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SERIES J: CABLE NETWORKS AND TRANSMISSION OF TELEVISION, SOUND PROGRAMME AND OTHER MULTIMEDIA SIGNALS

Cable modems and home networking

Physical layer specification for high speed transmission over coaxial networks

Recommendation ITU-T J.195.2

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Physical layer specification for high speed transmission over coaxial networks

Summary

Recommendation ITU-T J.195.2 specifies the physical (PHY) layer specification for high-speed data transmission over coaxial cable as part of the high performance network over coax (HiNoC). The HiNoC architecture consists of a HiNoC bridge (HB) and HiNoC modems (HMs), and the HiNoC protocol stack includes the media access control (MAC) layer and PHY layer. HiNoC utilizes the unassigned spectrum of the "last 100-meter" coaxial network to provide more bandwidth and improve spectral efficiency. This document contains descriptions for the signal transmission mode of the PHY layer, including frame structure, channel coding and modulation techniques.

History

Edition	Recommendation	Approval	Study Group	Unique ID*
1.0	ITU-T J.195.2	2014-10-29	9	11.1002/1000/12311

Keywords

HiNoC, PHY layer

* To access the Recommendation, type the URL http://handle.itu.int/ in the address field of your web browser, followed by the Recommendation's unique ID. For example, http://handle.itu.int/11.1002/1000/11830-en.

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Physical layer specification for high speed transmission over coaxial networks

1 Scope

This Recommendation specifies the physical (PHY) layer protocol and is part of a series of high performance network over coax (HiNoC) Recommendations for high-speed data transmission over coaxial cable.

This Recommendation applies to bi-directional high-performance wideband access digital systems that use coaxial cable connected between fibre-to-the-building (FTTB) and HiNoC modems (HMs).

Frequency planning, safety and electromagnetic compatibility (EMC) requirements are a national matter and are not covered by this Recommendation. Compliance remains the operators' responsibility.

2 References

The following ITU-T Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision; users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published. The reference to a document within this Recommendation does not give it, as a stand-alone document, the status of a Recommendation.

[ITU-T G.972] Recommendation ITU-T G.972 (2011), *Definition of terms relevant to optical fibre submarine cable systems*.

[ITU-T J.112] Recommendation ITU-T J.112 (1998), *Transmission systems for interactive cable television services*.

[ITU-T J.195.1] Recommendation ITU-T J.195.1 (2013), *Functional requirements for high speed transmission over coaxial networks connected with fibre to the building*.

3 Definitions

3.1 Terms defined elsewhere

This Recommendation uses the following terms defined elsewhere:

3.1.1 constellation mapping [ITU-T J.195.1]: The process of mapping the data bits to the constellation symbol.

3.1.2 cyclic redundancy check [ITU-T J.112]: A method of error detection using cyclic code.

3.1.3 forward error correction [ITU-T G.972]: A technique which consists of transmitting the data in an encoded form such that the redundancy added by the coding allows the decoding to detect and correct errors.

3.2 Terms defined in this Recommendation

This Recommendation defines the following terms:

3.2.1 available sub-carrier: Sub-carriers of OFDM symbol for data bearing.

3.2.2 control frame: Frame of the MAC layer used for access control and channel allocation.

3.2.3 cyclic prefix: Data located at the front of an OFDM symbol, which is a copy of the data from the end of the OFDM symbol.

3.2.4 data frame: Frame of the MAC layer used to carry data of the upper layer.

3.2.5 downlink: Link from HiNoC bridge (HB) to HiNoC modem (HM).

3.2.6 frame check sequence: A redundant sequence that is used for verifying the correctness of the received data.

3.2.7 Pd cycle: A time interval between two adjacent downlink probe frames.

3.2.8 probe frame: Frame of the physical layer used for carrying signalling frames of the MAC layer.

3.2.9 scrambler: Process that randomizes data using a pseudo-random binary sequence.

3.2.10 signalling frame: Frame of the MAC layer used for node admission, node quitting/deletion and link maintenance.

3.2.11 unavailable sub-carrier: Sub-carriers of OFDM symbol for adjacent channel protection and zero frequency sub-carrier.

3.2.12 uplink: Link from HiNoC modem (HM) to HiNoC bridge (HB).

4 Abbreviations and acronyms

This Recommendation uses the following abbreviations and acronyms:

BCH	Bose-Chaudhuri-Hocquenghem
CP	Cyclic Prefix
CRC	Cyclic Redundancy Check
Dd	downlink Data
DQPSK	Differential Quadrature Phase-Shift Keying
Du	uplink Data
FCS	Frame Check Sequence
FEC	Forward Error Correction
FTTB	Fibre-To-The-Building
HB	HiNoC Bridge
HiNoC	High performance Network over Coax
HM	HiNoC Modem
IFFT	Inverse Fast Fourier Transform
MAC	Media Access Control
OFDM	Orthogonal Frequency Division Multiplexing
Pd	downlink Probe
PSD	Power Spectral Density
Pu	uplink Probe
QAM	Quadrature Amplitude Modulation
QPSK	Quadrature Phase-Shift Keying

RF Radio Frequency

5 Conventions

The keywords "**is/are required to**" indicate a requirement which must be strictly followed and from which no deviation is permitted if conformance to this Recommendation is to be claimed.

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In the body of this Recommendation and its annexes, the words *shall*, *shall not*, *should*, and *may* sometimes appear, in which case they are to be interpreted, respectively, as *is required to*, *is prohibited from*, *is recommended*, and *can optionally*. The appearance of such phrases or keywords in an appendix or in material explicitly marked as *informative* are to be interpreted as having no normative intent.

6 PHY layer structure

6.1 Overview

A functional block diagram of the transmitter is shown in Figure 1.

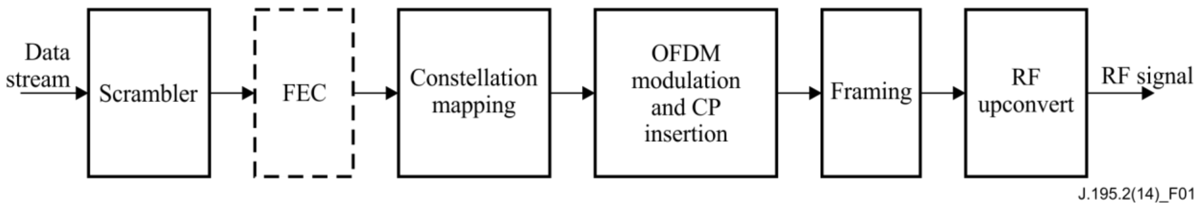


Figure 1 – Functional Block Diagram of the Transmitter

The data streams (service data and signalling data from the media access control (MAC) layer) are transmitted in the following process: scrambler, optional forward error correction (FEC) coding, constellation mapping, orthogonal frequency division multiplexing (OFDM) modulation, cyclic prefix (CP) insertion, framing (into different types of PHY packets) and up conversion to radio frequency (RF) signals.

6.2 Scrambler

The data entering into the transmitter is scrambled using the pseudo-random binary sequence that is defined by the generator polynomial $p(x) = 1 + x^{14} + x^{15}$. The structure of scrambler is shown in Figure 2. Prior to the first bit of each frame, the scrambler shifting register is required to be initialized to initial phase '010010011011000' (from bit 15 to bit 1) as shown in Figure 2. For each input bit, the scrambler is shifted 1 position. The input bits are combined with the scrambling sequence through an exclusive-or operator (XOR), resulting in the randomized output bits.

