5	6
2	2	4	6	5	4	6	5
3	3	4	4	5	5	6	6
4	4	4	4	6	6	5	5
5	5	4	4	4	4	4	4
6	6	5	5	5	5	5	5
7	7	6	6	6	6	6	6

TABLE 7-4. Time-Frequency codes and preamble patterns for band group 3

TFC Number	Base Sequence / Preamble	BAND_ID (n_b) for TFC					
1	1	7	8	9	7	8	9
2	2	7	9	8	7	9	8
3	3	7	7	8	8	9	9
4	4	7	7	9	9	8	8
5	5	7	7	7	7	7	7
6	6	8	8	8	8	8	8
7	7	9	9	9	9	9	9

TABLE 7-5. Time-Frequency codes and preamble patterns for band group 4

TFC Number	Base Sequence / Preamble	BAND_ID (n_b) for TFC					
1	1	10	11	12	10	11	12
2	2	10	12	11	10	12	11
3	3	10	10	11	11	12	12
4	4	10	10	12	12	11	11
5	5	10	10	10	10	10	10
6	6	11	11	11	11	11	11
7	7	12	12	12	12	12	12

TABLE 7-6. Time-Frequency codes and preamble patterns for band group 5

TFC Number	Base Sequence / Preamble	BAND_ID (n_b) for TFC					
5	5	13	13	13	13	13	13
6	6	14	14	14	14	14	14

The PHY layer channelization scheme is based on the definition of band groups, as defined in Table 7-1, and the definition of TFCs, as defined in Table 7-2 through Table 7-6, and is summarized in Table 7-7. The PHY channels are identified by channel numbers as shown in this table. The channel number takes on values from 0-255 (decimal). The values not defined in Table 7-7 are reserved for future use. Channel numbers 9-15 are mandatory. Channels using TFCs 1-4 shall also be referred to as time-frequency interleaved channels, and those using TFCs 5-7 shall also be referred to as fixed-frequency interleaved channels.

TABLE 7-7. Mapping of channel number to band group and time-frequency code

Channel Number (decimal)	Channel Number (octal)	(Band Group, TF Code)	Mandatory / Optional
9 - 15	011 - 017	(1, 1 - 7)	Mandatory
17 - 23	021 - 027	(2, 1 - 7)	Optional
25 - 31	031 - 037	(3, 1 - 7)	Optional
33 - 39	041 - 047	(4, 1 - 7)	Optional
45 - 46	055 - 056	(5, 5 - 6)	Optional

7.3 PHY Layer Timing

The values for the PHY layer timing parameters are defined in Table 7-8.

TABLE 7-8. PHY layer timing parameters

PHY Parameter	Value
pMIFSTime	$6 \times T_{SYM} = 1.875$ µs
pSIFSTime	$32 \times T_{SYM} = 10.0$ µs
pCCADetectTime	$18 \times T_{SYM} = 5.625$ µs
pBandSwitchTime	9.47 ns

7.3.1 Interframe Spacing

The interframe spacing parameters are given in Table 7-9.

TABLE 7-9. Interframe spacing parameters

MAC Parameter	Value
MIFS	pMIFSTime
SIFS	pSIFSTime

7.3.2 Receive-to-Transmit Turnaround Time

The RX-to-TX turnaround time shall not be greater than pSIFSTime. This turnaround time shall be measured at the air interface. The time elapsed from the leading edge of the last received symbol, where a symbol is composed of the OFDM symbol (IFFT output) and a zero-padded suffix, to the leading edge of the first transmitted symbol of the PLCP preamble for the next frame shall not be greater than pSIFSTime + T_{SYM}.

7.3.3 Transmit-to-Receive Turnaround Time

The TX-to-RX turnaround time shall not be greater than pSIFSTime. This turnaround time shall be measured at the air interface. The time elapsed from the leading edge of the last transmitted symbol until the receiver is ready to begin the reception of the next PHY frame shall not be greater than pSIFSTime + T_{SYM}.

7.3.4 Time Between Successive Transmissions

For uninterrupted successive transmissions by a device in standard mode, the inter-frame spacing after the packet shall be pSIFSTime if PLCP length field is zero, and shall not be less than pMIFSTime if the PLCP length field is nonzero. The interframe spacing time shall be measured at the air interface. When the PLCP length field is zero, the time elapsed from the leading edge of the last transmitted symbol to the leading edge of the first transmitted symbol of the PLCP preamble for the following packet shall be equal to pSIFSTime + T_{SYM}. When the PLCP length field is nonzero, the time elapsed from the leading edge of the last transmitted symbol to the leading edge of the first transmitted symbol of the PLCP preamble for the following packet shall not be less than pMIFSTime + T_{SYM}.

For burst mode transmissions, the interframe spacing between uninterrupted successive transmissions by a device shall be fixed to exactly pMIFSTime ±1 ns. The interframe spacing time shall be measured at the air interface. The time elapsed from the leading edge of the last transmitted symbol to the leading edge of the first transmitted symbol of the PLCP preamble for the following packet shall be fixed to exactly pMIFSTime + T_{SYM} ±1 ns.

7.3.5 Band Frequency Switch Time

The band frequency switch time is defined as the interval from when the PHY receives the last valid sample of a symbol on one band frequency until it is ready to receive the next symbol on a new band frequency. It is required that the switching time between band frequencies not exceed pBandSwitchTime to obtain the best performance.

8. TRANSMITTER SPECIFICATIONS

8.1 Transmit PSD Mask

The transmitted spectral mask shall have the following break points: an emissions level of 0 dBr (dB relative to the maximum spectral density of the signal) from -260 MHz to 260 MHz around the center frequency, -12 dBr at 285 MHz frequency offset, and -20 dBr at 330 MHz frequency offset and above. For all other intermediate frequencies, the emissions level is assumed to be linear in the dB scale. The transmitted spectral density of the transmitted signal shall fall within the spectral mask, as shown in Fig. 8-1.

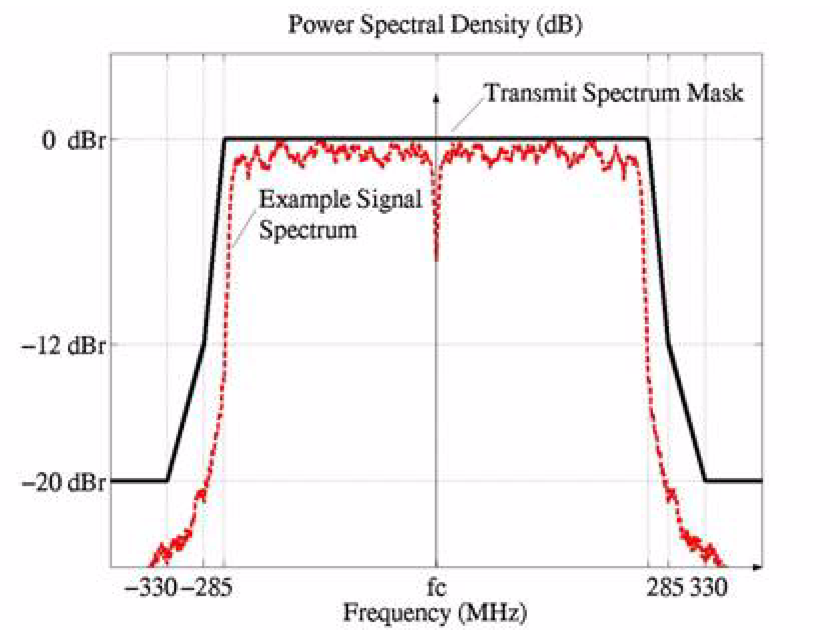

Fig. 8-1. Transmit power spectral density mask

8.2 Transmit Center Frequency Tolerance

The transmitted center frequency tolerance shall be ±20 ppm maximum.

8.3 Symbol Clock Frequency Tolerance

The symbol clock frequency tolerance shall be ±20 ppm maximum.

8.4 Clock Synchronization

The transmit center frequencies and the symbol clock frequency shall be derived from the same reference oscillator.

8.5 Phase Coherence

The transmit carrier frequencies shall be phase coherent within a single band over the duration of a single packet.

Phase coherence in TFI mode means that the phase of the LO is coherent when it returns to the same frequency. For example, let ω_k = radian frequency and θ_k=phase, k={1,2,3}. The LO can be represented as $\sin(\omega_k t + \theta_k)$. Let the hopping pattern be 1,2,3,1,2,3,... Frequency hops occur when t = NT, T=symbol duration. Thus at the hopping points, the LO is $\sin(\omega_1 T + \theta_1)$, $\sin(\omega_2 2T + \theta_2)$, $\sin(\omega_3 3T + \theta_3)$, $\sin(\omega_1 4T + \theta_1)$, $\sin(\omega_2 5T + \theta_2)$, $\sin(\omega_3 6T + \theta_3)$,... which is phase coherent by definition since the LO returns to the same phase θ_1 for N=1,4,...; θ_2 for N=2,5,...; θ_3 for N=3,6,...

8.6 Transmit Power Control

A device should provide support for transmit power control (TPC). The objective of a power control algorithm is to minimize the transmit power spectral density, while still providing a reliable link for the transfer of information.

When the device is using time-frequency interleaving, the monotonic dynamic range for the attenuation of the transmit power shall be 0 – 12 dB, with a step size granularity of 2 dB. On the other hand, when the device is using fixed-frequency interleaving, the monotonic dynamic range for the attenuation of the transmit power shall be 0 – 8 dB, with a step size granularity of 2 dB. Table 8-1 summaries the mapping between the TXPWR_LEVEL and the associated transmit power attenuation.

TABLE 8-1. Mapping between TXPWR_LEVEL and transmit power attenuation

TXPWR_LEVEL	TX Power Attenuation for TFI Modes	TX Power Attenuation for FFI Modes
0	0 dB	0 dB
1	2 dB	2 dB
2	4 dB	4 dB
3	6 dB	6 dB
4	8 dB	8 dB
5	10 dB	RESERVED
6	12 dB	RESERVED
7	RESERVED	RESERVED

In either case, the relative accuracy of change in transmit power attentuation shall be the maximum of ±1 dB or ±20% of the change in the attenuation (in the dB scale). As an example, for an attenuation change of 4 dB and an attenuation change of 8 dB, the allowed relative accuracy is ±1.0 dB and ±1.6 dB, respectively.

Finally, the device shall support a value for the signal-to-carrier leakage at transmitter output port of at least 20 dB and shall satisfy all necessary rules as defined by regulatory bodies where the device would be deployed.

8.7 Transmitter Constellation Error

The relative constellation RMS error, averaged over all data and pilot subcarriers of the OFDM symbols and over all of the frames, shall not exceed the values given in Table 8-2. Note that the relative constellation error values are a function of the transmit power attenuation. Relative constellation error values are based on a multi-path margin of 2.5 dB for data rates of 200 Mb/s and lower and 3.6 dB for data rates 320 Mb/s and higher, and an implementation loss of 2.5 dB. In addition, it is assumed that the degradation due to the relative constellation error can be no more than 0.5 dB for data rates of 200 Mb/s and lower, and 1.0 dB for data rates of 320 Mb/s and higher.

TABLE 8-2. Permissible relative constellation error for device transmitting at full power

	Relative Constellation RMS Error		
Data Rate (Mb/s)	No TX Attenuation	TX Attenuation of 2, 4, 6 dB (both TFI and FFI)	TX Attenuation of 8, 10, 12 dB (both TFI and FFI)
53.3, 80, 106.7, 160, 200	-17.0 dB	-15.5 dB	-14.5 dB
320, 400, 480	-19.5 dB	-18.0 dB	-17.0 dB

The relative constellation RMS error calculation shall be performed using a device capable of converting the transmitted signal into a stream of complex samples at 528 Msample/s or more, with sufficient accuracy in the I/Q imbalance, DC offset, phase noise, etc. The sampled signal shall then be processed in a manner similar to that of an ideal receiver including adding the first 32 samples of the zero-padded suffix to the received OFDM symbol via the overlap-and-add method. An example of the minimum steps necessary for receiver processing is listed below:

1. Detect the start of the packet and frame boundary.
2. Estimate the correct sampling time and frequency offset. Correct as needed.
3. Estimate the channel frequency response and equalize the channel.

4. For each of the data and pilot subcarriers, find the closest constellation point and compute the Euclidean distance.
5. Compute the RMS error, averaged over all the data and pilot subcarriers and over all frames, as follows:

$$RMS_{error} = \frac{1}{N_f}\sum_{i=1}^{N_f}\sqrt{\sum_{n=1+N_{sync}+N_{hdr}}^{N_{packet}}\left[\frac{\sum_{k=1}^{N_D}\left|R_{D,n}[k]-C_{D,n}[k]\right|^2+\sum_{k=1}^{N_P}\left|R_{P,n}[k]-C_{P,n}[k]\right|^2}{(N_D+N_P)N_{frame}P_0}\right]}\quad, \tag{8-1}$$

where N_f is the number of packets under test, N_{packet} is the number of symbols in the packet, N_{sync} is the number of symbols in the PLCP preamble, N_{hdr} is the number of symbols in the PLCP header, $N_{frame} = N_{packet} - N_{sync} - N_{hdr}$ is the number of symbols in the PSDU, N_D is the number of data subcarriers, N_P is the number of pilot subcarriers, P_0 is the average power of the data and pilot constellations, $C_{D,n}[k]$ and $C_{P,n}[k]$ are the transmitted k^{th} data subcarrier and k^{th} pilot subcarrier for the n^{th} OFDM symbol, respectively, and $R_{D,n}[k]$ and $R_{P,n}[k]$ are the observed k^{th} data subcarrier and k^{th} pilot subcarrier for the n^{th} OFDM symbol, respectively. The values for N_D and N_P are defined in Table 6-2, while the values for N_{sync}, N_{hdr}, N_{frame}, and N_{packet} are defined in Table 6-3. The RMS error shall be computed over the payload portion of the packet only. Hence, P_0 is also calculated over the payload only. P_0 is re-computed for every packet.

Editor's Note: The test shall be performed over a minimum of $N_f = 100$ packets, where the PSDU of each packet is at least 30 symbols in length and is generated from random data.

9. Receiver Specification

9.1 Receiver Sensitivity

For a packet error rate (PER) of less than 8% with a PSDU of 1024 octets, the minimum receiver sensitivity numbers in AWGN for the different data rates are listed in Table 9-1 for band group 1, where a noise figure of 6.6 dB (referenced at the antenna), an implementation loss of 2.5 dB, and a margin of 3 dB have been assumed.

TABLE 9-1. Minimum receiver sensitivities for band group 1

Data Rate (Mb/s)	Minimum Receiver Sensitivity (dBm)
53.3	-80.8
80	-78.9
106.7	-77.8
160	-75.9
200	-74.5
320	-72.8
400	-71.5
480	-70.4

9.2 Receiver CCA Performance

The start of a valid OFDM transmission at a receiver level equal to or greater than the minimum sensitivity for a 53.3 Mb/s transmission (-80.8 dBm) shall cause CCA to indicate that the channel is busy with a probability > 90% within pCCADetectTime.

9.3 Link Quality Indicator

A device should be capable of estimating the link quality of the received channel, where the link quality shall be defined as an estimate of the SNR available after the FFT and will included all implementation losses associated with that particular receiver architecture (quantization noise, channel estimation errors, etc.). Devices shall be capable of estimating values in the range from –6 dB to +12 dB. Estimating values above +12 dB is optional. All estimated values, when measured under static channel conditions, shall be monotonically increasing with signal strength over the entire reporting range. Note that the estimates may exhibit saturation behavior at values higher than +12 dB. Finally, the link quality estimates shall be made on a packet-by-packet basis.

When reporting the estimates of the link quality, the device shall quantize these values to the nearest dB in the range from –6 dB to +24 dB and report them as the link quality estimate (LQE). The accuracy of the LQE is defined as the standard deviation of the packet-by-packet estimates for a static AWGN channel and a fixed SNR value. Table 9-2 enumerates the allowed standard deviation of the estimates as a function of the reporting range. Even though the reported estimates should be nominally equal to the SNR after the FFT, no bounds on absolute accuracy with respect to an external reference plane are intended or implied by this specification.

TABLE 9-2. Allowed Standard Deviation for the LQE with a payload of 1024 Bytes

Link Quality Estimate (LQE)	Standard Deviation for Estimate (σ)
–6 dB, …, –4 dB	1.3 dB
–3 dB, …, 0 dB	1.1 dB
1 dB, …, 6 dB	0.9 dB
7 dB, …, 24 dB	0.7 dB

The mapping between LQE and the Link Quality Indicator (LQI) is summarized in Table 9-3. A standard encoding is used to report the estimates in the range from –6 dB (0000 0001) to +24 dB (0001 1111). The all-zero bit representation implies that reporting of LQE is not supported by the device, or that LQE is too small to be measured accurately. Additionally, the range from 1000 0000 to 1011 1111 and the range from 1100 0000 to 1111 1111 are defined to allow vendors to report additional link quality information. All other bit representations are reserved for future use.

Editor's Note: The test for the accuracy of the link quality estimate shall be performed over a minimum of $N_f = 1000$ *packets, where the PSDU of each packet is at least* 1024 *bytes in length and is generated from random data.*

TABLE 9-3. Encoding for the Link Quality Estimates

LQI	Description
0000 0000	Reporting of Link Quality is not supported, or Link Quality is too low to be measured
0000 0001 – 0001 1111	LQI = (LQE + 7) dB
0010 0000 – 0111 1111	Reserved
1000 0000 – 1011 1111	Vendor specific Link Quality encoding
1100 0000 – 1111 1111	Vendor specific Link Quality encoding

10. Ranging and Location Awareness

A device may implement the capability to determine the relative location of one device with respect to another. The distance or range between the devices can be estimated by multiplying the speed of light by the measured propagation delay between the devices. The following resources are included to support range detection and calculation in the MAC.