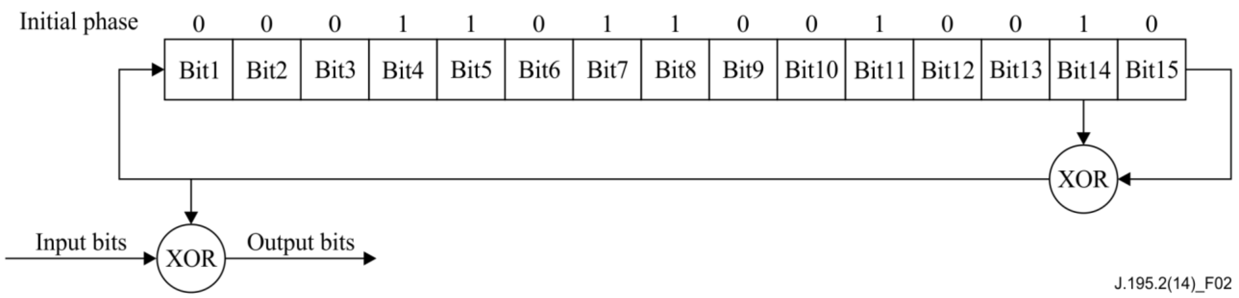


Figure 2 – Structure of the Scrambler

6.3 FEC code

6.3.1 Overview

The FEC encoder is required to support three truncated Bose-Chaudhuri-Hocquenghem (BCH) codes with the following code parameters: (508.472), (504.432), and (392.248).

6.3.2 (508.472) truncated BCH code

The (508.472) BCH code is truncated from (511.475) BCH code, a systematic code with the generator polynomial as shown in Equation (1).

$$g_1(x) = x^{36}+x^{35}+x^{34}+x^{31}+x^{30}+x^{25}+x^{23}+x^{21}+x^{20}+x^{19}+x^{16}+x^{15}+x^{11}+x^{8}+x^{7}+x^{5}+1 \qquad (1)$$

The octal representation for the generator polynomial is $(1630256304641)_8$.

6.3.3 (504.432) truncated BCH code

The (504.432) BCH code is truncated from (511.439) BCH code, a systematic code with the generator polynomial as shown in Equation (2).

$$\begin{aligned} g_2(x) = {} & x^{72}+x^{71}+x^{69}+x^{68}+x^{67}+x^{63}+x^{61}+x^{60}+x^{59}+x^{57}+x^{50}+x^{49}+x^{47}+x^{44}+ \\ & x^{43}+x^{41}+x^{40}+x^{39}+x^{35}+x^{33}+x^{32}+x^{28}+x^{27}+x^{26}+x^{25}+x^{24}+x^{23}+x^{22}+ \\ & x^{21}+x^{20}+x^{19}+x^{18}+x^{17}+x^{13}+x^{10}+x^{9}+x^{7}+x^{6}+x^{5}+x^{2}+1 \end{aligned} \qquad (2)$$

The octal representation for the generator polynomial is $(1561350064670543777423345)_8$.

6.3.4 (392.248) truncated BCH code

The (392.248) BCH code is truncated from (511.367) BCH code, a systematic code with the generator polynomial as shown in Equation (3).

$$\begin{aligned} g_3(x) = {} & x^{144}+x^{141}+x^{139}+x^{137}+x^{136}+x^{134}+x^{133}+x^{131}+x^{129}+x^{128}+x^{127}+x^{126}+x^{124}+x^{118}+ \\ & x^{116}+x^{114}+x^{110}+x^{108}+x^{107}+x^{106}+x^{104}+x^{103}+x^{101}+x^{100}+x^{97}+x^{96}+x^{94}+x^{91}+ \\ & x^{90}+x^{84}+x^{83}+x^{82}+x^{81}+x^{72}+x^{71}+x^{70}+x^{68}+x^{66}+x^{64}+x^{61}+x^{59}+x^{56}+x^{54}+ \\ & x^{53}+x^{51}+x^{50}+x^{49}+x^{46}+x^{44}+x^{43}+x^{39}+x^{38}+x^{35}+x^{31}+x^{30}+x^{29}+x^{27}+x^{26}+ \\ & x^{24}+x^{21}+x^{18}+x^{17}+x^{16}+x^{8}+x^{7}+x^{5}+x^{3}+x^{2}+1 \end{aligned} \qquad (3)$$

The octal representation for the generator polynomial is $(1126657202505666323017001652245562614435511600655)_8$.

6.3.5 Encoding procedure

The truncated BCH encoding procedure is shown in Figure 3. Suppose that the (n, k) truncated BCH code comes from the (n_s, k_s) systematic BCH code. Input bits enter the BCH encoder in order of $d_0, d_1, \cdots, d_{k-1}$. And $k_s - k$ zeros are added in front of d_0 to form k_s information bits. Then k_s information bits are encoded to an n_s bits code as per the original BCH code. Finally, the added $k_s - k$ zeros are deleted to get *n* bits output sequence $c_0, c_1, \cdots, c_{n-1}$.

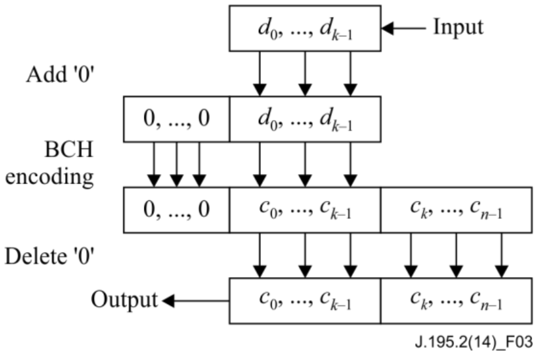


Figure 3 – Encoding procedure of truncated BCH code

6.4 Constellation mapping

6.4.1 Overview

The constellation mapping unit is required to support differential quadrature phase-shift keying (DQPSK), quadrature phase-shift keying (QPSK), 8 quadrature amplitude modulation (8QAM), 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, and 1024QAM constellations. The input bit order of constellation mapping is shown in Figure 4.

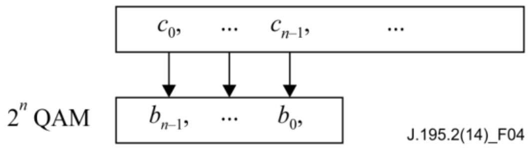


Figure 4 – Input bit order of constellation mapping

The input bit stream is in the order of c_0, ..., c_{n-1}, ... According to different constellation modes, n bits $\{b_{n-1},...,b_0\}$ are taken from the bit stream and mapped into a 2^n QAM symbol, where b_{n-1} is the first bit sent to the constellation mapping unit.

6.4.2 DQPSK

For the DQPSK constellation, the modulated symbol s_n is taken as the reference symbol, and two input bits b_1b_0 are mapped into symbol s_{n+1} according to the mapping table shown in Table 1.

Table 1 – DQPSK mapping

S_n	b_1b_0			
	00	**01**	**10**	**11**
+1	+1	+j	−j	−1
−1	−1	−j	+j	+1
+j	+j	−1	+1	−j
−j	−j	+1	−1	+j

As shown in Figure A.1 of Annex A, the four DQPSK symbols +1, +j, −1, −j correspond to the four points on the axis and the corresponding phases are 0, $\pi/2$, π, $3\pi/2$. The initial reference symbol

s_0 is set to +1 and s_0 should not be output. The DQPSK mapping is initialized at the beginning of each frame.

6.4.3 QPSK

For the QPSK constellation, each group of bits b_1b_0 is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.2 of Annex A and Table B.1 of Annex B.

6.4.4 8QAM

For 8QAM modulation, each group of bits $b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.3 of Annex A and Table B.2 of Annex B.

6.4.5 16QAM

For 16QAM modulation, each group of bits $b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.4 of Annex A and Table B.3 of Annex B.

6.4.6 32QAM

For 32QAM modulation, each group of bits $b_4b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.5 of Annex A and Table B.4 of Annex B.

6.4.7 64QAM

For 64QAM modulation, each group of bits $b_5b_4b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.6 of Annex A and Table B.5 of Annex B.

6.4.8 128QAM

For 128QAM modulation, each group of bits $b_6b_5b_4b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.7 of Annex A and Table B.6 of Annex B.

6.4.9 256QAM

For 256QAM modulation, each group of bits $b_7b_6b_5b_4b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.8 of Annex A and Table B.7 of Annex B.