10.1 Ranging requirements

If ranging is implemented, all devices shall support ranging capabilities with an accuracy and precision of ±60 cm or better.

10.2 Ranging reference signal

The propagation delay between two devices should be measured with respect to a ranging reference signal. The reference point is defined as the beginning of the first channel estimation symbol in the PLCP preamble, i.e., the first sample of the first channel estimation sequence $s_{sync,N_{pf}}[0]$ (see Section 6.2, Fig. 6-2, Fig. 6-3 and (6-2)).

10.3 PHY ranging resources

If ranging is supported, the PHY shall contain a MIB attribute pRangingTimer to capture the time of generation or detection of the ranging reference signal. This attribute represents a ranging timer, which is nominally a 32-bit value [31:0], with bit 0 clocked at 4224 MHz. This represents timing uncertainty of 7.1 cm.

In the minimum implementation, pRangingTimer is 15 bits of counter [17:3]; bits [31:18] and [2:0] = 0. Bit 3 is clocked at 528 MHz for 56.8 cm ranging uncertainty. To provide increasing precision, optional implementations may clock bit 2 at 1056 MHz (28.4 cm), bit 1 at 2112 MHz (14.2 cm), or clock bit 0 at 4224 MHz (7.1 cm). To support MAC algorithms that use multiple ranging transactions to correct for frequency offset between two stations, longer counters may be provided in PHY hardware or in MAC logic. If implemented in the PHY, more of the bits [31:18] will be active. For a list of valid timer configurations see Table 11-8.

10.4 PHY ranging operation

If ranging is supported, the PHY shall control when the counter pRangingTimer shall start, stop and reset. If ranging is supported, the value of the counter pRangingTimer shall be captured in a register exposed to the MAC when one of two events occurs:

- PHY is in transmit mode, and the PHY generates the ranging reference signal.
- PHY is in receive mode, and the PHY detects the ranging reference signal.

10.5 Ranging Calibration Constants

If ranging is supported, the PHY shall provide to the MAC implementation two constants in order to support ranging calculations in the MAC (e.g. in the PHY device specifications):

1. RANGING_TRANSMIT_DELAY = the time from the generation of the reference signal (see Section 10.2), triggering the pRangingTimer capture, to the time this signal reaches its own antenna,

2. RANGING_RECEIVE_DELAY = the time from the arrival of the reference signal at the antenna to the time this signal is first detected in the PHY, triggering the pRangingTimer clock capture.

These constants are 16-bit unsigned integer values, in units of 4224 MHz clock periods. These values allow the MAC to correct the pRangingTimer values for delays in the PHY and associated circuits.

10.6 Example Range Measurement (Informative)

Fig. 10-1 shows a pair of ranging frames being exchanged between two devices. R_{M1} is designated as the initial ranging measurement frame transmitted by device #1, whereas R_{M2} is designated as the reply ranging measurement frame transmitted by device #2. Each device must take two measurements: one when the ranging measurement frame is sent (T_i, where $i = 1, 2$), and one when the ranging measurement frame is received (R_i, where $i = 1, 2$). Next, each device must apply the calibration constants (see Section 10.5) to account for signal processing delays through the transmit and receive chains:

$$T_{ic} = T_i + \text{RANGING\_TRANSMIT\_DELAY}, \tag{10-1}$$

$$R_{ic} = R_i - \text{RANGING\_RECEIVE\_DELAY}, \tag{10-2}$$

where i = 1, 2, and where T_{ic} and R_{ic} are the calibrated time measurements. Finally, device #2 must deliver the measurement values T_{2c} and R_{2c} to device #1.

Given the four compensated time measurements, a simple range estimate, D, can be calculated as follows:

$$D = c \times \left[\frac{(R_{2c} - T_{1c}) - (T_{2c} - R_{1c})}{2} \right], \tag{10-3}$$

where c is the speed of light.

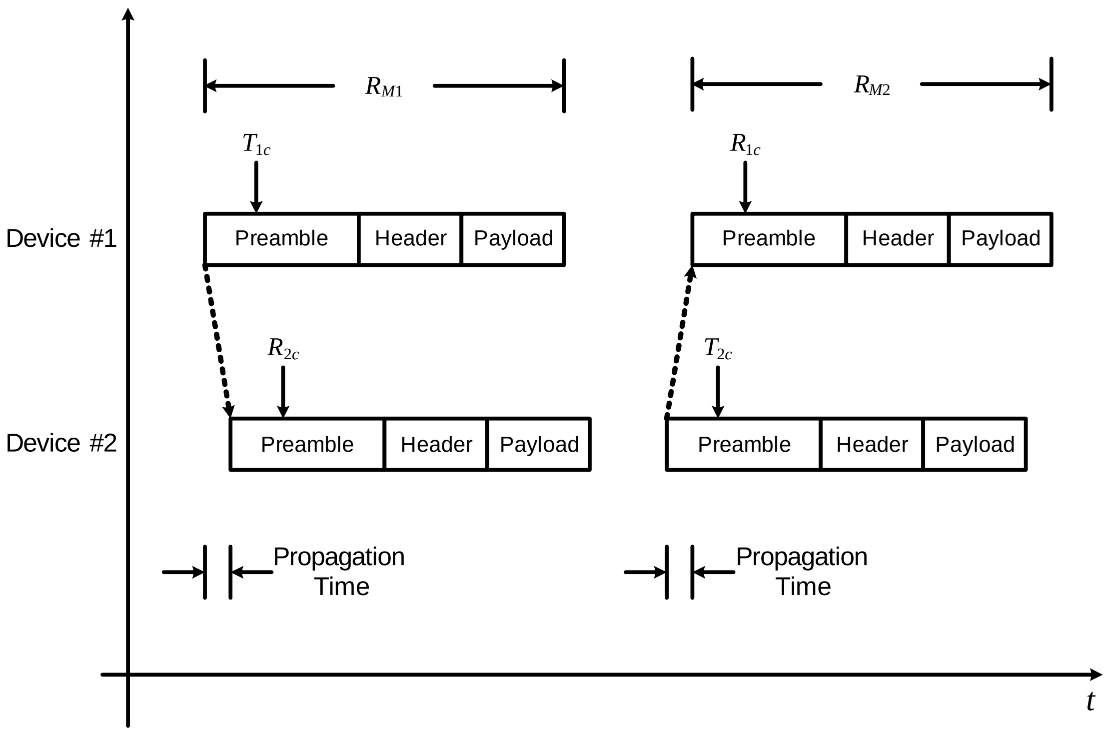

Fig. 10-1. Example ranging measurement frame pair

11. PHY SERVICE AND MANAGEMENT

The physical layer (PHY) provides data services to the medium access control (MAC) sublayer through the PHY service access point (SAP). These services are described in this clause in terms of PHY primitives exchanged between the MAC and the PHY via the PHY SAP.

To facilitate such data services, the MAC sublayer management entity (MLME) in turn provides management to the PHY layer management entity (PLME) on behalf of itself or the device management entity (ME). Management information is exchanged across the PLME SAP, and is expressed through the PLME primitives defined in this clause.

Both the PHY SAP and PLME SAP referenced in this specification are logical interfaces and do not necessarily imply a particular implementation or an exposed interface.

11.1 PHY SAP Interface

Table 11-1 lists the PHY SAP primitives for peer-to-peer interactions. Table 11-2 lists the PHY SAP primitives for sublayer-to-sublayer interactions only.

TABLE 11-1. PHY-SAP peer-to-peer service primitives

Primitive	Request	Indication	Response	Confirm
PHY-DATA	×	×	×	×

TABLE 11-2. PHY-SAP sublayer-to-sublayer service primitives

Primitive	Request	Indication	Response	Confirm
PHY-TX-START	×			×
PHY-TX-END	×			×
PHY-CCA-START	×			×
PHY-CCA-END	×			×
PHY-RX-START	×	×		×
PHY-RX-END	×	×		×

The remainder of this subclause describes the services provided using these PHY primitives.

11.1.1 Data Transfer

This mechanism supports the procedure of transferring an octet of data from the MAC entity to the PHY entity or vice versa. Table 11-3 lists the parameters that appear in the primitives of this subclause.

TABLE 11-3. PHY-DATA primitive parameters

Name	Type	Valid Range	Description
DATA	Bit String	0×00 - 0×FF	Appears in PHY-DATA.request and PHY-DATA.indication; specifies an octet of bit string for transfer from the MAC to the PHY or vice versa.

11.1.1.1 PHY-DATA.request

This primitive requests the transfer of an octet of data from the MAC to the PHY. The semantics of the primitive are as follows:

PHY-DATA.request(DATA)

11.1.1.1.1 When Generated

This primitive is generated by the MAC to request the transfer of a single octet of data from the MAC to the PHY. It may only be issued following a transmit initialization confirmation (PHY-TX-START.confirm) from the PHY.

11.1.1.1.2 Effect of Receipt

The PHY transfers a single octet of data from the MAC. It subsequently issues a PHY-DATA.confirm to the MAC.

11.1.1.2 PHY-DATA.confirm

This primitive reports the transfer of an octet of data from the MAC to the PHY. The semantics of the primitive are as follows:

PHY-DATA.confirm

11.1.1.2.1 When Generated

The primitive is generated by the PHY following the transfer of an octet of data from the MAC to the PHY.

11.1.1.2.2 Effect of Receipt

The MAC generates the next PHY-DATA.request to transfer the next octet of data to the PHY, if applicable.

11.1.1.3 PHY-DATA.indication

This primitive indicates a transfer of an octet of data from the PHY to the MAC. The semantics of the primitive are as follows:

PHY-DATA.indication(DATA)

11.1.1.3.1 When Generated

This primitive is generated by a receiving PHY entity to transfer an octet of available data to the local MAC entity. It may only be issued following a receive initialization confirmation (PHY-RX-START.confirm) from the PHY.

11.1.1.3.2 Effect of Receipt

The MAC transfers a single octet of data from the PHY. It subsequently issues a PHY-DATA.response to the PHY.

11.1.1.4 PHY-DATA.response

This primitive responds to the transfer of an octet of data from the PHY to the MAC. The semantics of the primitive are as follows:

PHY-DATA.response

11.1.1.4.1 When Generated

The primitive is generated by the MAC to respond to the PHY after an octet of data has been transferred from the PHY to the MAC.

11.1.1.4.2 Effect of Receipt

The PHY will generate the next PHY-DATA.indication for the transfer of the next available octet of data to the MAC, if applicable.

11.1.2 PHY Transmission Control

This mechanism supports the procedure of controlling the start or end of a PHY transmission. Table 11-4 lists the parameters that appear in the primitives of this subclause via TXVECTOR.

TABLE 11-4. TXVECTOR parameters

Name	Type	Valid Range	Description
LENGTH	Integer	0 .. pMaxFramePayloadSize for standard mode; 1 .. pMaxFramePayloadSize for burst mode	Specifies the number of octets in the frame payload (which does not include the FCS, tail bits, and pad bits) that the MAC is requesting the PHY to transmit.
DATARATE	Bit String	5 bits	Specifies the data rate at which the frame body is to be transmitted (see Table 6-14).
BURST_MODE	Enumeration	0 = standard mode; 1 = burst mode	Indicates whether the transmission is in the middle of a burst, i.e., whether the current PPDU will be followed by another PPDU transmitted by this device with a MIFS separation.
PREAMBLE_TYPE	Enumeration	0 = standard preamble; 1 = burst preamble	Specifies the type of preamble for the next PPDU when BM is set to 1; Reserved when BM is set to 0.
SCRAMBLER_INIT	Bit String	2 bits	Provides a 2-bit value to initialize the scrambler for the current PPDU transmission (see Table 6-19).
TXPWR_LEVEL	Integer	0-7	Specifies the transmit power attenuation for the current PPDU transmission (see Table 8-1)
TX_TFC	Bit String	3 bits	Specifies the TFC code used for transmission of the current packet (see Table 6-17).
BG_LSB	Enumeration	1 bit	Specifies the LSB of the band group used for transmission of the current packet (see Table 6-18).
MAC_HEADER	Octet String	10 octets	Provides the MAC header for the current PPDU for transmission.

11.1.2.1 PHY-TX-START.request

This primitive requests the local PHY entity to start the transmission of a PPDU onto the wireless medium. The semantics of the primitive are as follows:

PHY-TX-START.request(TXVECTOR)

11.1.2.1.1 When Generated

The primitive is generated by the MAC sublayer to initiate the transmission of a PPDU by the local PHY entity onto the wireless medium.

11.1.2.1.2 Effect of Receipt

The PHY begins transmitting a PLCP preamble. It subsequently issues a PHY-TX-START.confirm to the MAC.

11.1.2.2 PHY-TX-START.confirm

This primitive reports the start of the PLCP preamble transmission by the PHY. The semantics of the primitive are as follows:

PHY-TX-START.confirm

11.1.2.2.1 When Generated

This primitive is generated by the PHY to indicate to the MAC the start of transmission of the PPDU onto the wireless medium.

11.1.2.2.2 Effect of Receipt

The MAC proceeds to issue PHY-DATA.request primitives to transfer the TXVECTOR and frame body, if any, to the PHY when they are available, or to issue a PHY-TX-END.request primitive to end PHY’s transmission.

11.1.2.3 PHY-TX-END.request

This primitive requests the local PHY entity to end the transmission. The semantics of the primitive are as follows:

PHY-TX-END.request

11.1.2.3.1 When Generated

This primitive is generated by the MAC following reception of the last PHY-DATA.confirm from the PHY for the current MPDU transfer.

11.1.2.3.2 Effect of Receipt

The PHY stops the transmission and subsequently issues a PHY-TX-END.confirm to the MAC.

11.1.2.4 PHY-TX-END.confirm

This primitive reports the PHY's exit from the transmission. The semantics of the primitive are as follows:

PHY-TX-END.confirm

11.1.2.4.1 When Generated

This primitive is generated by the PHY upon stopping the local transmission.

11.1.2.4.2 Effect of Receipt

The MAC is in a position to initiate the next transmit, receiver, or power management operation.

11.1.3 PHY Reception Control

This mechanism supports the procedure of controlling the start or end of a PHY reception. Table 11-5 lists the parameters that appear in the primitives of this subclause via RXVECTOR.

TABLE 11-5. RXVECTOR parameters

Name	Type	Valid Range	Description
LENGTH	Integer	0 .. pMaxFramePayloadSize for standard mode; 1 .. pMaxFramePayloadSize for burst mode;	Specifies the number of octets in the frame payload (which does not include the FCS, tail bits, and pad bits) that the PHY will be transferring to the MAC.
DATARATE	Bit String	5 bits	Specifies the data rate at which the frame body is received (see Table 6-14).
BURST_MODE	Enumeration	0 = standard mode; 1 = burst mode	Indicates whether the reception is in the middle of a burst, i.e., whether the current PPDU will be followed by another PPDU transmitted by the same device with a MIFS separation.
PREAMBLE_TYPE	Enumeration	0 = standard preamble; 1 = burst preamble	Specifies the type of preamble for the next PPDU when BM is set to 1; Reserved when BM is set to 0.
TX_TFC	Bit String	3 bits	Specifies the TFC code used for transmission of the current packet (see Table 6-17).
BG_LSB	Enumeration	1 bit	Specifies the LSB of the band group used for transmission of the current packet (see Table 6-18).
MAC_HEADER	Octet String	10 Octets	Provides the MAC header for the received PPDU.
HEADER_ERROR	Integer	0-255	Value = 0: HCS valid Bit 4 = 1: HCS invalid Bit 3 = 1: Unsupported data rate
RSSI	Integer	0 .. RSSIMaximum	Provides the receive signal strength indication, in decibels, a measure of the energy observed at the antenna used to receive the PLCP preamble of the current PPDU, and a monotonically increasing function of the received power.
LQI	Bit String	8 bits	Provides a monotonically increasing measure of the link quality as assessed by the PHY (see Table 9-3).

11.1.3.1 PHY-RX-START.request

This primitive requests the local PHY entity to start reception. The semantics of the primitive are as follows:

PHY-RX-START.request

11.1.3.1.1 When Generated

The primitive is generated by the MAC sublayer to initiate or continue the acquisition of a PLCP preamble by the local PHY entity for an anticipated PPDU reception.

11.1.3.1.2 Effect of Receipt

The PHY begins PLCP preamble acquisition. It subsequently issues a PHY-RX-START.confirm to the MAC.

11.1.3.2 PHY-RX-START.indication

This primitive indicates acquisition of a PLCP preamble by the local PHY entity. The semantics of the primitive are as follows:

PHY-RX-START.indication

11.1.3.2.1 When Generated

This primitive is generated by a receiving PHY entity upon detecting the end of the synchronization sequence of a PLCP preamble.

11.1.3.2.2 Effect of Receipt

The MAC is provided with a reference time for determining the start of the received frame on the local air interface.

11.1.3.3 PHY-RX-START.confirm

This primitive reports reception of the PLCP header by the PHY. The semantics of the primitive are as follows:

PHY-RX-START.confirm(RXVECTOR)

11.1.3.3.1 When Generated

This primitive is generated by the PHY following complete reception of the PLCP header or a timeout.