6.4.10 512QAM

For 512QAM modulation, each group of bits $b_8b_7b_6b_5b_4b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.9 of Annex A and Table B.8 of Annex B.

6.4.11 1024QAM

For 1024QAM modulation, each group of bits $b_9b_8b_7b_6b_5b_4b_3b_2b_1b_0$ is mapped into a complex value (I+jQ) according to the constellation mapping shown in Figure A.10 of Annex A and Table B.9 of Annex B.

6.4.12 Power normalization factor

The power normalization factors of QPSK, 8QAM, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM and 1024QAM constellations are shown in Table 2.

Table 2 – Constellation mapping normalization factor

Modulation mode	Power normalization factor
QPSK	$\sqrt{2}$
8QAM	$\sqrt{6}$
16QAM	$\sqrt{10}$
32QAM	$\sqrt{24}$
64QAM	$\sqrt{42}$
128QAM	$\sqrt{96}$
256QAM	$\sqrt{170}$
512QAM	$\sqrt{384}$
1024QAM	$\sqrt{682}$

6.5 OFDM modulation and cyclic prefix insertion

6.5.1 OFDM modulation

An OFDM symbol consists of 256 sub-carriers in one 16 MHz channel with sub-carrier spacing of 62.5 kHz. The sub-carrier numbering is shown in Figure 5. A set of sub-carriers at the zero frequency point and frequencies on both channel sides are defined as unavailable sub-carriers, while the others are defined as available sub-carriers. Constellation symbols are required to be modulated onto available sub-carriers only. With 210 available carriers used, the effective channel bandwidth is 13.125 MHz.

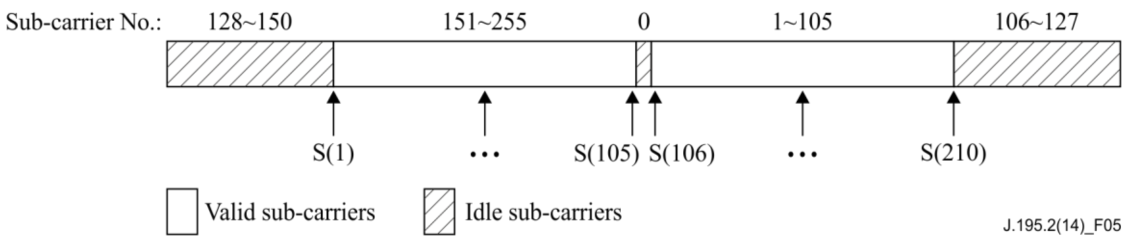


Figure 5 – OFDM sub-carrier numbering

The constellation symbols $s(k)$ are modulated to each available sub-carrier according to Figure 5. The corresponding relationship of frequency-domain signal $X_s(k)$ and constellation symbols $s(k)$ is shown in Equation (4).

$$X_s(k) = \begin{cases} s(k+105) & 1 \le k \le 105 \\ s(k-150) & 151 \le k \le 255 \\ 0 & k = 0 \text{ or } 106 \le k \le 150 \end{cases} \tag{4}$$

Frequency-domain signal $X_s(k)(0 \le k \le N_s - 1)$ is converted to time-domain signal $x_s(t)$ by computing an inverse Fast Fourier Transform (IFFT), which is mathematically defined by Equation (5) as follows.

$$x_s(t) = \frac{1}{\sqrt{N_s}} \sum_{k=0}^{N_s-1} X_s(k) e^{j2\pi k(\Delta f)_s (t-T_{CP})}, 0 \le t \le T_s \tag{5}$$

Where,

N_s : the total number of OFDM sub-carriers, which equals 256

$(\Delta f)_s$: OFDM sub-carrier spacing, which equals 62.5 kHz

T_{CP} : the time duration of the cyclic prefix of OFDM, which equals 1 μs

T_s : the time duration of OFDM symbol, which equals 17 μs

6.5.2 Cyclic prefix insertion

In the time domain, an OFDM symbol consists of a CP and OFDM symbol body. The CP duration, T_{CP}, is required to be 1 μs. The OFDM symbol body duration, T_U, is 16 μs, hence the OFDM symbol duration T_s is 17 μs.

The cyclic prefix insertion is shown in Figure 6. For each OFDM symbol, the last 16 samples (the time duration of which is 1 μs) of the IFFT output are required to be copied to the head of the OFDM symbol, which forms the CP.

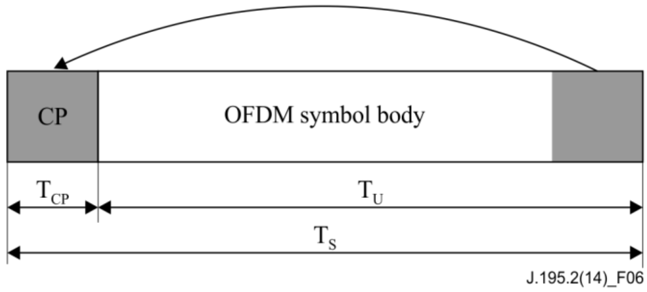


Figure 6 – Cyclic prefix insertion

7 Physical layer frame format

7.1 Overview

Four types of frames are defined in the HiNoC PHY layer: downlink probe (Pd) frame, uplink probe (Pu) frame, downlink data (Dd) frame, and uplink data (Du) frame. All of these PHY frames consist of a preamble and payload as shown in Figure 7.

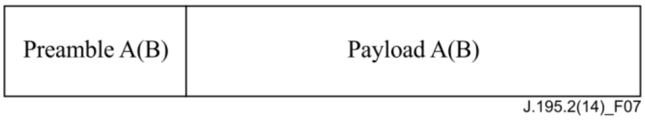


Figure 7 – PHY frame format

The four PHY frame formats are shown separately in Table 3.

Table 3 – PHY Frame Format

Frame type	Preamble	Payload
Pd frame	Preamble A	Payload A
Pu frame	Preamble B	Payload A
Dd frame	Preamble B	Payload B
Du frame	Preamble B	Payload B

The transmission of the four PHY frames is required to follow the timing relationship as shown in Figure 8. Pd frames are required to be transmitted periodically, and the Pd cycle, which is the time interval between the start time of two adjacent Pd frames, is equal to 65536 μs. The time slot for a Pu frame is in the middle of a Pd cycle, and the time interval between the start time of an adjacent Pd frame and a Pu frame is 32768 μs. The time slots for Pu frames are required to be reserved, and the MAC protocol decides whether Pu frames are transmitted or not. Dd frames and Du frames are required to be transmitted in the other time slots according to the time slot allocation by the MAC protocol.

The HiNoC system is required to utilize periodically transmitted Pd frames to synchronize the network.

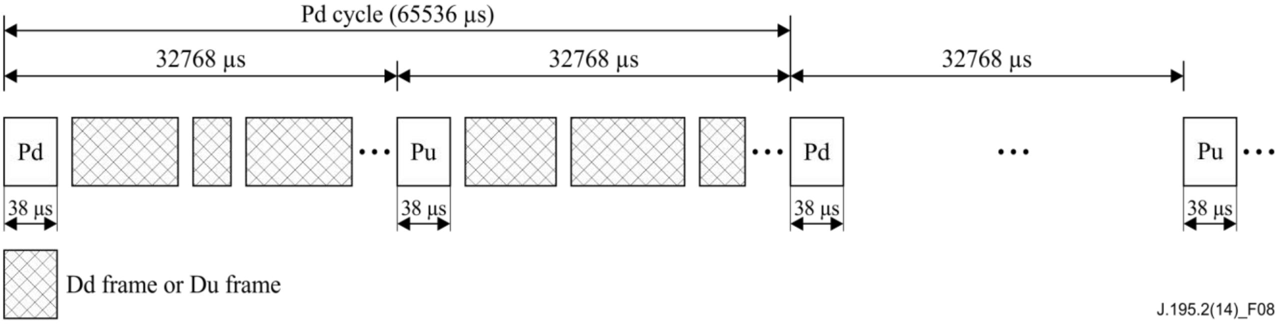


Figure 8 – Timing relationship of PHY frames

7.2 Preamble A

Preamble A consists of a synchronizing signal $S_A(t)$ followed by a reserved signal $R_A(t)$ as shown in Figure 9.

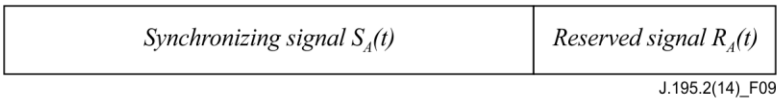


Figure 9 – Preamble A format

The synchronizing signal $S_A(t)$ is composed of two identical bandwidth limited pseudo-random signals. The duration T_A of $S_A(t)$ is 3.875 μs, and it is generated according to Equation (6). The duration of reserved signal $R_A(t)$ is 0.125 μs.

$$S_A(t) = \begin{cases} \frac{1}{\sqrt{N_A}} \sum_{k=0}^{N_A-1} X_A(k) e^{j2\pi k(\Delta f)_A t} & 0 \le t \le \frac{T_A}{2} \\ \frac{1}{\sqrt{N_A}} \sum_{k=0}^{N_A-1} X_A(k) e^{j2\pi k(\Delta f)_A (t-\frac{T_A}{2})} & \frac{T_A}{2} < t \le T_A \end{cases} \quad (6)$$

Where,

N_A: the number of sub-carriers of synchronizing signal in preamble A, which is equal to 31

$X_A(k)$: frequency domain synchronizing signal on the k^{th} sub-carrier

$(\Delta f)_A$: sub-carrier spacing of synchronizing signal in preamble A, which is equal to 516.1290 kHz

Equation (7) expresses the frequency domain synchronizing signal $X_A(k)$ on each sub-carrier in preamble A.

$$X_A(k) = \begin{cases} e^{j(\frac{2\pi}{N_A} n_{k,A} + \frac{\pi}{4})} & 1 \le k \le 13 \text{ or } 18 \le k \le 30 \\ 0 & 0,\quad 14 \le k \le 17 \end{cases} \qquad (7)$$

Where,

$n_{k,A}$: integers whose values are provided in Table 4.

Table 4 – Values of $n_{k,A}$

k	$n_{K,A}$	***k***	$n_{K,A}$
1	3	18	7
2	4	19	6
3	16	20	9
4	6	21	1
5	25	22	2
6	19	23	21
7	25	24	6
8	10	25	12
9	29	26	6
10	30	27	25
11	22	28	15
12	25	29	27
13	24	30	28

Reserved signal $R_A(t)$ includes two time-domain signal samples, R_{A1} and R_{A2}. The default values of R_{A1} and R_{A2} are $(1+j)/\sqrt{2}$.

7.3 Preamble B

Preamble B consists of a synchronizing signal $S_B(t)$ followed by a reserved signal $R_B(t)$ as shown in Figure 10.

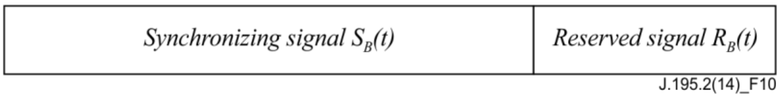


Figure 10 – Preamble B format

The synchronizing signal $S_B(t)$ is a bandwidth-limited pseudo-random signal with the duration T_B, which is equal to 3.9375 μs, and is generated according to Equation (8). The duration of reserved signal $R_B(t)$ is 0.0625 μs.

$$S_B(t) = \frac{1}{\sqrt{N_B}} \sum_{k=0}^{N_B-1} X_B(k) e^{j2\pi k(\Delta f)_B t}, 0 \le t \le T \qquad (8)$$

Where,

N_B: the number of sub-carriers of synchronizing signal in preamble B, which is equal to 63

$X_B(k)$: frequency domain synchronizing signal on the k[th] sub-carrier

$(\Delta f)_B$: sub-carrier spacing of synchronizing signal in preamble B, which is equal to 253.9683 kHz

Equation (9) expresses the frequency domain-synchronizing signal $X_B(k)$ on each sub-carrier in preamble B.

$$X_B(k) = \begin{cases} e^{j(\frac{2\pi}{N_B}n_{k,B}+\frac{\pi}{4})} & 1 \le k \le 26 \text{ or } 37 \le k \le 62 \\ 0 & 0, \quad 27 \le k \le 36 \end{cases} \tag{9}$$

Where,

$n_{k,B}$: are integers whose values are provided in Table 5.

Table 5 – Values of $n_{k,B}$

k	***n**K,B*	***k***	***n**K,B*
1	59	37	60
2	5	38	48
3	3	39	60
4	23	40	35
5	35	41	12
6	30	42	0
7	0	43	19
8	59	44	60
9	25	45	20
10	17	46	46
11	15	47	58
12	21	48	30
13	12	49	0
14	0	50	51
15	33	51	42
16	5	52	48
17	17	53	46
18	43	54	38
19	3	55	4
20	44	56	0
21	0	57	33
22	51	58	28
23	28	59	40
24	3	60	60

Table 5 – Values of $n_{k,B}$

k	$n_{K,B}$	k	$n_{K,B}$
25	15	61	58
26	3	62	4

Reserved signal $R_B(t)$ includes one time-domain signal sample R_B. The default value of R_B is $(1+j)/\sqrt{2}$.

7.4 Payload A

7.4.1 Function of payload A

Payload A is used to carry MAC signalling frames, and the maximum number of signalling bits carried in payload A is N_{INF}. When payload A is not FEC encoded, N_{INF} equals 752, otherwise N_{INF} equals 464.

7.4.2 Frame check sequence

Frame check sequence (FCS) adds 32 cyclic redundancy check (CRC) bits after N_{INF} MAC signalling bits to check whether signalling frames are transmitted correctly. The generator polynomial of CRC is shown in Equation (10).

$$g_4(x) = x^{32} + x^{26} + x^{23} + x^{22} + x^{16} + x^{12} + x^{11} + x^{10} + x^8 + x^7 + x^5 + x^4 + x^2 + x + 1 \qquad (10)$$

7.4.3 Scrambler

After the FCS, the data bits are required to be scrambled as described in clause 6.2.

7.4.4 FEC encoding

The HiNoC system is required to support two FEC modes for payload A. The first mode does not use FEC encoding, and the second mode uses FEC encoding. The second mode is the default mode. After being scrambled, the data bits either may not be FEC encoded or they may be FEC encoded using the (392.248) truncated BCH code specified in clause 6.3. The (392.248) truncated BCH code is used by default.

7.4.5 Protected field insertion

After the above processing, the total length (MAC signalling frame + FCS + optional FEC) is 784 bits. The process of protected field insertion is shown in Figure 11. The 784 bits are required to be equally divided into four segments, and each segment is filled into the signalling data unit in a left-first order, giving a total of 840 data bits.

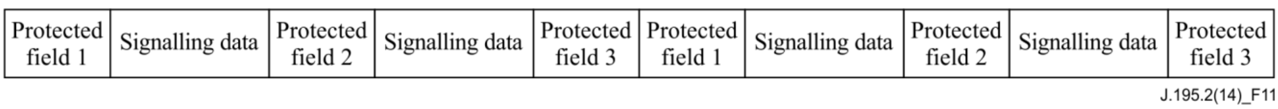


Figure 11 – Protected field insertion

Protected fields are defined in Table 6.

Table 6 – Protected field definition

Name	Definition
Protected field 1	1111111110
Protected field 2	1111111111
Protected field 3	11111111

7.4.6 DQPSK mapping

After protected field insertion, the 840 data bits are required to be mapped using the DQPSK constellation specified in clause 6.4.2 to form 420 DQPSK symbols.