11.1.3.3.2 Effect of Receipt

The MAC is in a position to receive PHY-DATA.request primitives for the transfer of the RXVECTOR and frame body, if any, or issue a PHY-RX-END.request to abort the receive operation.

11.1.3.4 PHY-RX-END.request

This primitive requests the local PHY entity to end the reception. The semantics of the primitive are as follows:

PHY-RX-END.request

11.1.3.4.1 When Generated

This primitive is generated by the MAC following reception of the last PHY-DATA.indication from the PHY for the anticipated receive MPDU transfer.

11.1.3.4.2 Effect of Receipt

The PHY stops the reception and issues a PHY-TX-END.confirm to the MAC.

11.1.3.5 PHY-RX-END.indication

This primitive indicates completion of a PPDU reception from the wireless medium. The semantics of the primitive are as follows:

PHY-RX-END.indication

11.1.3.5.1 When Generated

This primitive is generated by a receiving PHY entity upon receiving the complete PPDU from the wireless medium.

11.1.3.5.2 Effect of Receipt

The MAC is provided with a reference time for determining the end of the received frame on the local air interface.

11.1.3.6 PHY-RX-END.confirm

This primitive reports the PHY’s exit from the reception. The semantics of the primitive are as follows:

PHY-RX-END.confirm

11.1.3.6.1 When Generated

This primitive is generated by the PHY upon stopping the reception.

11.1.3.6.2 Effect of Receipt

The MAC is in a position to initiate the next transmit, receiver, or power management operation.

11.1.4 PHY CCA Control

This mechanism supports the procedure of controlling the start or end of a PHY CCA. There are no parameters that appear in the primitives of this subclause.

11.1.4.1 PHY-CCA-START.request

This primitive requests the local PHY entity to start its CCA operation. The semantics of the primitive are as follows:

PHY-CCA-START.request

11.1.4.1.1 When Generated

This primitive is generated by the MAC sublayer to initiate the CCA by the PHY entity.

11.1.4.1.2 Effect of Receipt

The PHY starts its CCA operation and reports the CCA result in the PHY MIB pCCA-Status attribute. It subsequently issues a PHY-CCA-START.confirm to the MAC. The PHY updates the CCAStatus value whenever the CCA result is changed, until a subsequent PHY-CCA-END.request is issued by the MAC.

11.1.4.2 PHY-CCA-START.confirm

This primitive reports the start of the CCA operation by the PHY. The semantics of the primitive are as follows:

PHY-CCA-START.confirm

11.1.4.2.1 When Generated

This primitive is generated by the PHY to indicate to the MAC the start of the CCA.

11.1.4.2.2 Effect of Receipt

The MAC/MLME may proceed to issue generic management primitives PLME-GET (CCAStatus) to obtain and update the CCA result.

11.1.4.3 PHY-CCA-END.request

This primitive requests the local PHY entity to end the CCA operation. The semantics of the primitive are as follows:

PHY-CCA-END.request

11.1.4.3.1 When Generated

This primitive is generated by the MAC whenever CCA is no longer needed.

11.1.4.3.2 Effect of Receipt

The PHY stops the CCA operation.

11.1.4.4 PHY-CCA-END.confirm

This primitive reports the end of the CCA operation by the PHY. The semantics of the primitive are as follows:

PHY-CCA-END.confirm

11.1.4.4.1 When Generated

This primitive is generated by the PHY upon stopping the CCA operation.

11.1.4.4.2 Effect of Receipt

The MAC stops issuing generic management primitives PLME-GET (pCCAStatus) to obtain the CCA result.

11.2 PLME SAP Interface

The PHY management service is provided using the generic management service primitives PLME-GET and PLME-SET operating on PHY MIB attributes defined in Table 11-6 and Table 11-7, and the management service primitives operating on no specific PHY MIB attributes as listed in Table 11-9.

TABLE 11-6. PHY MIB attributes

Name	Type	Valid Range	Description
pMaxFramePayloadSize	Integer	0 - 4095	Specifies the maximum allowed length of the frame payload (which does not include an FCS) in any MPDU.
pPowerState	Enumeration	SLEEP, STANDBY, READY	Specifies the power state of the PHY.
pCCAStatus	Enumeration	CHANNEL_BUSY, CHANNEL_CLEAR	Indicates the medium activity of the channel

TABLE 11-7. PHY MIB ranging attributes

Name	Type	Valid Range	Description
pRCLKOptions	Integer	See Table 11-8	Specifies the ranging support capabilities. Value set to 0 if ranging is not supported. bit 0: set if ranging is supported; bit 1: set if a 528 MHz timer is used; bit 2: set if a 1056 MHz timer is used; bit 3: set if a 2112 MHz timer is used; bit 4: set if a 4224 MHz timer is used; bit 5: set if pRangingTimer bits [23:18] are active; bit 6: set if pRangingTimer bits [31:24] are active
pRCLKTolerance	Integer	0 - 255	Specifies the PHY ranging timer accuracy in PPM.
pRangingTimer	Integer	0 - (2^{31}-1)	Specifies the ranging timer value via a 32-bit unsigned integer. If bit 4 of pRCLKOptions is 0, Timer[0] = 0. If bit 3 of pRCLKOptions is 0, Timer[1] = 0. If bit 2 of pRCLKOptions is 0, Timer[2] = 0. If bit 5 of pRCLKOptions is 0, Timer[23:18] = 0×00. If bit 6 of pRCLKOptions is 0, Timer[31:24] = 0×00.

TABLE 11-8. Ranging pRCLKOptions valid values

Value (Hex)	Active Timer Bits	Clock Frequency (MHz)	Timer Span
00	N/A	N/A	N/A
03	[17:3]	528	62.1 μs
05	[17:2]	1056	62.1 μs
09	[17:1]	2112	62.1 μs
11	[17:0]	4224	62.1 μs
23	[23:3]	528	3.97 ms
25	[23:2]	1056	3.97 ms
29	[23:1]	2112	3.97 ms
31	[23:0]	4224	3.97 ms
63	[31:3]	528	1.02 s
65	[31:2]	1056	1.02 s
69	[31:1]	2112	1.02 s
71	[31:0]	4224	1.02 s

TABLE 11-9. PLME-SAP service primitives

Primitive	Request	Indicate	Response	Confirm
PLME-RESET	×			×
PLME-RANGING-TIMER-START	×			×
PLME-RANGING-TIMER-END	×			×

11.2.1 PHY Reset

This mechanism supports the procedure of resetting the PHY layer and its management entity. Table 11-10 lists the parameters that appear in the primitives of this subclause.

TABLE 11-10. PLME-RESET primitive parameters

Name	Type	Valid Range	Description
ResetResultCode	Enumeration	SUCCESS, FAILED	Indicates the result of the PHY reset procedure.

11.2.1.1 PLME-RESET.request

This primitive requests to reset the PHY data path and its management entity and MIB. The semantics of the primitive are as follows:

PLME-RESET.request

11.2.1.1.1 When Generated

This primitive is generated by the MLME on behalf of itself or the DME whenever the PHY needs to be reset.

11.2.1.1.2 Effect of Receipt

The PHY resets both transmission and reception, the CCA operation, and its management entity and MIB. The PHY enters the STANDBY state. The PLME subsequently issues a PHY-RESET.confirm to the MLME.

11.2.1.2 PLME-RESET.confirm

This primitive reports the results of a reset procedure. The semantics of the primitive are as follows:

PLME-RESET.confirm(ResetResultCode)

11.2.1.2.1 When Generated

This primitive is generated by the PLME as a result of a PLME-RESET.request.

11.2.1.2.2 Effect of Receipt

The DME or MLME is notified of the results of the PHY reset procedure.

11.2.2 PHY Ranging Timer Control

This mechanism supports the procedure of enabling or disabling the PHY ranging timer. There are no parameters that appear in the primitives of this subclause.

11.2.2.1 PLME-RANGING-TIMER-START.request

This primitive requests to enable the PHY ranging timer. The semantics of the primitive are as follows:

PLME-RANGING-TIMER-START.request

11.2.2.1.1 When Generated

This primitive is generated by the MLME on behalf of itself or the DME to enable the PHY ranging timer.

11.2.2.1.2 Effect of Receipt

The PLME enables the PHY ranging timer. The PHY captures the value of the ranging timer in the MIB attribute pRangingTimer. It subsequently issues a PHY-RANGING-TIMER-START.confirm to the MLME.

11.2.2.2 PLME-RANGING-TIMER-START.confirm

This primitive reports the enabling of the PHY ranging timer. The semantics of the primitive are as follows:

PLME-RANGING-TIMER-START.confirm

11.2.2.2.1 When Generated

This primitive is generated by the PLME as a result of a PLME-RANGING-TIMER-START.request.

11.2.2.2.2 Effect of Receipt

The DME or MLME is notified of the enabling of the PHY ranging timer.

11.2.2.3 PLME-RANGING-TIMER-END.request

This primitive requests to disable the PHY ranging timer. The semantics of the primitive are as follows:

PLME-RANGING-TIMER-END.request

11.2.2.3.1 When Generated

This primitive is generated by the MLME on behalf of itself or the DME to disable the PHY ranging timer.

11.2.2.3.2 Effect of Receipt

The PLME disables the PHY ranging timer. It subsequently issues a PHY-RANGING-TIMER-END.confirm to the MLME.

11.2.2.4 PLME-RANGING-TIMER-END.confirm

This primitive reports the disabling of the PHY ranging timer. The semantics of the primitive are as follows:

PLME-RANGING-TIMER-END.confirm

11.2.2.4.1 When Generated

This primitive is generated by the PLME as a result of a PLME-RANGING-TIMER-START.request.

11.2.2.4.2 Effect of Receipt

The DME or MLME is notified of the disabling of the PHY ranging timer. The DME or MLME ceases to get the value of the MIB attribute pRangingTimer.

ANNEX A - EXAMPLE ENCODING OF A PHY PACKET

A.1 Introduction

In this Annex, an example test vector for a 40-octet payload transmitted at 200 Mb/s is provided. Note that in this example some of the intermediate data has been excluded for purposes of clarity, but the entire packet at the output of the transmitter is shown in Appendix A.4. The packet shall be created as shown in Fig. 6-1, where the standard PLCP preamble is created as shown in Fig. 6-2 and Fig. 6-3, the PLCP header is created as shown in Fig. 6-6 and Fig. 6-7, and the PSDU is created as shown in Fig. 6-11 and Fig. 6-12.

A.2 Example Device Parameters

The device parameters for this example are enumerated in Table A-1.

A.2.1 PHY Header

The PHY header is a non-scrambled 5-octet field as defined in Section 6.3.1. Based on the parameters listed in Table A-1, the PHY header is described in bits as:

phyHeader = [0 0 0
0 0 1 0 0 (Data Rate)
0 0 0 1 0 1 0 0 0 0 0 0 (Length in Octets)
0 0
0 1 (Scrambler Seed)
0 0
1 (Burst Mode)
0 (Preamble Type)
1 0 0 (TX_TFC)
1 (BG_LSB)
0 0 0 0 0 0 0 0], (11-1)

or, equivalently in octets as 20 28 80 94 00.

TABLE A-1. Example device parameters

Parameter	Value
Time Frequency Code (TFC)	1
Band Group	1
Preamble Mode	Standard
Data Rate	200 Mb/s
Modulation	QPSK
Coding Rate	5/8
FDS	NO
TDS	YES
RATE Bits (R1-R5)	00100
LENGTH	40 bytes
SCRAMBLER (S1-S2)	01
Preamble Type (PT) Bit	0
Burst Mode (BM) Bit	1

A.2.2 MAC Header

The MAC header is a 10-octet field and for this example is given by:

$$\text{D3 C2 36 8C 8F 36 0D BB ED BA} \tag{11-2}$$

The bit representation for the MAC Header is shown in Table A-2.

A.2.3 Generation of the HCS

The HCS is computed over the PHY and the MAC header using a 16-bit CRC as described in Section 6.3.3. HCS is calculated without the tail bits inserted between the PHY and MAC header. The resulting HCS is given by in bit representation as:

$$1\ 1\ 0\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 1\ 0\ 1\ 0\ 1\ 1 \tag{11-3}$$

The resulting 2 octets are appended to the end of the MAC header.

TABLE A-2. MAC header in bits

Bit #	Value	Bit #	Value	Bit #	Value	Bit #	Value
1	1	21	1	41	0	61	1
2	1	22	1	42	1	62	1
3	0	23	0	43	1	63	0
4	0	24	0	44	0	64	1
5	1	25	0	45	1	65	1
6	0	26	0	46	1	66	0
7	1	27	1	47	0	67	1
8	1	28	1	48	0	68	1
9	0	29	0	49	1	69	0
10	1	30	0	50	0	70	1
11	0	31	0	51	1	71	1
12	0	32	1	52	1	72	1
13	0	33	1	53	0	73	0
14	0	34	1	54	0	74	1
15	1	35	1	55	0	75	0
16	1	36	1	56	0	76	1
17	0	37	0	57	1	77	1
18	1	38	0	58	1	78	1
19	1	39	0	59	0	79	0
20	0	40	1	60	1	80	1

A.2.4 PLCP Header

The PHY header and a scrambled version of the MAC header and HCS are encoded using a shortened Reed-Solomon (23,17) code as defined in Section 6.3.2. The Reed-Solomon message octets are given in Table A-3. The resulting Reed-Solomon parity octets are listed in Table A-4.

TABLE A-3. Reed-Solomon message octets

m_i	Octet Value
m_{16}	20
m_{15}	28
m_{14}	80
m_{13}	94
m_{12}	00
m_{11}	D3
m_{10}	E2
m_9	36
m_8	94
m_7	8F
m_6	3C
m_5	8D
m_4	BC
m_3	CD
m_2	B8
m_1	A3
m_0	D5

TABLE A-4. Reed-Solomon parity octets

r_i	Octet Value
r_5	BC
r_4	6E
r_3	DF
r_2	A9
r_1	5E
r_0	BD

A.3 Frame Payload Transmission

The frame payload that is transmitted in this example is given in Table A-5.

TABLE A-5. 40-octet payload

#		#		#		#	
1	7B	11	2B	21	92	31	FB
2	B1	12	D5	22	DD	32	56
3	C0	13	6E	23	11	33	78
4	0A	14	E7	24	9E	34	E5
5	AB	15	02	25	B2	35	DC
6	87	16	E2	26	BA	36	29
7	44	17	F6	27	AE	37	F5
8	71	18	EA	28	59	38	CC
9	33	19	0E	29	A4	39	00
10	C1	20	A5	30	08	40	3C

The FCS for the 40-octet message is given below in octet format

DE 89 E6 B2 (11-4)

The FCS along with the tail bits and potentially pad bits are then appended to the frame payload to create the PSDU.

A.4 Complete Transmitted Packet

The symbol structure for the entire transmitted packet transmission is shown in Table A-6, where selected symbols of the packet are shown in Table A-7 through Table A-26. Each table describes exactly one symbol (165 complex values). Note that the length of this packet is exactly 48 symbols.