7.4.7 OFDM modulation

The 420 symbols are required to be modulated into the available sub-carriers of two OFDM symbols. OFDM modulation is specified in clause 6.5.

7.5 Payload B

7.5.1 Function of payload B

Payload B is used to carry MAC data frames and control frames.

7.5.2 Scrambler

The data bits in MAC data frames and control frames are scrambled as described in clause 6.2.

7.5.3 FEC encoding

The HiNoC system is required to support two FEC modes for payload B. The first mode does not use FEC encoding and the second mode does use FEC encoding. The second mode is the default mode. After being scrambled, the data bits either may not be FEC encoded or may be FEC encoded using the (508.472) or (504.432) truncated BCH code specified in clause 6.3. The (504.432) truncated BCH code is used by default.

7.5.4 Adaptive constellation mapping

Adaptive constellation mapping requires the selection of proper constellations for each sub-carrier dynamically adapted to the channel characteristics, and forms a constellation scheme for 210 available sub-carriers. According to the constellation scheme, the data bits are mapped into constellation symbols and then modulated to the corresponding sub-carriers. The QAM constellation can vary from 2 to 10 bits per symbol (QPSK, 8QAM, 16QAM, 32QAM, 64QAM, 128QAM, 256QAM, 512QAM, and 1024QAM) as specified in clause 6.4.

7.5.5 OFDM modulation

After adaptive constellation mapping, the constellation symbols are modulated into OFDM symbols as specified in clause 6.5. Payload B can contain a maximum of 256 OFDM symbols.

8 Spectrum mask

The limit power spectral density (PSD) mask for HiNoC is shown in Figure 12, with the frequencies as presented in Table 7, where the bandwidth is equal to fH1 – fL3.

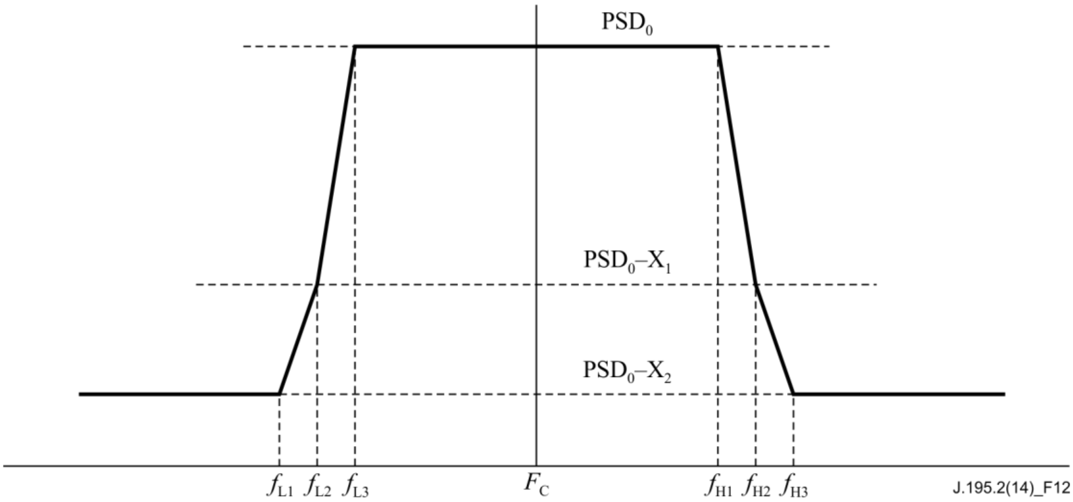


Figure 12 – Limit PSD mask of single channel for HiNoC

The proposed values of frequency spectrum parameters for HiNoC are shown in Table 7. It is assumed that intermediate points between those defined in Figure 12 are obtained by linear interpolation (dB over linear frequency scale).

Table 7 – Parameters of limit PSD mask for HiNoC

Parameters	**Frequency (MHz)**	**PSD(dBm/Hz) (Note 1)**	**Note/description**
$F_C - f_{L1}$	9.40625	$PSD_0 - 60$	F_C is carrier frequency
$F_C - f_{L2}$	8	$PSD_0 - 50$	
$F_C - f_{L3}$	6.59375	PSD_0	
F_C	$F_C \leq 1192$	PSD_0	
$f_{H1} - F_C$	6.59375	PSD_0	
$f_{H2} - F_C$	8	$PSD_0 - 50$	
$f_{H3} - F_C$	9.40625	$PSD_0 - 60$	
NOTE 1 – $PSD_0 \leq -70.75$ dBm/Hz. NOTE 2 – Sub-carriers below f_{L3}, and above f_{H1} shall not be used for transmission of data or auxiliary information.			

Annex A

Constellation mapping

(This annex forms an integral part of this Recommendation.)

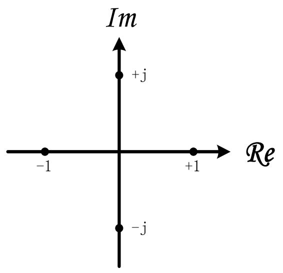
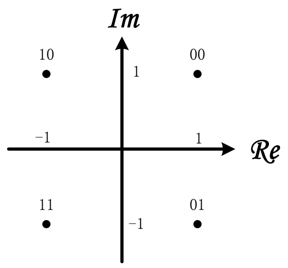
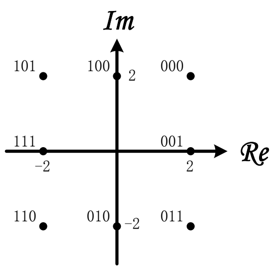