TABLE A-6. Symbol structure for entire packet

Symbol 1	1st Packet/Frame Synchronization Sequence (samples 1-165)
Symbols 2-24	Modulated version of Symbol 1: modulation depends on Cover Sequence (symbols not shown)
Symbol 25	Channel Estimation Sequence (samples 3961-4125)
Symbols 26-30	Same as Symbol 25 (symbols not shown)
Symbols 31-42	PLCP Header (samples 4951-6930)
Symbols 43-end	Payload (samples 6931-7913)

TABLE A-7. Time-domain sequence for symbol #1

#	Real	Imag	#	Real	Imag	#	Real	Imag
1	7.2502	0	56	13.9370	0	111	4.2370	0
2	-15.1001	0	57	6.5985	0	112	-12.6823	0
3	-10.9990	0	58	-12.1234	0	113	-0.3899	0
4	-15.4425	0	59	-10.7979	0	114	-7.4523	0
5	9.3676	0	60	-11.0255	0	115	-12.8712	0
6	12.0306	0	61	9.9044	0	116	-9.8260	0
7	-9.5222	0	62	19.4840	0	117	2.6664	0
8	12.7154	0	63	-11.2784	0	118	1.2813	0
9	10.6058	0	64	18.6810	0	119	-7.7174	0
10	-15.0007	0	65	-2.3140	0	120	5.2808	0
11	-9.2273	0	66	12.8568	0	121	2.0114	0
12	-14.6340	0	67	13.6233	0	122	-11.7876	0
13	12.1101	0	68	16.9414	0	123	-10.6875	0
14	14.7279	0	69	-9.7685	0	124	-13.6090	0
15	-8.1493	0	70	-4.2602	0	125	5.5260	0
16	14.9830	0	71	8.5381	0	126	8.1946	0
17	10.3396	0	72	-10.7736	0	127	-9.8679	0
18	-9.0705	0	73	-2.5570	0	128	9.2682	0
19	-2.9403	0	74	6.1622	0	129	0	0
20	-7.5837	0	75	4.4568	0	130	0	0
21	9.3190	0	76	4.6921	0	131	0	0
22	12.4117	0	77	-3.7101	0	132	0	0
23	-3.6063	0	78	-10.9504	0	133	0	0
24	11.6098	0	79	6.5996	0	134	0	0
25	8.7557	0	80	-9.2869	0	135	0	0
26	-3.7146	0	81	3.9620	0	136	0	0
27	-1.4823	0	82	-10.6080	0	137	0	0
28	-1.7076	0	83	-11.0476	0	138	0	0
29	7.6820	0	84	-12.8524	0	139	0	0
30	11.7169	0	85	10.5925	0	140	0	0
31	-1.7673	0	86	7.8831	0	141	0	0
32	10.4290	0	87	-7.4843	0	142	0	0
33	-0.9322	0	88	10.8510	0	143	0	0
34	13.2257	0	89	-6.0241	0	144	0	0
35	13.5427	0	90	12.1742	0	145	0	0
36	15.9064	0	91	18.2083	0	146	0	0
37	-6.6140	0	92	14.6981	0	147	0	0
38	-5.1637	0	93	-14.1955	0	148	0	0

TABLE A-7. Time-domain sequence for symbol #1

39	9.4106	0	94	-13.9823	0	149	0	0
40	-9.8547	0	95	10.4213	0	150	0	0
41	-6.1887	0	96	-18.5661	0	151	0	0
42	13.1285	0	97	4.6744	0	152	0	0
43	12.2913	0	98	-14.0099	0	153	0	0
44	11.9654	0	99	-20.0484	0	154	0	0
45	-10.0215	0	100	-16.3792	0	155	0	0
46	-17.9233	0	101	11.3789	0	156	0	0
47	11.0597	0	102	10.4036	0	157	0	0
48	-17.7466	0	103	-12.6712	0	158	0	0
49	3.7112	0	104	16.4112	0	159	0	0
50	-14.5092	0	105	-7.5042	0	160	0	0
51	-15.9572	0	106	10.5737	0	161	0	0
52	-19.0400	0	107	11.9367	0	162	0	0
53	11.3624	0	108	12.6414	0	163	0	0
54	6.7377	0	109	-13.5990	0	164	0	0
55	-10.2026	0	110	-7.3374	0	165	0	0

TABLE A-8. Time-domain sequence for symbol #25

#	Real	Imag	#	Real	Imag	#	Real	Imag
3961	9.8995	0	4016	13.5986	0	4071	0.7116	0
3962	-7.2562	0	4017	3.7818	0	4072	12.0037	0
3963	-8.4976	0	4018	9.4041	0	4073	13.1716	0
3964	7.0257	0	4019	-8.8197	0	4074	0.3003	0
3965	0.3928	0	4020	-2.2902	0	4075	5.7548	0
3966	17.7030	0	4021	19.9806	0	4076	12.1077	0
3967	-11.7901	0	4022	-2.0604	0	4077	9.3034	0
3968	12.3091	0	4023	-6.1139	0	4078	-8.2817	0
3969	-11.7563	0	4024	-10.8551	0	4079	14.3560	0
3970	5.3317	0	4025	-9.8995	0	4080	-16.5921	0
3971	7.2923	0	4026	3.8499	0	4081	12.7035	0
3972	-2.5968	0	4027	5.9205	0	4082	-2.2428	0
3973	16.7493	0	4028	16.2487	0	4083	6.7585	0
3974	-3.8235	0	4029	4.9132	0	4084	8.7422	0
3975	-2.2717	0	4030	-15.2805	0	4085	-7.6215	0
3976	-0.0808	0	4031	11.6706	0	4086	-0.0991	0
3977	6.0000	0	4032	6.5789	0	4087	-9.9805	0
3978	-12.8722	0	4033	4.9279	0	4088	13.4091	0
3979	-12.9997	0	4034	6.7958	0	4089	0	0
3980	-7.5541	0	4035	-2.8129	0	4090	0	0
3981	17.4249	0	4036	-15.6939	0	4091	0	0
3982	-12.2915	0	4037	-18.2254	0	4092	0	0
3983	-3.9802	0	4038	-13.4653	0	4093	0	0
3984	17.4186	0	4039	-15.8214	0	4094	0	0
3985	0.5597	0	4040	-12.9716	0	4095	0	0
3986	-11.3055	0	4041	-6.0000	0	4096	0	0
3987	-20.2687	0	4042	13.9538	0	4097	0	0
3988	-12.5852	0	4043	-4.0309	0	4098	0	0
3989	-0.7328	0	4044	-16.5369	0	4099	0	0
3990	18.6881	0	4045	9.0572	0	4100	0	0
3991	1.3508	0	4046	-7.5991	0	4101	0	0
3992	-10.9864	0	4047	7.5677	0	4102	0	0
3993	18.3848	0	4048	0.7103	0	4103	0	0
3994	-3.4662	0	4049	-0.0744	0	4104	0	0
3995	-0.9163	0	4050	15.7589	0	4105	0	0
3996	2.0911	0	4051	-16.7636	0	4106	0	0
3997	-13.9331	0	4052	-5.4543	0	4107	0	0
3998	-18.0095	0	4053	10.0305	0	4108	0	0

TABLE A-8. Time-domain sequence for symbol #25

3999	5.9530	0	4054	13.8226	0	4109	0	0
4000	8.2221	0	4055	-1.7224	0	4110	0	0
4001	-15.8583	0	4056	16.1963	0	4111	0	0
4002	5.5459	0	4057	-1.4142	0	4112	0	0
4003	-14.4491	0	4058	-9.2484	0	4113	0	0
4004	-2.2933	0	4059	17.3049	0	4114	0	0
4005	-9.6066	0	4060	-5.8931	0	4115	0	0
4006	-14.0188	0	4061	-17.7161	0	4116	0	0
4007	13.1612	0	4062	-11.7285	0	4117	0	0
4008	-8.9657	0	4063	1.0413	0	4118	0	0
4009	-18.8284	0	4064	14.6324	0	4119	0	0
4010	-10.1388	0	4065	17.0299	0	4120	0	0
4011	-4.4768	0	4066	4.9622	0	4121	0	0
4012	0.0705	0	4067	-16.8781	0	4122	0	0
4013	1.8713	0	4068	15.2393	0	4123	0	0
4014	15.9283	0	4069	0.7395	0	4124	0	0
4015	18.4954	0	4070	-14.1115	0	4125	0	0

TABLE A-9. Time-domain sequence for symbol #31

#	Real	Imag	#	Real	Imag	#	Real	Imag
4951	-24.0416	0	5006	4.9458	0	5061	5.1465	0
4952	17.0934	0	5007	-1.3721	0	5062	4.0559	0
4953	-10.1885	0	5008	-0.3136	0	5063	2.0000	0
4954	-3.7917	0	5009	0.8293	0	5064	-10.8757	0
4955	6.1113	0	5010	-21.8677	0	5065	26.8015	0
4956	3.1685	0	5011	23.8626	0	5066	11.9007	0
4957	-4.3795	0	5012	19.1469	0	5067	-5.9224	0
4958	-18.1249	0	5013	-9.9532	0	5068	4.8359	0
4959	0.8659	0	5014	11.0442	0	5069	22.8651	0
4960	17.0610	0	5015	-4.2426	0	5070	-5.8629	0
4961	5.4753	0	5016	-28.1502	0	5071	-3.7995	0
4962	6.8694	0	5017	-10.9862	0	5072	-0.7381	0
4963	8.7059	0	5018	-0.5257	0	5073	8.6174	0
4964	5.6139	0	5019	-9.9625	0	5074	-4.6997	0
4965	16.4724	0	5020	-1.5968	0	5075	-11.5808	0
4966	-11.3538	0	5021	4.7904	0	5076	-20.1242	0
4967	5.1716	0	5022	6.0344	0	5077	-13.1194	0
4968	0.8281	0	5023	-0.6649	0	5078	10.0394	0
4969	-13.3243	0	5024	-16.6432	0	5079	0	0
4970	12.7665	0	5025	6.4458	0	5080	0	0
4971	-8.5005	0	5026	7.9961	0	5081	0	0
4972	0.2355	0	5027	8.1933	0	5082	0	0
4973	14.9466	0	5028	-2.7742	0	5083	0	0
4974	1.9262	0	5029	-9.2911	0	5084	0	0
4975	-2.7422	0	5030	-4.1074	0	5085	0	0
4976	12.6604	0	5031	-10.8284	0	5086	0	0
4977	21.4445	0	5032	17.5945	0	5087	0	0
4978	14.5548	0	5033	-0.2063	0	5088	0	0
4979	23.8425	0	5034	3.0344	0	5089	0	0
4980	-7.1320	0	5035	4.9369	0	5090	0	0
4981	3.1928	0	5036	-23.9435	0	5091	0	0
4982	-11.7240	0	5037	1.5958	0	5092	0	0
4983	9.8995	0	5038	-4.2665	0	5093	0	0
4984	12.0012	0	5039	13.5706	0	5094	0	0
4985	-5.6722	0	5040	8.6342	0	5095	0	0
4986	0.8512	0	5041	7.3411	0	5096	0	0
4987	-4.4057	0	5042	10.4947	0	5097	0	0
4988	-4.2563	0	5043	0.1600	0	5098	0	0

TABLE A-9. Time-domain sequence for symbol #31

4989	12.5905	0	5044	-5.0297	0	5099	0	0
4990	15.0799	0	5045	-21.8209	0	5100	0	0
4991	-21.7473	0	5046	-7.1065	0	5101	0	0
4992	-6.8287	0	5047	-9.8995	0	5102	0	0
4993	-10.0805	0	5048	9.3736	0	5103	0	0
4994	7.1849	0	5049	-2.6079	0	5104	0	0
4995	0.4041	0	5050	-5.5876	0	5105	0	0
4996	-6.5773	0	5051	-0.7136	0	5106	0	0
4997	8.6865	0	5052	8.6168	0	5107	0	0
4998	4.4659	0	5053	-4.3333	0	5108	0	0
4999	-2.0000	0	5054	-4.4183	0	5109	0	0
5000	-13.1786	0	5055	-18.0517	0	5110	0	0
5001	-4.5024	0	5056	-9.1457	0	5111	0	0
5002	8.6659	0	5057	3.2409	0	5112	0	0
5003	-15.4846	0	5058	6.7812	0	5113	0	0
5004	-14.3738	0	5059	2.9810	0	5114	0	0
5005	-4.7619	0	5060	-10.4372	0	5115	0	0

TABLE A-10. Time-domain sequence for symbol #32

#	Real	Imag	#	Real	Imag	#	Real	Imag
5116	24.0416	0	5171	-4.9458	0	5226	-5.1465	0
5117	-17.0934	0	5172	1.3721	0	5227	-4.0559	0
5118	10.1885	0	5173	0.3136	0	5228	-2.0000	0
5119	3.7917	0	5174	-0.8293	0	5229	10.8757	0
5120	-6.1113	0	5175	21.8677	0	5230	-26.8015	0
5121	-3.1685	0	5176	-23.8626	0	5231	-11.9007	0
5122	4.3795	0	5177	-19.1469	0	5232	5.9224	0
5123	18.1249	0	5178	9.9532	0	5233	-4.8359	0
5124	-0.8659	0	5179	-11.0442	0	5234	-22.8651	0
5125	-17.0610	0	5180	4.2426	0	5235	5.8629	0
5126	-5.4753	0	5181	28.1502	0	5236	3.7995	0
5127	-6.8694	0	5182	10.9862	0	5237	0.7381	0
5128	-8.7059	0	5183	0.5257	0	5238	-8.6174	0
5129	-5.6139	0	5184	9.9625	0	5239	4.6997	0
5130	-16.4724	0	5185	1.5968	0	5240	11.5808	0
5131	11.3538	0	5186	-4.7904	0	5241	20.1242	0
5132	-5.1716	0	5187	-6.0344	0	5242	13.1194	0
5133	-0.8281	0	5188	0.6649	0	5243	-10.0394	0
5134	13.3243	0	5189	16.6432	0	5244	0	0
5135	-12.7665	0	5190	-6.4458	0	5245	0	0
5136	8.5005	0	5191	-7.9961	0	5246	0	0
5137	-0.2355	0	5192	-8.1933	0	5247	0	0
5138	-14.9466	0	5193	2.7742	0	5248	0	0
5139	-1.9262	0	5194	9.2911	0	5249	0	0
5140	2.7422	0	5195	4.1074	0	5250	0	0
5141	-12.6604	0	5196	10.8284	0	5251	0	0
5142	-21.4445	0	5197	-17.5945	0	5252	0	0
5143	-14.5548	0	5198	0.2063	0	5253	0	0
5144	-23.8425	0	5199	-3.0344	0	5254	0	0
5145	7.1320	0	5200	-4.9369	0	5255	0	0
5146	-3.1928	0	5201	23.9435	0	5256	0	0
5147	11.7240	0	5202	-1.5958	0	5257	0	0
5148	-9.8995	0	5203	4.2665	0	5258	0	0
5149	-12.0012	0	5204	-13.5706	0	5259	0	0
5150	5.6722	0	5205	-8.6342	0	5260	0	0
5151	-0.8512	0	5206	-7.3411	0	5261	0	0
5152	4.4057	0	5207	-10.4947	0	5262	0	0
5153	4.2563	0	5208	-0.1600	0	5263	0	0

TABLE A-10. Time-domain sequence for symbol #32

5154	-12.5905	0	5209	5.0297	0	5264	0	0
5155	-15.0799	0	5210	21.8209	0	5265	0	0
5156	21.7473	0	5211	7.1065	0	5266	0	0
5157	6.8287	0	5212	9.8995	0	5267	0	0
5158	10.0805	0	5213	-9.3736	0	5268	0	0
5159	-7.1849	0	5214	2.6079	0	5269	0	0
5160	-0.4041	0	5215	5.5876	0	5270	0	0
5161	6.5773	0	5216	0.7136	0	5271	0	0
5162	-8.6865	0	5217	-8.6168	0	5272	0	0
5163	-4.4659	0	5218	4.3333	0	5273	0	0
5164	2.0000	0	5219	4.4183	0	5274	0	0
5165	13.1786	0	5220	18.0517	0	5275	0	0
5166	4.5024	0	5221	9.1457	0	5276	0	0
5167	-8.6659	0	5222	-3.2409	0	5277	0	0
5168	15.4846	0	5223	-6.7812	0	5278	0	0
5169	14.3738	0	5224	-2.9810	0	5279	0	0
5170	4.7619	0	5225	10.4372	0	5280	0	0

TABLE A-11. Time-domain sequence for symbol #33

#	Real	Imag	#	Real	Imag	#	Real	Imag
5281	4.2426	0	5336	18.5388	0	5391	5.9604	0
5282	-13.1537	0	5337	1.9820	0	5392	-7.1869	0
5283	-17.1802	0	5338	3.4892	0	5393	4.0000	0
5284	-10.9092	0	5339	22.1600	0	5394	-6.2479	0
5285	-0.1366	0	5340	9.9179	0	5395	-6.4936	0
5286	-2.7590	0	5341	18.8865	0	5396	5.7625	0
5287	-0.5540	0	5342	32.0170	0	5397	2.8239	0
5288	11.1969	0	5343	-5.2683	0	5398	-12.9276	0
5289	-5.2620	0	5344	-3.5078	0	5399	-2.5922	0
5290	-15.1817	0	5345	-9.8995	0	5400	-1.3835	0
5291	-3.2615	0	5346	-3.5444	0	5401	-16.1242	0
5292	14.6765	0	5347	14.8763	0	5402	-16.6353	0
5293	12.5016	0	5348	0.4054	0	5403	3.0835	0
5294	1.3575	0	5349	6.6606	0	5404	20.5041	0
5295	-4.8180	0	5350	-9.7213	0	5405	3.9251	0
5296	-4.8701	0	5351	4.6199	0	5406	3.5259	0
5297	-0.1421	0	5352	27.4419	0	5407	22.7779	0
5298	-7.9815	0	5353	-1.5665	0	5408	2.1000	0
5299	0.5341	0	5354	-7.0722	0	5409	0	0
5300	-3.7717	0	5355	-12.8162	0	5410	0	0
5301	17.3607	0	5356	-19.5550	0	5411	0	0
5302	12.6644	0	5357	-9.6481	0	5412	0	0
5303	-15.2406	0	5358	-6.7917	0	5413	0	0
5304	-2.9655	0	5359	-2.1632	0	5414	0	0
5305	-18.4746	0	5360	3.5409	0	5415	0	0
5306	6.0360	0	5361	-28.1421	0	5416	0	0
5307	7.1150	0	5362	18.3975	0	5417	0	0
5308	0.9319	0	5363	0.6840	0	5418	0	0
5309	-0.9734	0	5364	-16.2015	0	5419	0	0
5310	-2.4154	0	5365	-13.0015	0	5420	0	0
5311	-1.1355	0	5366	11.1119	0	5421	0	0
5312	0.4057	0	5367	11.8478	0	5422	0	0
5313	-4.2426	0	5368	-8.7904	0	5423	0	0
5314	-3.3064	0	5369	4.3325	0	5424	0	0
5315	13.8805	0	5370	-4.8574	0	5425	0	0
5316	-4.7961	0	5371	23.7675	0	5426	0	0
5317	-8.5115	0	5372	-11.3327	0	5427	0	0
5318	7.2995	0	5373	-0.1815	0	5428	0	0

TABLE A-11. Time-domain sequence for symbol #33

5319	13.5124	0	5374	-13.4025	0	5429	0	0
5320	-1.7741	0	5375	-10.7172	0	5430	0	0
5321	-0.1796	0	5376	6.4914	0	5431	0	0
5322	6.2154	0	5377	4.2426	0	5432	0	0
5323	-16.8899	0	5378	-2.1451	0	5433	0	0
5324	11.9162	0	5379	-2.3329	0	5434	0	0
5325	1.7221	0	5380	-21.4181	0	5435	0	0
5326	-14.0809	0	5381	7.6444	0	5436	0	0
5327	6.6777	0	5382	-4.0902	0	5437	0	0
5328	5.8488	0	5383	-11.9214	0	5438	0	0
5329	-4.0000	0	5384	9.5413	0	5439	0	0
5330	-9.3321	0	5385	1.3512	0	5440	0	0
5331	7.3456	0	5386	0.6923	0	5441	0	0
5332	-12.8859	0	5387	-11.8448	0	5442	0	0
5333	-1.5262	0	5388	27.3831	0	5443	0	0
5334	3.1087	0	5389	-14.9188	0	5444	0	0
5335	11.6419	0	5390	4.4764	0	5445	0	0

TABLE A-12. Time-domain sequence for symbol #34

#	Real	Imag	#	Real	Imag	#	Real	Imag
5446	4.2426	0	5501	18.5388	0	5556	5.9604	0
5447	-13.1537	0	5502	1.9820	0	5557	-7.1869	0
5448	-17.1802	0	5503	3.4892	0	5558	4.0000	0
5449	-10.9092	0	5504	22.1600	0	5559	-6.2479	0
5450	-0.1366	0	5505	9.9179	0	5560	-6.4936	0
5451	-2.7590	0	5506	18.8865	0	5561	5.7625	0
5452	-0.5540	0	5507	32.0170	0	5562	2.8239	0
5453	11.1969	0	5508	-5.2683	0	5563	-12.9276	0
5454	-5.2620	0	5509	-3.5078	0	5564	-2.5922	0
5455	-15.1817	0	5510	-9.8995	0	5565	-1.3835	0
5456	-3.2615	0	5511	-3.5444	0	5566	-16.1242	0
5457	14.6765	0	5512	14.8763	0	5567	-16.6353	0
5458	12.5016	0	5513	0.4054	0	5568	3.0835	0
5459	1.3575	0	5514	6.6606	0	5569	20.5041	0
5460	-4.8180	0	5515	-9.7213	0	5570	3.9251	0
5461	-4.8701	0	5516	4.6199	0	5571	3.5259	0
5462	-0.1421	0	5517	27.4419	0	5572	22.7779	0
5463	-7.9815	0	5518	-1.5665	0	5573	2.1000	0
5464	0.5341	0	5519	-7.0722	0	5574	0	0
5465	-3.7717	0	5520	-12.8162	0	5575	0	0
5466	17.3607	0	5521	-19.5550	0	5576	0	0
5467	12.6644	0	5522	-9.6481	0	5577	0	0
5468	-15.2406	0	5523	-6.7917	0	5578	0	0
5469	-2.9655	0	5524	-2.1632	0	5579	0	0
5470	-18.4746	0	5525	3.5409	0	5580	0	0
5471	6.0360	0	5526	-28.1421	0	5581	0	0
5472	7.1150	0	5527	18.3975	0	5582	0	0
5473	0.9319	0	5528	0.6840	0	5583	0	0
5474	-0.9734	0	5529	-16.2015	0	5584	0	0
5475	-2.4154	0	5530	-13.0015	0	5585	0	0
5476	-1.1355	0	5531	11.1119	0	5586	0	0
5477	0.4057	0	5532	11.8478	0	5587	0	0
5478	-4.2426	0	5533	-8.7904	0	5588	0	0
5479	-3.3064	0	5534	4.3325	0	5589	0	0
5480	13.8805	0	5535	-4.8574	0	5590	0	0
5481	-4.7961	0	5536	23.7675	0	5591	0	0
5482	-8.5115	0	5537	-11.3327	0	5592	0	0
5483	7.2995	0	5538	-0.1815	0	5593	0	0

TABLE A-12. Time-domain sequence for symbol #34

5484	13.5124	0	5539	-13.4025	0	5594	0	0
5485	-1.7741	0	5540	-10.7172	0	5595	0	0
5486	-0.1796	0	5541	6.4914	0	5596	0	0
5487	6.2154	0	5542	4.2426	0	5597	0	0
5488	-16.8899	0	5543	-2.1451	0	5598	0	0
5489	11.9162	0	5544	-2.3329	0	5599	0	0
5490	1.7221	0	5545	-21.4181	0	5600	0	0
5491	-14.0809	0	5546	7.6444	0	5601	0	0
5492	6.6777	0	5547	-4.0902	0	5602	0	0
5493	5.8488	0	5548	-11.9214	0	5603	0	0
5494	-4.0000	0	5549	9.5413	0	5604	0	0
5495	-9.3321	0	5550	1.3512	0	5605	0	0
5496	7.3456	0	5551	0.6923	0	5606	0	0
5497	-12.8859	0	5552	-11.8448	0	5607	0	0
5498	-1.5262	0	5553	27.3831	0	5608	0	0
5499	3.1087	0	5554	-14.9188	0	5609	0	0
5500	11.6419	0	5555	4.4764	0	5610	0	0

TABLE A-13. Time-domain sequence for symbol #35

#	Real	Imag	#	Real	Imag	#	Real	Imag
5611	-24.0416	0	5666	-2.9050	0	5721	-17.7167	0
5612	1.2285	0	5667	22.4537	0	5722	12.1590	0
5613	6.2281	0	5668	-1.7791	0	5723	6.8284	0
5614	-2.4405	0	5669	1.3932	0	5724	-8.1108	0
5615	-16.6922	0	5670	5.2041	0	5725	7.9329	0
5616	12.5876	0	5671	4.5919	0	5726	7.1087	0
5617	-2.7848	0	5672	7.8750	0	5727	9.1810	0
5618	20.5619	0	5673	14.4637	0	5728	2.5262	0
5619	-6.7767	0	5674	3.6928	0	5729	0.1477	0
5620	-5.3672	0	5675	-15.5563	0	5730	-0.4629	0
5621	1.3931	0	5676	-18.4535	0	5731	-4.3116	0
5622	-8.7222	0	5677	-17.8908	0	5732	-3.9144	0
5623	5.5412	0	5678	-4.7247	0	5733	5.0427	0
5624	8.2742	0	5679	2.6761	0	5734	-14.0415	0
5625	-11.1326	0	5680	5.2050	0	5735	5.3231	0
5626	13.6553	0	5681	-16.3751	0	5736	-10.8456	0
5627	14.9706	0	5682	-20.1239	0	5737	21.9483	0
5628	-7.3539	0	5683	-3.0812	0	5738	14.2813	0
5629	4.3129	0	5684	-22.4182	0	5739	0	0
5630	3.5615	0	5685	-12.5504	0	5740	0	0
5631	12.5790	0	5686	-12.9163	0	5741	0	0
5632	-5.1377	0	5687	-3.3050	0	5742	0	0
5633	-0.9516	0	5688	-4.2879	0	5743	0	0
5634	-11.6666	0	5689	-16.9968	0	5744	0	0
5635	4.1200	0	5690	0.9189	0	5745	0	0
5636	-6.5941	0	5691	18.9706	0	5746	0	0
5637	-1.0811	0	5692	19.6647	0	5747	0	0
5638	-4.5680	0	5693	9.9963	0	5748	0	0
5639	-4.9643	0	5694	-8.3693	0	5749	0	0
5640	12.1569	0	5695	-13.3688	0	5750	0	0
5641	19.5146	0	5696	-4.5933	0	5751	0	0
5642	-0.9429	0	5697	15.2973	0	5752	0	0
5643	1.4142	0	5698	-9.8130	0	5753	0	0
5644	-7.0567	0	5699	6.0221	0	5754	0	0
5645	-8.0593	0	5700	16.2300	0	5755	0	0
5646	5.0362	0	5701	-9.2183	0	5756	0	0
5647	-4.1482	0	5702	2.1858	0	5757	0	0
5648	16.5043	0	5703	-7.2938	0	5758	0	0

TABLE A-13. Time-domain sequence for symbol #35

5649	-20.0347	0	5704	6.6777	0	5759	0	0
5650	-9.1876	0	5705	-11.6898	0	5760	0	0
5651	18.3057	0	5706	-3.1900	0	5761	0	0
5652	22.8762	0	5707	9.8995	0	5762	0	0
5653	-8.8941	0	5708	12.5315	0	5763	0	0
5654	-2.7532	0	5709	-11.1695	0	5764	0	0
5655	18.4753	0	5710	-0.6615	0	5765	0	0
5656	2.0806	0	5711	-6.8063	0	5766	0	0
5657	22.2955	0	5712	-9.5438	0	5767	0	0
5658	5.9221	0	5713	-5.1607	0	5768	0	0
5659	-1.1716	0	5714	-3.5267	0	5769	0	0
5660	2.8639	0	5715	19.8364	0	5770	0	0
5661	-2.6644	0	5716	-3.7194	0	5771	0	0
5662	-9.5058	0	5717	12.6011	0	5772	0	0
5663	-17.3618	0	5718	-9.0206	0	5773	0	0
5664	9.7653	0	5719	-7.0547	0	5774	0	0
5665	-13.4519	0	5720	5.3828	0	5775	0	0

TABLE A-14. Time-domain sequence for symbol #36

#	Real	Imag	#	Real	Imag	#	Real	Imag
5776	24.0416	0	5831	2.9050	0	5886	17.7167	0
5777	-1.2285	0	5832	-22.4537	0	5887	-12.1590	0
5778	-6.2281	0	5833	1.7791	0	5888	-6.8284	0
5779	2.4405	0	5834	-1.3932	0	5889	8.1108	0
5780	16.6922	0	5835	-5.2041	0	5890	-7.9329	0
5781	-12.5876	0	5836	-4.5919	0	5891	-7.1087	0
5782	2.7848	0	5837	-7.8750	0	5892	-9.1810	0
5783	-20.5619	0	5838	-14.4637	0	5893	-2.5262	0
5784	6.7767	0	5839	-3.6928	0	5894	-0.1477	0
5785	5.3672	0	5840	15.5563	0	5895	0.4629	0
5786	-1.3931	0	5841	18.4535	0	5896	4.3116	0
5787	8.7222	0	5842	17.8908	0	5897	3.9144	0
5788	-5.5412	0	5843	4.7247	0	5898	-5.0427	0
5789	-8.2742	0	5844	-2.6761	0	5899	14.0415	0
5790	11.1326	0	5845	-5.2050	0	5900	-5.3231	0
5791	-13.6553	0	5846	16.3751	0	5901	10.8456	0
5792	-14.9706	0	5847	20.1239	0	5902	-21.9483	0
5793	7.3539	0	5848	3.0812	0	5903	-14.2813	0
5794	-4.3129	0	5849	22.4182	0	5904	0	0
5795	-3.5615	0	5850	12.5504	0	5905	0	0
5796	-12.5790	0	5851	12.9163	0	5906	0	0
5797	5.1377	0	5852	3.3050	0	5907	0	0
5798	0.9516	0	5853	4.2879	0	5908	0	0
5799	11.6666	0	5854	16.9968	0	5909	0	0
5800	-4.1200	0	5855	-0.9189	0	5910	0	0
5801	6.5941	0	5856	-18.9706	0	5911	0	0
5802	1.0811	0	5857	-19.6647	0	5912	0	0
5803	4.5680	0	5858	-9.9963	0	5913	0	0
5804	4.9643	0	5859	8.3693	0	5914	0	0
5805	-12.1569	0	5860	13.3688	0	5915	0	0
5806	-19.5146	0	5861	4.5933	0	5916	0	0
5807	0.9429	0	5862	-15.2973	0	5917	0	0
5808	-1.4142	0	5863	9.8130	0	5918	0	0
5809	7.0567	0	5864	-6.0221	0	5919	0	0
5810	8.0593	0	5865	-16.2300	0	5920	0	0
5811	-5.0362	0	5866	9.2183	0	5921	0	0
5812	4.1482	0	5867	-2.1858	0	5922	0	0
5813	-16.5043	0	5868	7.2938	0	5923	0	0

TABLE A-14. Time-domain sequence for symbol #36

5814	20.0347	0	5869	-6.6777	0	5924	0	0
5815	9.1876	0	5870	11.6898	0	5925	0	0
5816	-18.3057	0	5871	3.1900	0	5926	0	0
5817	-22.8762	0	5872	-9.8995	0	5927	0	0
5818	8.8941	0	5873	-12.5315	0	5928	0	0
5819	2.7532	0	5874	11.1695	0	5929	0	0
5820	-18.4753	0	5875	0.6615	0	5930	0	0
5821	-2.0806	0	5876	6.8063	0	5931	0	0
5822	-22.2955	0	5877	9.5438	0	5932	0	0
5823	-5.9221	0	5878	5.1607	0	5933	0	0
5824	1.1716	0	5879	3.5267	0	5934	0	0
5825	-2.8639	0	5880	-19.8364	0	5935	0	0
5826	2.6644	0	5881	3.7194	0	5936	0	0
5827	9.5058	0	5882	-12.6011	0	5937	0	0
5828	17.3618	0	5883	9.0206	0	5938	0	0
5829	-9.7653	0	5884	7.0547	0	5939	0	0
5830	13.4519	0	5885	-5.3828	0	5940	0	0

TABLE A-15. Time-domain sequence for symbol #37

#	Real	Imag	#	Real	Imag	#	Real	Imag
5941	4.2426	0	5996	-4.3089	0	6051	-13.5796	0
5942	-1.8468	0	5997	10.8565	0	6052	19.3353	0
5943	-15.1061	0	5998	-11.0905	0	6053	-8.8284	0
5944	2.7413	0	5999	-14.0788	0	6054	-10.1153	0
5945	12.4704	0	6000	20.2929	0	6055	-16.2659	0
5946	10.3586	0	6001	11.9481	0	6056	0.8329	0
5947	20.5888	0	6002	4.3048	0	6057	5.7774	0
5948	10.9830	0	6003	-5.7093	0	6058	0.6510	0
5949	-3.2115	0	6004	-7.3066	0	6059	23.2530	0
5950	6.5708	0	6005	18.3848	0	6060	9.7423	0
5951	17.3275	0	6006	1.9790	0	6061	-19.3417	0
5952	23.2973	0	6007	4.5623	0	6062	5.8509	0
5953	-3.0369	0	6008	9.5259	0	6063	-0.6105	0
5954	-8.2836	0	6009	6.5196	0	6064	8.7611	0
5955	13.5021	0	6010	-19.1521	0	6065	-0.5866	0
5956	-4.2381	0	6011	-7.6440	0	6066	-18.0597	0
5957	-15.3137	0	6012	-0.0769	0	6067	-0.3860	0
5958	-10.0926	0	6013	10.0399	0	6068	-9.0988	0
5959	8.8508	0	6014	-1.6119	0	6069	0	0
5960	-1.5965	0	6015	-5.4914	0	6070	0	0
5961	-7.5391	0	6016	-6.5538	0	6071	0	0
5962	-1.3772	0	6017	-21.0010	0	6072	0	0
5963	-5.0895	0	6018	9.3804	0	6073	0	0
5964	-6.7737	0	6019	2.2762	0	6074	0	0
5965	6.3412	0	6020	-16.0339	0	6075	0	0
5966	-10.3550	0	6021	-7.3137	0	6076	0	0
5967	-1.2634	0	6022	13.0858	0	6077	0	0
5968	18.0168	0	6023	-13.8978	0	6078	0	0
5969	3.4930	0	6024	-14.0688	0	6079	0	0
5970	8.5356	0	6025	-20.5407	0	6080	0	0
5971	6.1278	0	6026	-16.7484	0	6081	0	0
5972	-4.4886	0	6027	9.8334	0	6082	0	0
5973	-7.0711	0	6028	6.0345	0	6083	0	0
5974	-11.1013	0	6029	-14.8265	0	6084	0	0
5975	-1.0020	0	6030	-3.2709	0	6085	0	0
5976	11.8188	0	6031	-5.0617	0	6086	0	0
5977	-11.3586	0	6032	-3.4572	0	6087	0	0
5978	3.5484	0	6033	-12.5113	0	6088	0	0

TABLE A-15. Time-domain sequence for symbol #37

5979	8.0844	0	6034	-0.3660	0	6089	0	0
5980	3.3981	0	6035	5.2678	0	6090	0	0
5981	-5.4950	0	6036	7.8317	0	6091	0	0
5982	-1.0818	0	6037	1.4142	0	6092	0	0
5983	7.6612	0	6038	8.0314	0	6093	0	0
5984	-9.3134	0	6039	2.8777	0	6094	0	0
5985	5.2879	0	6040	-2.5007	0	6095	0	0
5986	10.7782	0	6041	10.7117	0	6096	0	0
5987	-5.5576	0	6042	-22.3685	0	6097	0	0
5988	-2.9331	0	6043	1.4888	0	6098	0	0
5989	3.1716	0	6044	-11.4387	0	6099	0	0
5990	-5.0080	0	6045	4.3234	0	6100	0	0
5991	-13.3326	0	6046	-24.5712	0	6101	0	0
5992	-9.0034	0	6047	22.2033	0	6102	0	0
5993	-7.3545	0	6048	5.8341	0	6103	0	0
5994	20.2103	0	6049	5.0932	0	6104	0	0
5995	15.4262	0	6050	27.9607	0	6105	0	0