Figure A.1 – DQPSK constellation



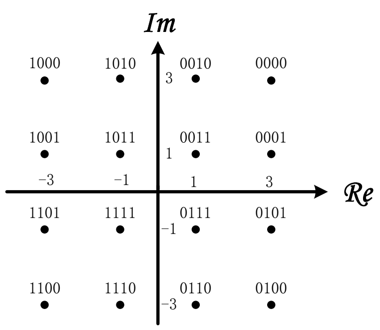
Bit order: b_1,b_0

Figure A.2 – QPSK constellation



Bit order: b_2,b_1,b_0

Figure A.3 – 8QAM constellation



Bit order: b_3,b_2,b_1,b_0

Figure A.4 – 16QAM constellation

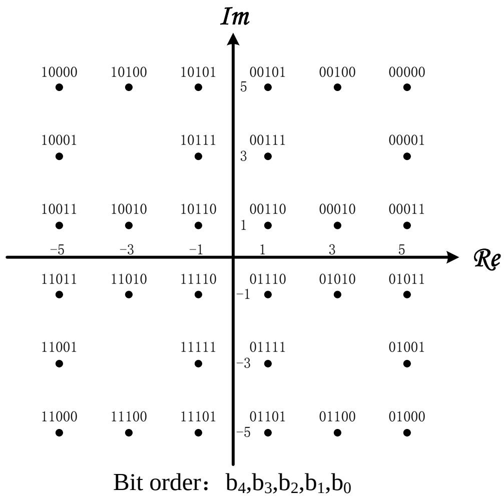


Figure A.5 – 32QAM constellation

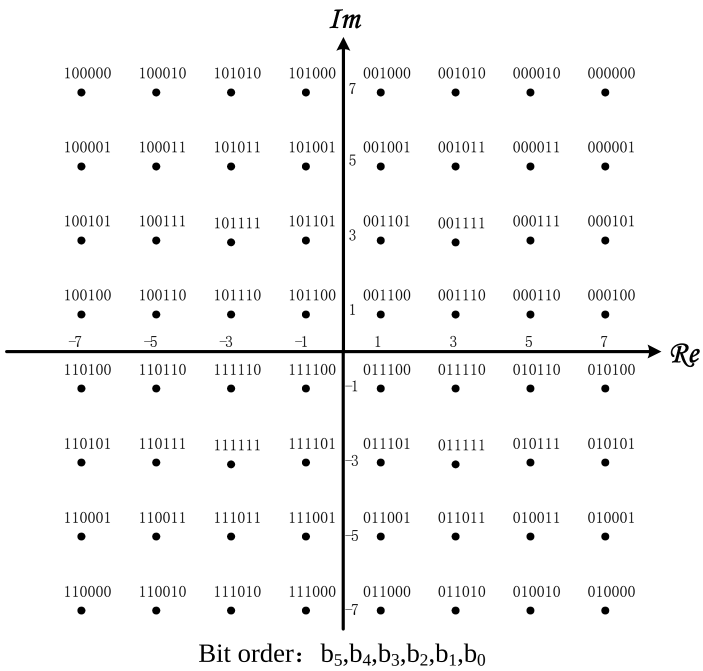
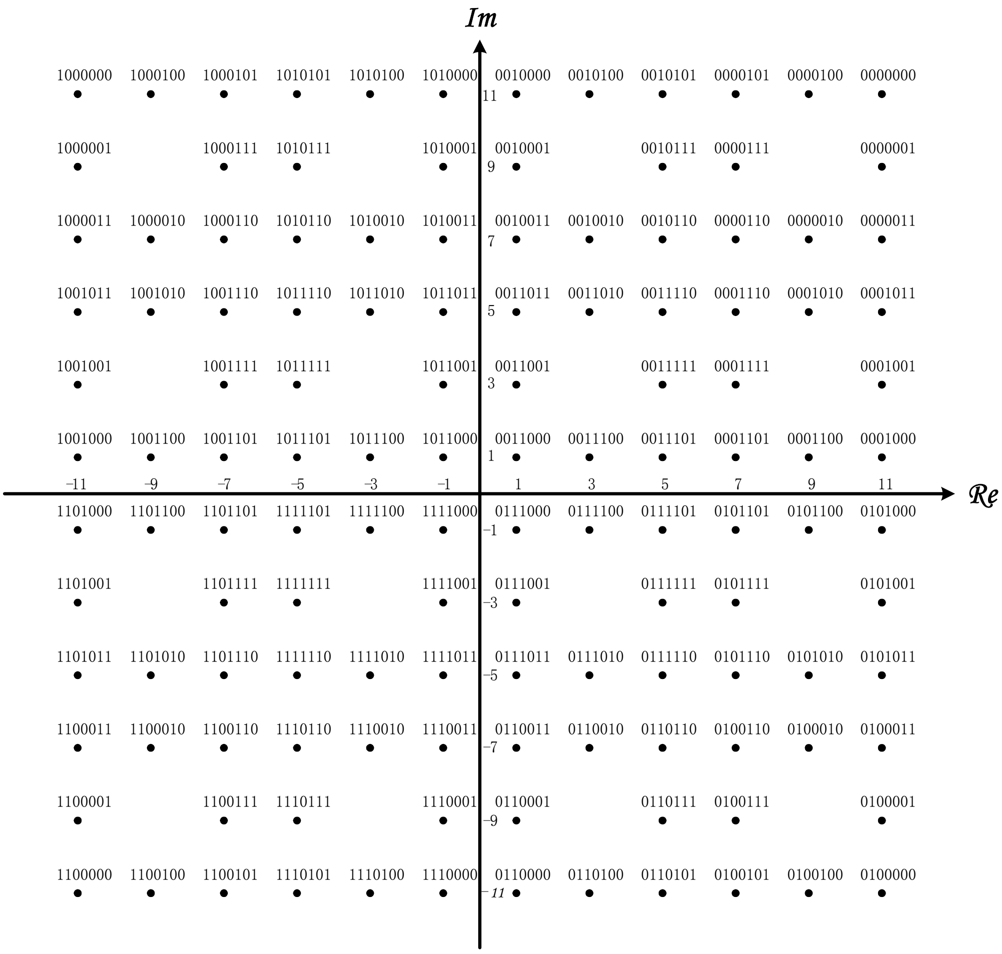