TABLE A-16. Time-domain sequence for symbol #38

#	Real	Imag	#	Real	Imag	#	Real	Imag
6106	-4.2426	0	6161	4.3089	0	6216	13.5796	0
6107	1.8468	0	6162	-10.8565	0	6217	-19.3353	0
6108	15.1061	0	6163	11.0905	0	6218	8.8284	0
6109	-2.7413	0	6164	14.0788	0	6219	10.1153	0
6110	-12.4704	0	6165	-20.2929	0	6220	16.2659	0
6111	-10.3586	0	6166	-11.9481	0	6221	-0.8329	0
6112	-20.5888	0	6167	-4.3048	0	6222	-5.7774	0
6113	-10.9830	0	6168	5.7093	0	6223	-0.6510	0
6114	3.2115	0	6169	7.3066	0	6224	-23.2530	0
6115	-6.5708	0	6170	-18.3848	0	6225	-9.7423	0
6116	-17.3275	0	6171	-1.9790	0	6226	19.3417	0
6117	-23.2973	0	6172	-4.5623	0	6227	-5.8509	0
6118	3.0369	0	6173	-9.5259	0	6228	0.6105	0
6119	8.2836	0	6174	-6.5196	0	6229	-8.7611	0
6120	-13.5021	0	6175	19.1521	0	6230	0.5866	0
6121	4.2381	0	6176	7.6440	0	6231	18.0597	0
6122	15.3137	0	6177	0.0769	0	6232	0.3860	0
6123	10.0926	0	6178	-10.0399	0	6233	9.0988	0
6124	-8.8508	0	6179	1.6119	0	6234	0	0
6125	1.5965	0	6180	5.4914	0	6235	0	0
6126	7.5391	0	6181	6.5538	0	6236	0	0
6127	1.3772	0	6182	21.0010	0	6237	0	0
6128	5.0895	0	6183	-9.3804	0	6238	0	0
6129	6.7737	0	6184	-2.2762	0	6239	0	0
6130	-6.3412	0	6185	16.0339	0	6240	0	0
6131	10.3550	0	6186	7.3137	0	6241	0	0
6132	1.2634	0	6187	-13.0858	0	6242	0	0
6133	-18.0168	0	6188	13.8978	0	6243	0	0
6134	-3.4930	0	6189	14.0688	0	6244	0	0
6135	-8.5356	0	6190	20.5407	0	6245	0	0
6136	-6.1278	0	6191	16.7484	0	6246	0	0
6137	4.4886	0	6192	-9.8334	0	6247	0	0
6138	7.0711	0	6193	-6.0345	0	6248	0	0
6139	11.1013	0	6194	14.8265	0	6249	0	0
6140	1.0020	0	6195	3.2709	0	6250	0	0
6141	-11.8188	0	6196	5.0617	0	6251	0	0
6142	11.3586	0	6197	3.4572	0	6252	0	0
6143	-3.5484	0	6198	12.5113	0	6253	0	0

TABLE A-16. Time-domain sequence for symbol #38

6144	-8.0844	0	6199	0.3660	0	6254	0	0
6145	-3.3981	0	6200	-5.2678	0	6255	0	0
6146	5.4950	0	6201	-7.8317	0	6256	0	0
6147	1.0818	0	6202	-1.4142	0	6257	0	0
6148	-7.6612	0	6203	-8.0314	0	6258	0	0
6149	9.3134	0	6204	-2.8777	0	6259	0	0
6150	-5.2879	0	6205	2.5007	0	6260	0	0
6151	-10.7782	0	6206	-10.7117	0	6261	0	0
6152	5.5576	0	6207	22.3685	0	6262	0	0
6153	2.9331	0	6208	-1.4888	0	6263	0	0
6154	-3.1716	0	6209	11.4387	0	6264	0	0
6155	5.0080	0	6210	-4.3234	0	6265	0	0
6156	13.3326	0	6211	24.5712	0	6266	0	0
6157	9.0034	0	6212	-22.2033	0	6267	0	0
6158	7.3545	0	6213	-5.8341	0	6268	0	0
6159	-20.2103	0	6214	-5.0932	0	6269	0	0
6160	-15.4262	0	6215	-27.9607	0	6270	0	0

TABLE A-17. Time-domain sequence for symbol #39

#	Real	Imag	#	Real	Imag	#	Real	Imag
6271	26.8701	0	6326	-8.3688	0	6381	9.1614	0
6272	-10.7431	0	6327	-3.6002	0	6382	-5.9404	0
6273	-18.3894	0	6328	18.7576	0	6383	-2.8284	0
6274	-7.0754	0	6329	10.7848	0	6384	14.4913	0
6275	-1.5203	0	6330	15.3808	0	6385	-7.6184	0
6276	1.4489	0	6331	-3.4561	0	6386	1.4148	0
6277	0.0681	0	6332	-12.7662	0	6387	-8.1464	0
6278	13.3719	0	6333	0.4346	0	6388	-7.3790	0
6279	0.7927	0	6334	5.1090	0	6389	-4.6623	0
6280	5.3528	0	6335	-9.8995	0	6390	4.0859	0
6281	-8.2045	0	6336	-14.9101	0	6391	7.1149	0
6282	-7.0861	0	6337	-0.6692	0	6392	8.8677	0
6283	-9.6901	0	6338	9.2635	0	6393	-6.0197	0
6284	-4.4190	0	6339	11.6910	0	6394	2.6793	0
6285	-1.9052	0	6340	-2.7168	0	6395	25.2282	0
6286	-10.9489	0	6341	3.4763	0	6396	14.3283	0
6287	-27.6569	0	6342	6.2512	0	6397	12.6888	0
6288	10.5007	0	6343	-5.9643	0	6398	-17.7742	0
6289	-1.5164	0	6344	14.6145	0	6399	0	0
6290	-14.3487	0	6345	16.9253	0	6400	0	0
6291	-7.7967	0	6346	3.9017	0	6401	0	0
6292	-14.3702	0	6347	13.9901	0	6402	0	0
6293	3.9170	0	6348	0.4787	0	6403	0	0
6294	8.8099	0	6349	9.2451	0	6404	0	0
6295	2.6917	0	6350	-7.4253	0	6405	0	0
6296	-5.9424	0	6351	16.3431	0	6406	0	0
6297	-5.8326	0	6352	-0.6619	0	6407	0	0
6298	-1.8318	0	6353	-2.1854	0	6408	0	0
6299	-21.3049	0	6354	-3.9771	0	6409	0	0
6300	-8.6065	0	6355	-11.9180	0	6410	0	0
6301	-8.2873	0	6356	1.8453	0	6411	0	0
6302	1.6414	0	6357	-10.0586	0	6412	0	0
6303	18.3848	0	6358	13.5421	0	6413	0	0
6304	-8.5055	0	6359	-23.1770	0	6414	0	0
6305	-10.0740	0	6360	-23.2615	0	6415	0	0
6306	3.6550	0	6361	2.7515	0	6416	0	0
6307	-6.4324	0	6362	15.4696	0	6417	0	0
6308	5.8417	0	6363	-6.1240	0	6418	0	0

TABLE A-17. Time-domain sequence for symbol #39

6309	26.8974	0	6364	-5.8123	0	6419	0	0
6310	7.2349	0	6365	24.3804	0	6420	0	0
6311	2.4841	0	6366	-2.5350	0	6421	0	0
6312	-25.2955	0	6367	15.5563	0	6422	0	0
6313	12.4199	0	6368	7.9985	0	6423	0	0
6314	0.8516	0	6369	-13.4292	0	6424	0	0
6315	5.0465	0	6370	2.7688	0	6425	0	0
6316	7.5167	0	6371	-16.0225	0	6426	0	0
6317	-11.7766	0	6372	-5.4199	0	6427	0	0
6318	7.3772	0	6373	16.0929	0	6428	0	0
6319	-2.8284	0	6374	8.1966	0	6429	0	0
6320	-9.4836	0	6375	8.3444	0	6430	0	0
6321	10.5684	0	6376	-4.4070	0	6431	0	0
6322	2.2946	0	6377	-2.1384	0	6432	0	0
6323	-16.4232	0	6378	-0.7330	0	6433	0	0
6324	9.4363	0	6379	-15.0033	0	6434	0	0
6325	-1.7897	0	6380	-2.0334	0	6435	0	0

TABLE A-18. Time-domain sequence for symbol #40

#	Real	Imag	#	Real	Imag	#	Real	Imag
6436	-26.8701	0	6491	8.3688	0	6546	-9.1614	0
6437	10.7431	0	6492	3.6002	0	6547	5.9404	0
6438	18.3894	0	6493	-18.7576	0	6548	2.8284	0
6439	7.0754	0	6494	-10.7848	0	6549	-14.4913	0
6440	1.5203	0	6495	-15.3808	0	6550	7.6184	0
6441	-1.4489	0	6496	3.4561	0	6551	-1.4148	0
6442	-0.0681	0	6497	12.7662	0	6552	8.1464	0
6443	-13.3719	0	6498	-0.4346	0	6553	7.3790	0
6444	-0.7927	0	6499	-5.1090	0	6554	4.6623	0
6445	-5.3528	0	6500	9.8995	0	6555	-4.0859	0
6446	8.2045	0	6501	14.9101	0	6556	-7.1149	0
6447	7.0861	0	6502	0.6692	0	6557	-8.8677	0
6448	9.6901	0	6503	-9.2635	0	6558	6.0197	0
6449	4.4190	0	6504	-11.6910	0	6559	-2.6793	0
6450	1.9052	0	6505	2.7168	0	6560	-25.2282	0
6451	10.9489	0	6506	-3.4763	0	6561	-14.3283	0
6452	27.6569	0	6507	-6.2512	0	6562	-12.6888	0
6453	-10.5007	0	6508	5.9643	0	6563	17.7742	0
6454	1.5164	0	6509	-14.6145	0	6564	0	0
6455	14.3487	0	6510	-16.9253	0	6565	0	0
6456	7.7967	0	6511	-3.9017	0	6566	0	0
6457	14.3702	0	6512	-13.9901	0	6567	0	0
6458	-3.9170	0	6513	-0.4787	0	6568	0	0
6459	-8.8099	0	6514	-9.2451	0	6569	0	0
6460	-2.6917	0	6515	7.4253	0	6570	0	0
6461	5.9424	0	6516	-16.3431	0	6571	0	0
6462	5.8326	0	6517	0.6619	0	6572	0	0
6463	1.8318	0	6518	2.1854	0	6573	0	0
6464	21.3049	0	6519	3.9771	0	6574	0	0
6465	8.6065	0	6520	11.9180	0	6575	0	0
6466	8.2873	0	6521	-1.8453	0	6576	0	0
6467	-1.6414	0	6522	10.0586	0	6577	0	0
6468	-18.3848	0	6523	-13.5421	0	6578	0	0
6469	8.5055	0	6524	23.1770	0	6579	0	0
6470	10.0740	0	6525	23.2615	0	6580	0	0
6471	-3.6550	0	6526	-2.7515	0	6581	0	0
6472	6.4324	0	6527	-15.4696	0	6582	0	0
6473	-5.8417	0	6528	6.1240	0	6583	0	0

TABLE A-18. Time-domain sequence for symbol #40

6474	-26.8974	0	6529	5.8123	0	6584	0	0
6475	-7.2349	0	6530	-24.3804	0	6585	0	0
6476	-2.4841	0	6531	2.5350	0	6586	0	0
6477	25.2955	0	6532	-15.5563	0	6587	0	0
6478	-12.4199	0	6533	-7.9985	0	6588	0	0
6479	-0.8516	0	6534	13.4292	0	6589	0	0
6480	-5.0465	0	6535	-2.7688	0	6590	0	0
6481	-7.5167	0	6536	16.0225	0	6591	0	0
6482	11.7766	0	6537	5.4199	0	6592	0	0
6483	-7.3772	0	6538	-16.0929	0	6593	0	0
6484	2.8284	0	6539	-8.1966	0	6594	0	0
6485	9.4836	0	6540	-8.3444	0	6595	0	0
6486	-10.5684	0	6541	4.4070	0	6596	0	0
6487	-2.2946	0	6542	2.1384	0	6597	0	0
6488	16.4232	0	6543	0.7330	0	6598	0	0
6489	-9.4363	0	6544	15.0033	0	6599	0	0
6490	1.7897	0	6545	2.0334	0	6600	0	0

TABLE A-19. Time-domain sequence for symbol #41

#	Real	Imag	#	Real	Imag	#	Real	Imag
6601	21.2132	0	6656	-29.1176	0	6711	13.4834	0
6602	-19.2759	0	6657	-17.4814	0	6712	8.0450	0
6603	-13.0178	0	6658	4.4509	0	6713	-16.8284	0
6604	11.3705	0	6659	9.3295	0	6714	1.3748	0
6605	10.1838	0	6660	-0.3226	0	6715	-19.3215	0
6606	17.7854	0	6661	-6.3761	0	6716	-16.3364	0
6607	9.1938	0	6662	8.4122	0	6717	-1.7305	0
6608	6.6528	0	6663	27.2959	0	6718	3.2442	0
6609	7.7490	0	6664	-7.4088	0	6719	-0.0653	0
6610	-5.0398	0	6665	-21.2132	0	6720	10.7310	0
6611	2.3687	0	6666	-4.9547	0	6721	0.9962	0
6612	4.6466	0	6667	-26.6757	0	6722	8.1854	0
6613	12.0147	0	6668	1.5377	0	6723	3.4585	0
6614	13.6126	0	6669	8.8062	0	6724	-5.0708	0
6615	-8.4246	0	6670	1.4625	0	6725	7.2014	0
6616	6.0367	0	6671	-11.5579	0	6726	2.5851	0
6617	15.3137	0	6672	-8.0684	0	6727	2.6914	0
6618	9.2860	0	6673	-4.2343	0	6728	-7.9982	0
6619	13.2957	0	6674	1.8951	0	6729	0	0
6620	-8.0570	0	6675	-6.5136	0	6730	0	0
6621	-18.7755	0	6676	19.2543	0	6731	0	0
6622	11.8976	0	6677	7.6344	0	6732	0	0
6623	6.2117	0	6678	7.2191	0	6733	0	0
6624	9.9430	0	6679	9.4739	0	6734	0	0
6625	-4.0695	0	6680	5.7438	0	6735	0	0
6626	-5.8465	0	6681	7.3137	0	6736	0	0
6627	-0.0574	0	6682	-6.6956	0	6737	0	0
6628	-14.0676	0	6683	6.5434	0	6738	0	0
6629	-9.3718	0	6684	-7.8110	0	6739	0	0
6630	11.0560	0	6685	-9.3042	0	6740	0	0
6631	3.2374	0	6686	8.8269	0	6741	0	0
6632	-4.2206	0	6687	-8.0733	0	6742	0	0
6633	-12.7279	0	6688	-25.4963	0	6743	0	0
6634	-3.3156	0	6689	3.5842	0	6744	0	0
6635	13.5657	0	6690	-0.8877	0	6745	0	0
6636	-7.5897	0	6691	-9.8120	0	6746	0	0
6637	0.1368	0	6692	8.8656	0	6747	0	0
6638	-12.3638	0	6693	-5.1103	0	6748	0	0

TABLE A-19. Time-domain sequence for symbol #41

6639	11.9640	0	6694	-22.1330	0	6749	0	0
6640	-12.8865	0	6695	2.1984	0	6750	0	0
6641	-14.2552	0	6696	-2.9995	0	6751	0	0
6642	9.3610	0	6697	7.0711	0	6752	0	0
6643	-10.1759	0	6698	3.6542	0	6753	0	0
6644	30.0969	0	6699	9.3593	0	6754	0	0
6645	-9.4119	0	6700	5.8059	0	6755	0	0
6646	-0.1784	0	6701	-0.7837	0	6756	0	0
6647	-0.0147	0	6702	4.8168	0	6757	0	0
6648	13.7112	0	6703	3.7003	0	6758	0	0
6649	11.1716	0	6704	-17.2949	0	6759	0	0
6650	-5.6646	0	6705	-6.2301	0	6760	0	0
6651	20.9372	0	6706	4.1003	0	6761	0	0
6652	-7.3846	0	6707	-15.9115	0	6762	0	0
6653	0.1534	0	6708	-5.5652	0	6763	0	0
6654	0.3033	0	6709	-7.8941	0	6764	0	0
6655	6.5679	0	6710	-1.9190	0	6765	0	0

TABLE A-20. Time-domain sequence for symbol #42

#	Real	Imag	#	Real	Imag	#	Real	Imag
6766	-21.2132	0	6821	29.1176	0	6876	-13.4834	0
6767	19.2759	0	6822	17.4814	0	6877	-8.0450	0
6768	13.0178	0	6823	-4.4509	0	6878	16.8284	0
6769	-11.3705	0	6824	-9.3295	0	6879	-1.3748	0
6770	-10.1838	0	6825	0.3226	0	6880	19.3215	0
6771	-17.7854	0	6826	6.3761	0	6881	16.3364	0
6772	-9.1938	0	6827	-8.4122	0	6882	1.7305	0
6773	-6.6528	0	6828	-27.2959	0	6883	-3.2442	0
6774	-7.7490	0	6829	7.4088	0	6884	0.0653	0
6775	5.0398	0	6830	21.2132	0	6885	-10.7310	0
6776	-2.3687	0	6831	4.9547	0	6886	-0.9962	0
6777	-4.6466	0	6832	26.6757	0	6887	-8.1854	0
6778	-12.0147	0	6833	-1.5377	0	6888	-3.4585	0
6779	-13.6126	0	6834	-8.8062	0	6889	5.0708	0
6780	8.4246	0	6835	-1.4625	0	6890	-7.2014	0
6781	-6.0367	0	6836	11.5579	0	6891	-2.5851	0
6782	-15.3137	0	6837	8.0684	0	6892	-2.6914	0
6783	-9.2860	0	6838	4.2343	0	6893	7.9982	0
6784	-13.2957	0	6839	-1.8951	0	6894	0	0
6785	8.0570	0	6840	6.5136	0	6895	0	0
6786	18.7755	0	6841	-19.2543	0	6896	0	0
6787	-11.8976	0	6842	-7.6344	0	6897	0	0
6788	-6.2117	0	6843	-7.2191	0	6898	0	0
6789	-9.9430	0	6844	-9.4739	0	6899	0	0
6790	4.0695	0	6845	-5.7438	0	6900	0	0
6791	5.8465	0	6846	-7.3137	0	6901	0	0
6792	0.0574	0	6847	6.6956	0	6902	0	0
6793	14.0676	0	6848	-6.5434	0	6903	0	0
6794	9.3718	0	6849	7.8110	0	6904	0	0
6795	-11.0560	0	6850	9.3042	0	6905	0	0
6796	-3.2374	0	6851	-8.8269	0	6906	0	0
6797	4.2206	0	6852	8.0733	0	6907	0	0
6798	12.7279	0	6853	25.4963	0	6908	0	0
6799	3.3156	0	6854	-3.5842	0	6909	0	0
6800	-13.5657	0	6855	0.8877	0	6910	0	0
6801	7.5897	0	6856	9.8120	0	6911	0	0
6802	-0.1368	0	6857	-8.8656	0	6912	0	0
6803	12.3638	0	6858	5.1103	0	6913	0	0

TABLE A-20. Time-domain sequence for symbol #42

6804	-11.9640	0	6859	22.1330	0	6914	0	0
6805	12.8865	0	6860	-2.1984	0	6915	0	0
6806	14.2552	0	6861	2.9995	0	6916	0	0
6807	-9.3610	0	6862	-7.0711	0	6917	0	0
6808	10.1759	0	6863	-3.6542	0	6918	0	0
6809	-30.0969	0	6864	-9.3593	0	6919	0	0
6810	9.4119	0	6865	-5.8059	0	6920	0	0
6811	0.1784	0	6866	0.7837	0	6921	0	0
6812	0.0147	0	6867	-4.8168	0	6922	0	0
6813	-13.7112	0	6868	-3.7003	0	6923	0	0
6814	-11.1716	0	6869	17.2949	0	6924	0	0
6815	5.6646	0	6870	6.2301	0	6925	0	0
6816	-20.9372	0	6871	-4.1003	0	6926	0	0
6817	7.3846	0	6872	15.9115	0	6927	0	0
6818	-0.1534	0	6873	5.5652	0	6928	0	0
6819	-0.3033	0	6874	7.8941	0	6929	0	0
6820	-6.5679	0	6875	1.9190	0	6930	0	0

TABLE A-21. Time-domain sequence for symbol #43

#	Real	Imag	#	Real	Imag	#	Real	Imag
6931	5.6569	-15.5563	6986	4.5972	9.2839	7041	8.1378	4.8784
6932	-7.3256	-5.8859	6987	10.0968	2.7119	7042	1.7870	-1.6942
6933	-3.4562	8.0375	6988	8.5499	7.9283	7043	0.0000	-5.1716
6934	-2.1729	-3.4839	6989	-7.9708	-5.9453	7044	8.9829	14.1947
6935	3.1765	0.6753	6990	-2.4135	12.9526	7045	5.4362	-1.9039
6936	0.2959	6.3641	6991	-13.7910	-2.2408	7046	2.1940	-16.1145
6937	4.7368	9.7582	6992	7.3309	-2.7881	7047	-8.6025	-3.1296
6938	-4.9815	7.4272	6993	-5.7758	17.8872	7048	1.6272	-4.7230
6939	10.8796	2.0273	6994	-4.9856	1.3084	7049	-0.7598	-5.3260
6940	-0.9253	-1.4276	6995	5.6569	-12.7279	7050	-9.4105	10.1188
6941	-11.7830	-1.9553	6996	-24.5126	-11.9274	7051	-2.7831	5.7734
6942	-8.6512	-8.4905	6997	3.3019	14.1191	7052	6.0694	-2.9262
6943	-7.6180	3.8784	6998	-14.6726	-6.6855	7053	-1.6380	-1.1872
6944	-3.1359	-2.1070	6999	-4.4027	12.9101	7054	-11.3373	-2.0241
6945	2.5044	-9.5182	7000	4.4330	-0.3948	7055	-4.4831	10.9295
6946	-5.5661	3.7362	7001	-1.5017	-9.0949	7056	17.6827	0.5902
6947	-5.6569	-3.6569	7002	10.0538	6.3784	7057	1.5137	-4.9642
6948	5.2865	-0.2268	7003	-4.5365	-3.1989	7058	-10.4545	3.2112
6949	10.5334	19.4120	7004	9.0527	-3.2487	7059	0	0
6950	0.1996	16.8985	7005	-0.9686	-0.8514	7060	0	0
6951	-7.8014	-1.1601	7006	2.3481	1.4031	7061	0	0
6952	4.2362	6.4591	7007	2.8578	-7.8070	7062	0	0
6953	-7.9485	2.1321	7008	3.1287	-6.3080	7063	0	0
6954	0.0994	13.2728	7009	4.3057	-0.1872	7064	0	0
6955	-2.6643	7.9382	7010	14.7856	-2.7287	7065	0	0
6956	7.2059	3.6947	7011	-5.6569	-7.6569	7066	0	0
6957	-0.6246	2.3534	7012	2.8560	6.9983	7067	0	0
6958	2.0810	-5.0736	7013	-9.5841	-6.7473	7068	0	0
6959	-1.5367	2.5028	7014	-8.9301	13.5903	7069	0	0
6960	-2.0227	-6.0615	7015	5.9662	-5.8718	7070	0	0
6961	-5.2936	-7.0084	7016	7.4282	1.3332	7071	0	0
6962	3.6447	-1.7857	7017	-2.7779	11.3060	7072	0	0
6963	8.4853	-4.2426	7018	-0.2445	-8.3119	7073	0	0
6964	4.0458	-3.6770	7019	17.9780	0.5471	7074	0	0
6965	6.3857	-0.7584	7020	-19.6581	-18.2471	7075	0	0
6966	-7.8420	-12.3965	7021	-7.4235	-2.4253	7076	0	0
6967	-4.9671	-3.8454	7022	2.0931	0.4803	7077	0	0
6968	-4.2232	-7.5612	7023	8.4971	-5.5347	7078	0	0

TABLE A-21. Time-domain sequence for symbol #43

6969	2.4266	4.1413	7024	3.8439	-8.9789	7079	0	0
6970	-5.3201	4.9082	7025	14.8830	10.5244	7080	0	0
6971	-1.3061	2.3318	7026	-2.2545	4.3930	7081	0	0
6972	-9.2108	-6.1741	7027	2.8284	-7.0711	7082	0	0
6973	-5.8050	-23.6260	7028	8.1303	-11.1961	7083	0	0
6974	27.1735	-0.4131	7029	0.1118	-19.3846	7084	0	0
6975	0.4294	11.3002	7030	-0.9545	-6.5142	7085	0	0
6976	-6.5053	7.5784	7031	14.1934	3.9169	7086	0	0
6977	-0.9615	-8.2982	7032	13.9534	1.7256	7087	0	0
6978	-10.0636	-4.3610	7033	6.4476	-1.2708	7088	0	0
6979	0.0000	10.8284	7034	-4.3143	9.4710	7089	0	0
6980	-12.6022	4.7360	7035	-16.3508	4.4966	7090	0	0
6981	-0.0423	-0.0882	7036	4.6826	4.7574	7091	0	0
6982	-4.3698	11.8128	7037	0.8997	-1.6766	7092	0	0
6983	2.4377	7.8184	7038	2.6272	-5.3143	7093	0	0
6984	3.8926	-4.0643	7039	-6.9830	-1.7148	7094	0	0
6985	2.6905	7.6677	7040	2.6619	-3.6913	7095	0	0

TABLE A-22. Time-domain sequence for symbol #44

#	Real	Imag	#	Real	Imag	#	Real	Imag
7096	-15.5563	5.6569	7151	9.2839	4.5972	7206	4.8784	8.1378
7097	-5.8859	-7.3256	7152	2.7119	10.0968	7207	-1.6942	1.7870
7098	8.0375	-3.4562	7153	7.9283	8.5499	7208	-5.1716	0.0000
7099	-3.4839	-2.1729	7154	-5.9453	-7.9708	7209	14.1947	8.9829
7100	0.6753	3.1765	7155	12.9526	-2.4135	7210	-1.9039	5.4362
7101	6.3641	0.2959	7156	-2.2408	-13.7910	7211	-16.1145	2.1940
7102	9.7582	4.7368	7157	-2.7881	7.3309	7212	-3.1296	-8.6025
7103	7.4272	-4.9815	7158	17.8872	-5.7758	7213	-4.7230	1.6272
7104	2.0273	10.8796	7159	1.3084	-4.9856	7214	-5.3260	-0.7598
7105	-1.4276	-0.9253	7160	-12.7279	5.6569	7215	10.1188	-9.4105
7106	-1.9553	-11.7830	7161	-11.9274	-24.5126	7216	5.7734	-2.7831
7107	-8.4905	-8.6512	7162	14.1191	3.3019	7217	-2.9262	6.0694
7108	3.8784	-7.6180	7163	-6.6855	-14.6726	7218	-1.1872	-1.6380
7109	-2.1070	-3.1359	7164	12.9101	-4.4027	7219	-2.0241	-11.3373
7110	-9.5182	2.5044	7165	-0.3948	4.4330	7220	10.9295	-4.4831
7111	3.7362	-5.5661	7166	-9.0949	-1.5017	7221	0.5902	17.6827
7112	-3.6569	-5.6569	7167	6.3784	10.0538	7222	-4.9642	1.5137
7113	-0.2268	5.2865	7168	-3.1989	-4.5365	7223	3.2112	-10.4545
7114	19.4120	10.5334	7169	-3.2487	9.0527	7224	0	0
7115	16.8985	0.1996	7170	-0.8514	-0.9686	7225	0	0
7116	-1.1601	-7.8014	7171	1.4031	2.3481	7226	0	0
7117	6.4591	4.2362	7172	-7.8070	2.8578	7227	0	0
7118	2.1321	-7.9485	7173	-6.3080	3.1287	7228	0	0
7119	13.2728	0.0994	7174	-0.1872	4.3057	7229	0	0
7120	7.9382	-2.6643	7175	-2.7287	14.7856	7230	0	0
7121	3.6947	7.2059	7176	-7.6569	-5.6569	7231	0	0
7122	2.3534	-0.6246	7177	6.9983	2.8560	7232	0	0
7123	-5.0736	2.0810	7178	-6.7473	-9.5841	7233	0	0
7124	2.5028	-1.5367	7179	13.5903	-8.9301	7234	0	0
7125	-6.0615	-2.0227	7180	-5.8718	5.9662	7235	0	0
7126	-7.0084	-5.2936	7181	1.3332	7.4282	7236	0	0
7127	-1.7857	3.6447	7182	11.3060	-2.7779	7237	0	0
7128	-4.2426	8.4853	7183	-8.3119	-0.2445	7238	0	0
7129	-3.6770	4.0458	7184	0.5471	17.9780	7239	0	0
7130	-0.7584	6.3857	7185	-18.2471	-19.6581	7240	0	0
7131	-12.3965	-7.8420	7186	-2.4253	-7.4235	7241	0	0
7132	-3.8454	-4.9671	7187	0.4803	2.0931	7242	0	0
7133	-7.5612	-4.2232	7188	-5.5347	8.4971	7243	0	0

TABLE A-22. Time-domain sequence for symbol #44

7134	4.1413	2.4266	7189	-8.9789	3.8439	7244	0	0
7135	4.9082	-5.3201	7190	10.5244	14.8830	7245	0	0
7136	2.3318	-1.3061	7191	4.3930	-2.2545	7246	0	0
7137	-6.1741	-9.2108	7192	-7.0711	2.8284	7247	0	0
7138	-23.6260	-5.8050	7193	-11.1961	8.1303	7248	0	0
7139	-0.4131	27.1735	7194	-19.3846	0.1118	7249	0	0
7140	11.3002	0.4294	7195	-6.5142	-0.9545	7250	0	0
7141	7.5784	-6.5053	7196	3.9169	14.1934	7251	0	0
7142	-8.2982	-0.9615	7197	1.7256	13.9534	7252	0	0
7143	-4.3610	-10.0636	7198	-1.2708	6.4476	7253	0	0
7144	10.8284	0.0000	7199	9.4710	-4.3143	7254	0	0
7145	4.7360	-12.6022	7200	4.4966	-16.3508	7255	0	0
7146	-0.0882	-0.0423	7201	4.7574	4.6826	7256	0	0
7147	11.8128	-4.3698	7202	-1.6766	0.8997	7257	0	0
7148	7.8184	2.4377	7203	-5.3143	2.6272	7258	0	0
7149	-4.0643	3.8926	7204	-1.7148	-6.9830	7259	0	0
7150	7.6677	2.6905	7205	-3.6913	2.6619	7260	0	0

TABLE A-23. Time-domain sequence for symbol #45

#	Real	Imag	#	Real	Imag	#	Real	Imag
7261	4.2426	1.4142	7316	-3.7965	-3.8348	7371	1.0272	9.7552
7262	-9.0284	-6.4358	7317	10.0479	1.0744	7372	-6.0192	8.8716
7263	9.9329	5.4955	7318	5.8456	-5.3574	7373	0.5858	6.0000
7264	-15.6100	-19.1940	7319	5.6773	8.0844	7374	1.3770	-8.0634
7265	6.4262	-3.9811	7320	-4.5314	-9.4594	7375	-10.6254	-0.1091
7266	8.6776	2.7611	7321	4.1378	-11.2395	7376	8.6844	12.7212
7267	1.6156	8.6983	7322	11.9433	9.8801	7377	-5.0839	-0.3012
7268	0.6804	11.9387	7323	-8.9144	-2.3267	7378	-20.5265	3.3287
7269	-2.3869	6.2620	7324	-5.2063	1.5669	7379	-4.7078	7.8844
7270	-9.2055	0.5013	7325	1.4142	-4.2426	7380	5.2643	-1.0267
7271	-5.9799	12.0769	7326	-5.1850	7.3146	7381	-4.7342	0.4403
7272	8.6424	12.2814	7327	-4.7431	-5.5691	7382	5.2284	5.4375
7273	11.0325	5.9058	7328	1.9036	2.3519	7383	-15.9664	-9.1970
7274	0.8695	-3.4337	7329	-2.9460	-2.4286	7384	2.5172	16.1653
7275	3.3488	2.5280	7330	9.4621	-16.4579	7385	-2.5701	0.9309
7276	13.9412	9.1555	7331	19.6582	-3.2065	7386	10.1756	-1.6611
7277	1.4142	4.8284	7332	-0.9931	-1.0878	7387	-6.4483	-20.4933
7278	-1.3303	-4.8535	7333	-7.6131	2.5665	7388	-11.0273	0.3051
7279	-1.9441	2.7731	7334	-3.6724	-7.2341	7389	0	0
7280	2.8071	-8.2579	7335	-16.2091	-2.9789	7390	0	0
7281	1.1122	13.0724	7336	-4.6108	9.2346	7391	0	0
7282	2.5126	-4.3936	7337	2.8397	-1.4574	7392	0	0
7283	-7.2980	0.4676	7338	10.5571	-1.2599	7393	0	0
7284	-2.0863	13.9107	7339	-3.1598	11.2551	7394	0	0
7285	11.7183	-4.7818	7340	6.8204	8.5555	7395	0	0
7286	-15.1614	5.2562	7341	1.4142	0.8284	7396	0	0
7287	-4.9963	-5.8573	7342	6.4053	4.5493	7397	0	0
7288	-8.7059	-0.7558	7343	14.5286	7.1405	7398	0	0
7289	-6.0637	-6.8116	7344	5.0887	-4.8862	7399	0	0
7290	8.9261	1.4829	7345	-3.4922	-6.8898	7400	0	0
7291	-1.1142	3.6990	7346	-10.2580	-4.5815	7401	0	0
7292	5.3707	8.5904	7347	16.5492	2.7190	7402	0	0
7293	-1.4142	-4.2426	7348	-1.5320	-5.9925	7403	0	0
7294	-15.7666	0.5872	7349	5.5954	-13.7035	7404	0	0
7295	-6.9068	-7.3585	7350	11.5529	16.8321	7405	0	0
7296	3.6025	-0.9987	7351	5.0196	1.2358	7406	0	0
7297	-3.6364	-6.4725	7352	13.4144	-1.6963	7407	0	0
7298	-1.6752	-1.5960	7353	5.4665	9.1202	7408	0	0