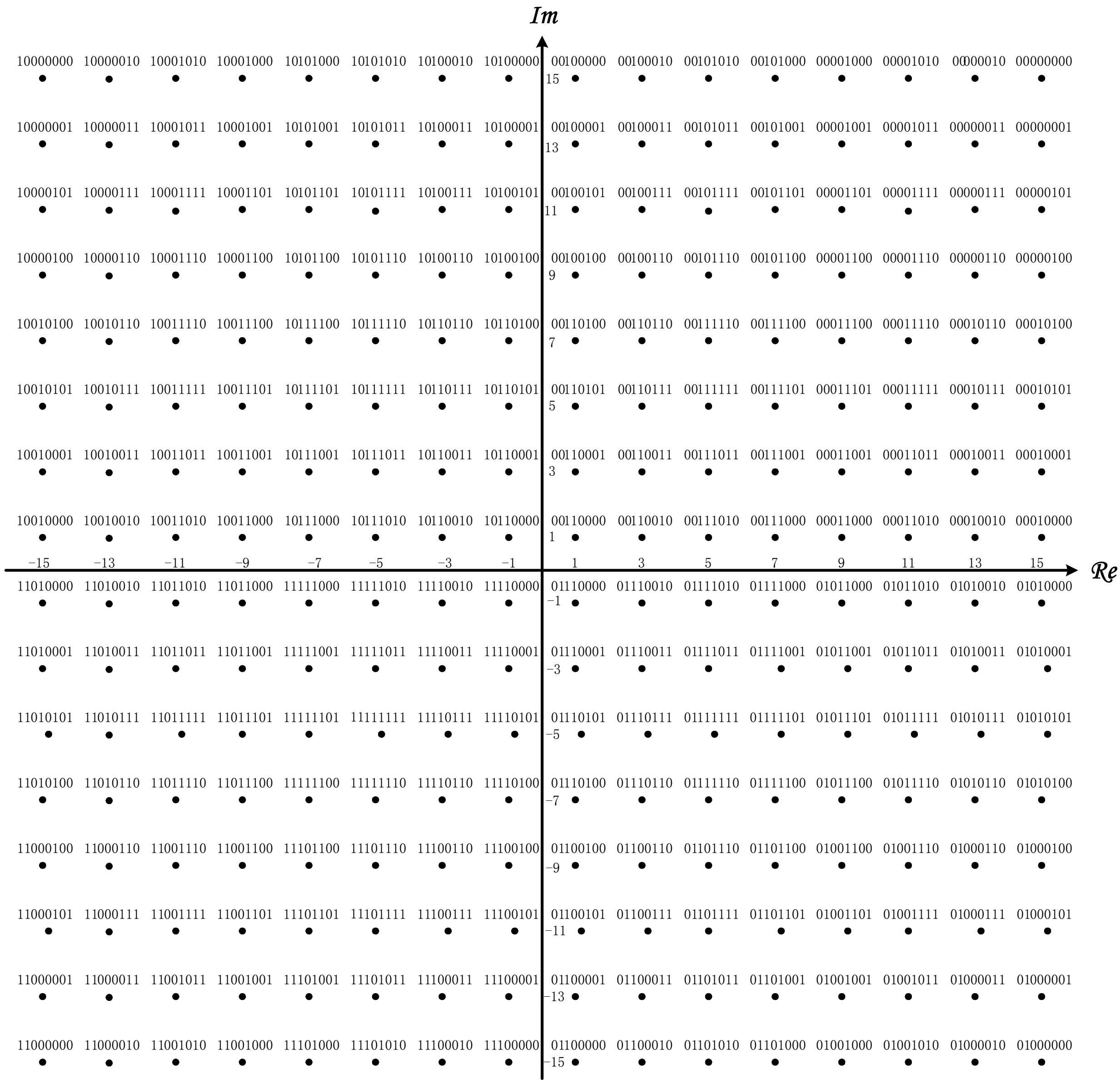
Figure A.6 – 64QAM constellation



Bit order：

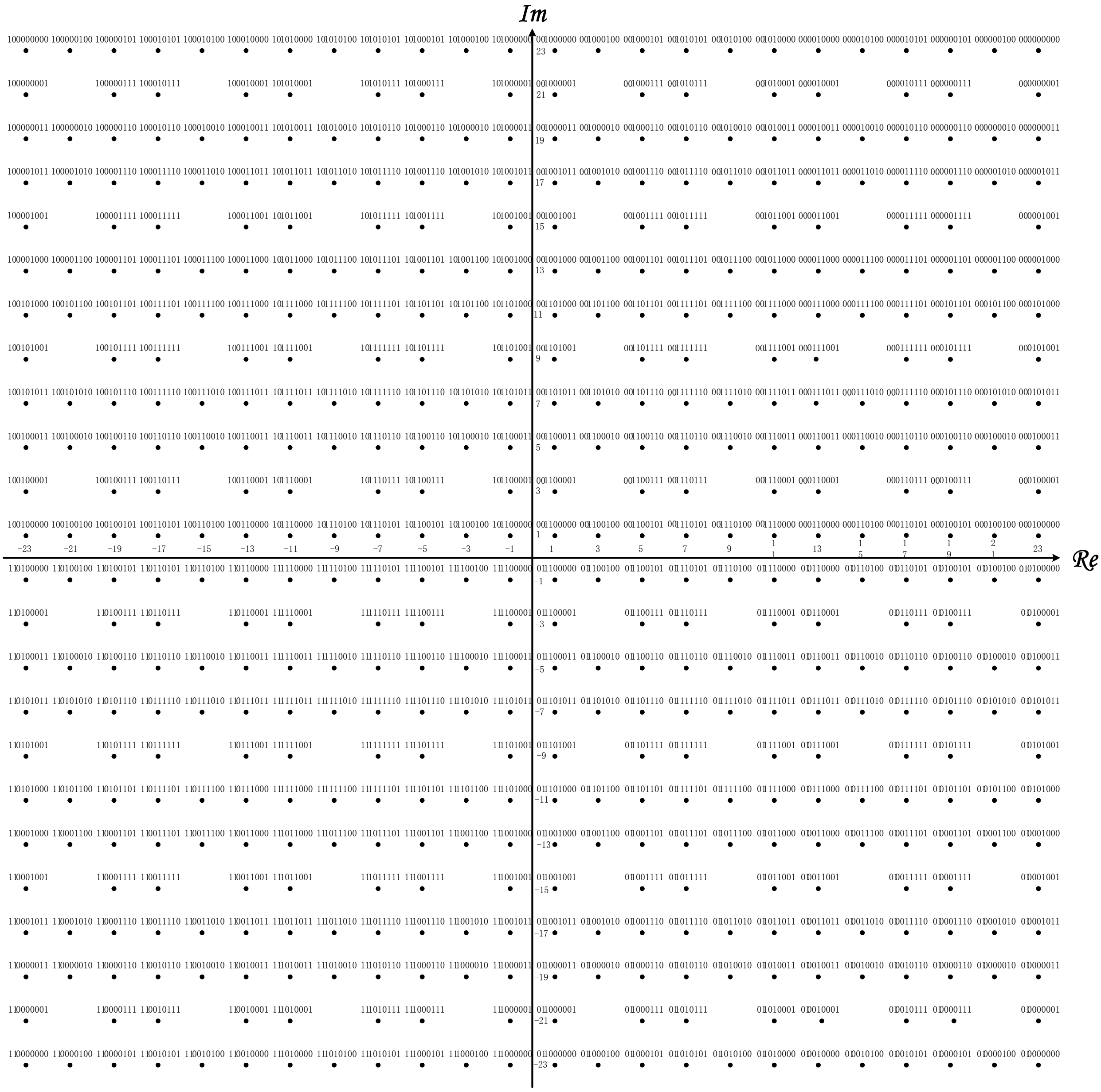
$b_6,b_5,b_4,b_3,b_2,b_1,b_0$

Figure A.7 – 128QAM constellation



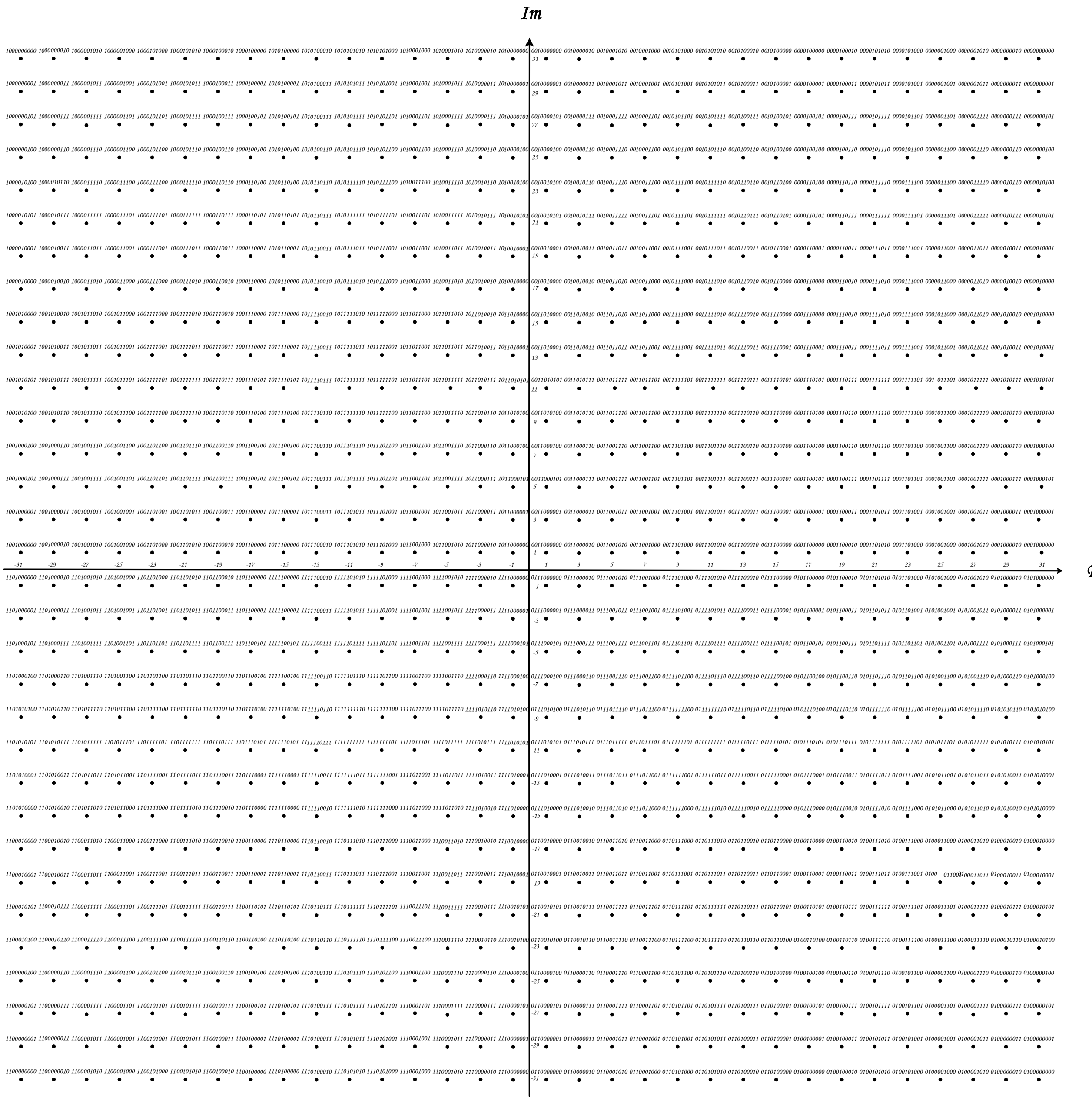
Bit order：
$b_7,b_6,b_5,b_4,b_3,b_2,b_1,b_0$

Figure A.8 – 256QAM constellation



Bit order:
$b_8,b_7,b_6,b_5,b_4,b_3,b_2,b_1,b_0$

Figure A.9 – 512QAM constellation



Bit order:
$b_9,b_8,b_7,b_6,b_5,b_4,b_3,b_2,b_1,b_0$

Figure A.10 – 1024QAM constellation

Annex B

Constellation mapping table

(This annex forms an integral part of this Recommendation.)