TABLE A-23. Time-domain sequence for symbol #45

7299	-13.8144	3.8826	7354	7.2999	2.0320	7409	0	0
7300	0.6665	-4.3316	7355	-11.0236	2.9343	7410	0	0
7301	3.9176	-0.8204	7356	-14.7595	-7.6027	7411	0	0
7302	6.0209	2.3768	7357	-4.2426	-9.8995	7412	0	0
7303	3.5727	2.8193	7358	-0.9229	11.6744	7413	0	0
7304	15.1533	-18.2266	7359	11.1216	14.0275	7414	0	0
7305	12.8255	10.1401	7360	4.3153	-9.8931	7415	0	0
7306	3.0603	7.8972	7361	-5.5007	-6.4315	7416	0	0
7307	6.9705	-4.0379	7362	0.0886	-4.9611	7417	0	0
7308	-0.7904	5.6695	7363	-10.3844	-0.9855	7418	0	0
7309	-3.4142	-6.0000	7364	-18.5329	-12.6878	7419	0	0
7310	-4.5378	-7.8844	7365	6.0824	-2.3512	7420	0	0
7311	1.3226	2.9139	7366	-3.6198	17.2992	7421	0	0
7312	-5.2441	-4.4187	7367	-6.4316	-2.8694	7422	0	0
7313	1.8071	-9.1950	7368	4.5733	-6.9678	7423	0	0
7314	-3.6387	-6.6753	7369	6.2729	-6.5884	7424	0	0
7315	-4.9321	-0.1460	7370	-5.4742	-14.3621	7425	0	0

TABLE A-24. Time-domain sequence for symbol #46

#	Real	Imag	#	Real	Imag	#	Real	Imag
7426	1.4142	4.2426	7481	-3.8348	-3.7965	7536	9.7552	1.0272
7427	-6.4358	-9.0284	7482	1.0744	10.0479	7537	8.8716	-6.0192
7428	5.4955	9.9329	7483	-5.3574	5.8456	7538	6.0000	0.5858
7429	-19.1940	-15.6100	7484	8.0844	5.6773	7539	-8.0634	1.3770
7430	-3.9811	6.4262	7485	-9.4594	-4.5314	7540	-0.1091	-10.6254
7431	2.7611	8.6776	7486	-11.2395	4.1378	7541	12.7212	8.6844
7432	8.6983	1.6156	7487	9.8801	11.9433	7542	-0.3012	-5.0839
7433	11.9387	0.6804	7488	-2.3267	-8.9144	7543	3.3287	-20.5265
7434	6.2620	-2.3869	7489	1.5669	-5.2063	7544	7.8844	-4.7078
7435	0.5013	-9.2055	7490	-4.2426	1.4142	7545	-1.0267	5.2643
7436	12.0769	-5.9799	7491	7.3146	-5.1850	7546	0.4403	-4.7342
7437	12.2814	8.6424	7492	-5.5691	-4.7431	7547	5.4375	5.2284
7438	5.9058	11.0325	7493	2.3519	1.9036	7548	-9.1970	-15.9664
7439	-3.4337	0.8695	7494	-2.4286	-2.9460	7549	16.1653	2.5172
7440	2.5280	3.3488	7495	-16.4579	9.4621	7550	0.9309	-2.5701
7441	9.1555	13.9412	7496	-3.2065	19.6582	7551	-1.6611	10.1756
7442	4.8284	1.4142	7497	-1.0878	-0.9931	7552	-20.4933	-6.4483
7443	-4.8535	-1.3303	7498	2.5665	-7.6131	7553	0.3051	-11.0273
7444	2.7731	-1.9441	7499	-7.2341	-3.6724	7554	0	0
7445	-8.2579	2.8071	7500	-2.9789	-16.2091	7555	0	0
7446	13.0724	1.1122	7501	9.2346	-4.6108	7556	0	0
7447	-4.3936	2.5126	7502	-1.4574	2.8397	7557	0	0
7448	0.4676	-7.2980	7503	-1.2599	10.5571	7558	0	0
7449	13.9107	-2.0863	7504	11.2551	-3.1598	7559	0	0
7450	-4.7818	11.7183	7505	8.5555	6.8204	7560	0	0
7451	5.2562	-15.1614	7506	0.8284	1.4142	7561	0	0
7452	-5.8573	-4.9963	7507	4.5493	6.4053	7562	0	0
7453	-0.7558	-8.7059	7508	7.1405	14.5286	7563	0	0
7454	-6.8116	-6.0637	7509	-4.8862	5.0887	7564	0	0
7455	1.4829	8.9261	7510	-6.8898	-3.4922	7565	0	0
7456	3.6990	-1.1142	7511	-4.5815	-10.2580	7566	0	0
7457	8.5904	5.3707	7512	2.7190	16.5492	7567	0	0
7458	-4.2426	-1.4142	7513	-5.9925	-1.5320	7568	0	0
7459	0.5872	-15.7666	7514	-13.7035	5.5954	7569	0	0
7460	-7.3585	-6.9068	7515	16.8321	11.5529	7570	0	0
7461	-0.9987	3.6025	7516	1.2358	5.0196	7571	0	0
7462	-6.4725	-3.6364	7517	-1.6963	13.4144	7572	0	0
7463	-1.5960	-1.6752	7518	9.1202	5.4665	7573	0	0

TABLE A-24. Time-domain sequence for symbol #46

7464	3.8826	-13.8144	7519	2.0320	7.2999	7574	0	0
7465	-4.3316	0.6665	7520	2.9343	-11.0236	7575	0	0
7466	-0.8204	3.9176	7521	-7.6027	-14.7595	7576	0	0
7467	2.3768	6.0209	7522	-9.8995	-4.2426	7577	0	0
7468	2.8193	3.5727	7523	11.6744	-0.9229	7578	0	0
7469	-18.2266	15.1533	7524	14.0275	11.1216	7579	0	0
7470	10.1401	12.8255	7525	-9.8931	4.3153	7580	0	0
7471	7.8972	3.0603	7526	-6.4315	-5.5007	7581	0	0
7472	-4.0379	6.9705	7527	-4.9611	0.0886	7582	0	0
7473	5.6695	-0.7904	7528	-0.9855	-10.3844	7583	0	0
7474	-6.0000	-3.4142	7529	-12.6878	-18.5329	7584	0	0
7475	-7.8844	-4.5378	7530	-2.3512	6.0824	7585	0	0
7476	2.9139	1.3226	7531	17.2992	-3.6198	7586	0	0
7477	-4.4187	-5.2441	7532	-2.8694	-6.4316	7587	0	0
7478	-9.1950	1.8071	7533	-6.9678	4.5733	7588	0	0
7479	-6.6753	-3.6387	7534	-6.5884	6.2729	7589	0	0
7480	-0.1460	-4.9321	7535	-14.3621	-5.4742	7590	0	0

TABLE A-25. Time-domain sequence for symbol #47

#	Real	Imag	#	Real	Imag	#	Real	Imag
7591	-2.8284	7.0711	7646	9.4126	-3.0015	7701	2.7923	6.6644
7592	13.9421	15.9959	7647	-3.8268	-13.2745	7702	-2.6903	3.6856
7593	-3.7703	7.2471	7648	10.3114	4.9883	7703	-2.8284	-7.6569
7594	-8.6675	4.3944	7649	4.2137	0.6988	7704	5.8013	-7.7852
7595	1.0182	-8.4175	7650	-3.3219	-0.6549	7705	-3.2658	-6.0507
7596	-15.3914	-10.5005	7651	-0.0032	-0.1500	7706	-5.7868	-7.7895
7597	-6.8927	-1.7940	7652	-8.0071	-16.0955	7707	6.3477	-4.8991
7598	7.8557	-13.8528	7653	0.1460	-0.4320	7708	0.1301	4.2344
7599	0.6006	0.9272	7654	-4.9965	-9.6813	7709	3.5516	5.1450
7600	-2.1683	-5.8756	7655	-8.4853	4.2426	7710	-1.3679	-3.5906
7601	6.9292	-10.3237	7656	-6.2649	1.4403	7711	3.8268	-1.5539
7602	8.9010	4.3986	7657	3.3303	-0.0537	7712	1.2239	-1.9365
7603	-8.3112	-4.3839	7658	-22.4698	4.9352	7713	-7.7590	1.6254
7604	-11.8377	-14.3747	7659	-14.1762	-0.3587	7714	-15.7783	-9.6889
7605	2.6927	-3.4803	7660	19.1651	1.1810	7715	1.3396	-1.1696
7606	1.1823	-13.4777	7661	-9.3186	6.8608	7716	-9.4345	0.6938
7607	-8.0000	-6.3431	7662	-2.0123	15.2532	7717	-3.1315	-3.7000
7608	12.7148	-4.1065	7663	3.3994	9.2149	7718	11.1439	6.9109
7609	-1.3977	4.7058	7664	-4.1535	-0.3888	7719	0	0
7610	6.0659	6.6030	7665	14.6364	-1.2104	7720	0	0
7611	-6.8543	-27.5782	7666	6.2109	-5.9018	7721	0	0
7612	-14.1040	-5.1843	7667	-1.7435	-5.5865	7722	0	0
7613	8.1044	-9.1837	7668	-4.6282	-11.0184	7723	0	0
7614	8.9777	15.2762	7669	1.6434	3.7524	7724	0	0
7615	9.2388	-2.1712	7670	-0.8793	6.6448	7725	0	0
7616	4.2990	1.1415	7671	8.0000	17.6569	7726	0	0
7617	6.5188	1.1778	7672	-1.0481	-5.3588	7727	0	0
7618	-8.8306	-7.2690	7673	9.2416	-2.5985	7728	0	0
7619	0.2538	10.9253	7674	-3.8724	9.9821	7729	0	0
7620	13.0311	12.9525	7675	-0.4267	-1.4857	7730	0	0
7621	9.5764	6.1682	7676	13.8860	16.6384	7731	0	0
7622	-4.7108	-6.8444	7677	-7.5032	-3.5767	7732	0	0
7623	-2.8284	7.0711	7678	-7.2244	0.3915	7733	0	0
7624	-3.4868	0.6474	7679	-9.2388	11.3428	7734	0	0
7625	-7.9269	6.7388	7680	6.1916	5.3634	7735	0	0
7626	-9.6788	-3.5997	7681	2.6750	-5.3372	7736	0	0
7627	-4.1829	-0.1412	7682	-4.2841	4.9974	7737	0	0
7628	1.9907	-8.0221	7683	-3.2470	16.0511	7738	0	0

TABLE A-25. Time-domain sequence for symbol #47

7629	1.9794	3.1843	7684	1.0061	5.1601	7739	0	0
7630	1.3870	-10.5432	7685	13.2307	-5.1395	7740	0	0
7631	-9.0740	13.8490	7686	4.9801	-6.7891	7741	0	0
7632	2.8425	-5.6272	7687	-2.8284	4.2426	7742	0	0
7633	24.5997	1.3490	7688	-0.4633	5.5202	7743	0	0
7634	-1.9499	12.1128	7689	-9.9344	-4.7059	7744	0	0
7635	-2.9158	-3.0863	7690	1.1803	-4.3625	7745	0	0
7636	14.1004	4.5271	7691	-0.3159	-7.3669	7746	0	0
7637	8.3636	-11.8332	7692	-0.3946	9.4537	7747	0	0
7638	-9.7956	15.2216	7693	2.6625	8.3662	7748	0	0
7639	-2.8284	-3.6569	7694	-1.8895	4.3969	7749	0	0
7640	-4.3340	-2.0237	7695	5.0740	4.2932	7750	0	0
7641	-14.9631	2.7171	7696	19.2196	-1.9946	7751	0	0
7642	11.5858	0.2895	7697	-0.5002	4.0203	7752	0	0
7643	7.2764	-6.3213	7698	-3.9311	-8.4467	7753	0	0
7644	-5.6386	2.6519	7699	3.3136	-1.2864	7754	0	0
7645	-5.2697	-1.0019	7700	-3.2461	7.7026	7755	0	0

TABLE A-26. Time-domain sequence for symbol #48

#	Real	Imag	#	Real	Imag	#	Real	Imag
7756	-7.0711	2.8284	7811	3.0015	-9.4126	7866	-6.6644	-2.7923
7757	-15.9959	-13.9421	7812	13.2745	3.8268	7867	-3.6856	2.6903
7758	-7.2471	3.7703	7813	-4.9883	-10.3114	7868	7.6569	2.8284
7759	-4.3944	8.6675	7814	-0.6988	-4.2137	7869	7.7852	-5.8013
7760	8.4175	-1.0182	7815	0.6549	3.3219	7870	6.0507	3.2658
7761	10.5005	15.3914	7816	0.1500	0.0032	7871	7.7895	5.7868
7762	1.7940	6.8927	7817	16.0955	8.0071	7872	4.8991	-6.3477
7763	13.8528	-7.8557	7818	0.4320	-0.1460	7873	-4.2344	-0.1301
7764	-0.9272	-0.6006	7819	9.6813	4.9965	7874	-5.1450	-3.5516
7765	5.8756	2.1683	7820	-4.2426	8.4853	7875	3.5906	1.3679
7766	10.3237	-6.9292	7821	-1.4403	6.2649	7876	1.5539	-3.8268
7767	-4.3986	-8.9010	7822	0.0537	-3.3303	7877	1.9365	-1.2239
7768	4.3839	8.3112	7823	-4.9352	22.4698	7878	-1.6254	7.7590
7769	14.3747	11.8377	7824	0.3587	14.1762	7879	9.6889	15.7783
7770	3.4803	-2.6927	7825	-1.1810	-19.1651	7880	1.1696	-1.3396
7771	13.4777	-1.1823	7826	-6.8608	9.3186	7881	-0.6938	9.4345
7772	6.3431	8.0000	7827	-15.2532	2.0123	7882	3.7000	3.1315
7773	4.1065	-12.7148	7828	-9.2149	-3.3994	7883	-6.9109	-11.1439
7774	-4.7058	1.3977	7829	0.3888	4.1535	7884	0	0
7775	-6.6030	-6.0659	7830	1.2104	-14.6364	7885	0	0
7776	27.5782	6.8543	7831	5.9018	-6.2109	7886	0	0
7777	5.1843	14.1040	7832	5.5865	1.7435	7887	0	0
7778	9.1837	-8.1044	7833	11.0184	4.6282	7888	0	0
7779	-15.2762	-8.9777	7834	-3.7524	-1.6434	7889	0	0
7780	2.1712	-9.2388	7835	-6.6448	0.8793	7890	0	0
7781	-1.1415	-4.2990	7836	-17.6569	-8.0000	7891	0	0
7782	-1.1778	-6.5188	7837	5.3588	1.0481	7892	0	0
7783	7.2690	8.8306	7838	2.5985	-9.2416	7893	0	0
7784	-10.9253	-0.2538	7839	-9.9821	3.8724	7894	0	0
7785	-12.9525	-13.0311	7840	1.4857	0.4267	7895	0	0
7786	-6.1682	-9.5764	7841	-16.6384	-13.8860	7896	0	0
7787	6.8444	4.7108	7842	3.5767	7.5032	7897	0	0
7788	-7.0711	2.8284	7843	-0.3915	7.2244	7898	0	0
7789	-0.6474	3.4868	7844	-11.3428	9.2388	7899	0	0
7790	-6.7388	7.9269	7845	-5.3634	-6.1916	7900	0	0
7791	3.5997	9.6788	7846	5.3372	-2.6750	7901	0	0
7792	0.1412	4.1829	7847	-4.9974	4.2841	7902	0	0
7793	8.0221	-1.9907	7848	-16.0511	3.2470	7903	0	0

TABLE A-26. Time-domain sequence for symbol #48

7794	-3.1843	-1.9794	7849	-5.1601	-1.0061	7904	0	0
7795	10.5432	-1.3870	7850	5.1395	-13.2307	7905	0	0
7796	-13.8490	9.0740	7851	6.7891	-4.9801	7906	0	0
7797	5.6272	-2.8425	7852	-4.2426	2.8284	7907	0	0
7798	-1.3490	-24.5997	7853	-5.5202	0.4633	7908	0	0
7799	-12.1128	1.9499	7854	4.7059	9.9344	7909	0	0
7800	3.0863	2.9158	7855	4.3625	-1.1803	7910	0	0
7801	-4.5271	-14.1004	7856	7.3669	0.3159	7911	0	0
7802	11.8332	-8.3636	7857	-9.4537	0.3946	7912	0	0
7803	-15.2216	9.7956	7858	-8.3662	-2.6625	7913	0	0
7804	3.6569	2.8284	7859	-4.3969	1.8895	7914	0	0
7805	2.0237	4.3340	7860	-4.2932	-5.0740	7915	0	0
7806	-2.7171	14.9631	7861	1.9946	-19.2196	7916	0	0
7807	-0.2895	-11.5858	7862	-4.0203	0.5002	7917	0	0
7808	6.3213	-7.2764	7863	8.4467	3.9311	7918	0	0
7809	-2.6519	5.6386	7864	1.2864	-3.3136	7919	0	0
7810	1.0019	5.2697	7865	-7.7026	3.2461	7920	0	0

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ANNEX B - RECOMMENDED OUT-OF-BAND EMISSIONS LIMITS

Table B-1 defines recommended out-of-band emissions limits when close proximity between UWB devices, and cellular phones and GPS downlink devices is required. The emission limits are specified for average power and exclude possible narrowband spectrum spikes or spurs. The following parameters were assumed in the derivation of the limits recommended in this section:

1. Device separation of 60 cm.
2. Noise figure 7 dB for cellular and 3.5 dB for GPS, respectively.
3. Allowed noise increase 1 dB for cellular and 0.5 dB for GPS, respectively.
4. Victim antenna gain of -3 dBi.
5. Free space path loss model (f equals to lower limit of the victim receiver band).

TABLE B-1. Recommended emissions limits

Frequency Band (MHz)	Recommended limit (dBm/MHz)
869-894	-83.3
925-960	-82.5
1570-1581	-84.7
1805-1880	-76.8
1930-1990	-76.2
2110-2170	-75.4

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