Table B.1 – QPSK

b_1b_0	Re(Sn)	Im(Sn)	b_1b_0	Re(Sn)	Im(Sn)
00	1	1	10	−1	1
01	1	−1	11	−1	−1
Normalization factor: $\sqrt{2}$					

Table B.2 – 8QAM

$b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_2b_1b_0$	Re(Sn)	Im(Sn)
000	2	2	100	0	2
001	2	0	101	−2	2
010	0	2	110	−2	−2
011	2	−2	111	−2	0
Normalization factor: $\sqrt{6}$					

Table B.3 – 16QAM

$b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
0000	3	3	1000	−3	3
0001	3	1	1001	−3	1
0010	1	3	1010	−1	3
0011	1	1	1011	−1	1
0100	3	−3	1100	−3	−3
0101	3	−1	1101	−3	−1
0110	1	−3	1110	−1	−3
0111	1	−1	1111	−1	−1
Normalization factor: $\sqrt{10}$					

Table B.4 – 32QAM

$b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
00000	5	5	10000	−5	5
00001	5	3	10001	−5	3
00010	3	1	10010	−3	1
00011	5	1	10011	−5	1
00100	3	5	10100	−3	5
00101	1	5	10101	−1	5
00110	1	1	10110	−1	1
00111	1	3	10111	−1	3
01000	5	−5	11000	−5	−5
01001	5	−3	11001	−5	−3
01010	3	−1	11010	−3	−1
01011	5	−1	11011	−5	−1
01100	3	−5	11100	−3	−5
01101	1	−5	11101	−1	−5
01110	1	−1	11110	−1	−1
01111	1	−3	11111	−1	−3
Normalization factor: $\sqrt{24}$					

Table B.5 – 64QAM

$b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
000000	7	7	100000	−7	7
000001	7	5	100001	−7	5
000010	5	7	100010	−5	7
000011	5	5	100011	−5	5
000100	7	1	100100	−7	1
000101	7	3	100101	−7	3
000110	5	1	100110	−5	1
000111	5	3	100111	−5	3
001000	1	7	101000	−1	7
001001	1	5	101001	−1	5
001010	3	7	101010	−3	7
001011	3	5	101011	−3	5
001100	1	1	101100	−1	1
001101	1	3	101101	−1	3
001110	3	1	101110	−3	1
001111	3	3	101111	−3	3
010000	7	−7	110000	−7	−7

Table B.5 – 64QAM

$b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
010001	7	−5	110001	−7	−5
010010	5	−7	110010	−5	−7
010011	5	−5	110011	−5	−5
010100	7	−1	110100	−7	−1
010101	7	−3	110101	−7	−3
010110	5	−1	110110	−5	−1
010111	5	−3	110111	−5	−3
011000	1	−7	111000	−1	−7
011001	1	−5	111001	−1	−5
011010	3	−7	111010	−3	−7
011011	3	−5	111011	−3	−5
011100	1	−1	111100	−1	−1
011101	1	−3	111101	−1	−3
011110	3	−1	111110	−3	−1
011111	3	−3	111111	−3	−3
Normalization factor: $\sqrt{42}$					

Table B.6 – 128QAM

$b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
0000000	11	11	1000000	−11	11
0000001	11	9	1000001	−11	9
0000010	9	7	1000010	−9	7
0000011	11	7	1000011	−11	7
0000100	9	11	1000100	−9	11
0000101	7	11	1000101	−7	11
0000110	7	7	1000110	−7	7
0000111	7	9	1000111	−7	9
0001000	11	1	1001000	−11	1
0001001	11	3	1001001	−11	3
0001010	9	5	1001010	−9	5
0001011	11	5	1001011	−11	5
0001100	9	1	1001100	−9	1
0001101	7	1	1001101	−7	1
0001110	7	5	1001110	−7	5
0001111	7	3	1001111	−7	3
0010000	1	11	1010000	−1	11

Table B.6 – 128QAM

$b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
0010001	1	9	1010001	−1	9
0010010	3	7	1010010	−3	7
0010011	1	7	1010011	−1	7
0010100	3	11	1010100	−3	11
0010101	5	11	1010101	−5	11
0010110	5	7	1010110	−5	7
0010111	5	9	1010111	−5	9
0011000	1	1	1011000	−1	1
0011001	1	3	1011001	−1	3
0011010	3	5	1011010	−3	5
0011011	1	5	1011011	−1	5
0011100	3	1	1011100	−3	1
0011101	5	1	1011101	−5	1
0011110	5	5	1011110	−5	5
0011111	5	3	1011111	−5	3
0100000	11	−11	1100000	−11	−11
0100001	11	−9	1100001	−11	−9
0100010	9	−7	1100010	−9	−7
0100011	11	−7	1100011	−11	−7
0100100	9	−11	1100100	−9	−11
0100101	7	−11	1100101	−7	−11
0100110	7	−7	1100110	−7	−7
0100111	7	−9	1100111	−7	−9
0101000	11	−1	1101000	−11	−1
0101001	11	−3	1101001	−11	−3
0101010	9	−5	1101010	−9	−5
0101011	11	−5	1101011	−11	−5
0101100	9	−1	1101100	−9	−1
0101101	7	−1	1101101	−7	−1
0101110	7	−5	1101110	−7	−5
0101111	7	−3	1101111	−7	−3
0110000	1	−11	1110000	−1	−11
0110001	1	−9	1110001	−1	−9
0110010	3	−7	1110010	−3	−7
0110011	1	−7	1110011	−1	−7
0110100	3	−11	1110100	−3	−11
0110101	5	−11	1110101	−5	−11
0110110	5	−7	1110110	−5	−7

Table B.6 – 128QAM

$b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
0110111	5	−9	1110111	−5	−9
0111000	1	−1	1111000	−1	−1
0111001	1	−3	1111001	−1	−3
0111010	3	−5	1111010	−3	−5
0111011	1	−5	1111011	−1	−5
0111100	3	−1	1111100	−3	−1
0111101	5	−1	1111101	−5	−1
0111110	5	−5	1111110	−5	−5
0111111	5	−3	1111111	−5	−3
Normalization factor: $\sqrt{96}$					

Table B.7 – 256QAM

$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
00000000	15	15	10000000	−15	15
00000001	15	13	10000001	−15	13
00000010	13	15	10000010	−13	15
00000011	13	13	10000011	−13	13
00000100	15	9	10000100	−15	9
00000101	15	11	10000101	−15	11
00000110	13	9	10000110	−13	9
00000111	13	11	10000111	−13	11
00001000	9	15	10001000	−9	15
00001001	9	13	10001001	−9	13
00001010	11	15	10001010	−11	15
00001011	11	13	10001011	−11	13
00001100	9	9	10001100	−9	9
00001101	9	11	10001101	−9	11
00001110	11	9	10001110	−11	9
00001111	11	11	10001111	−11	11
00010000	15	1	10010000	−15	1
00010001	15	3	10010001	−15	3
00010010	13	1	10010010	−13	1
00010011	13	3	10010011	−13	3
00010100	15	7	10010100	−15	7
00010101	15	5	10010101	−15	5
00010110	13	7	10010110	−13	7
00010111	13	5	10010111	−13	5
00011000	9	1	10011000	−9	1
00011001	9	3	10011001	−9	3
00011010	11	1	10011010	−11	1

Table B.7 – 256QAM

$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
00011011	11	3	10011011	−11	3
00011100	9	7	10011100	−9	7
00011101	9	5	10011101	−9	5
00011110	11	7	10011110	−11	7
00011111	11	5	10011111	−11	5
00100000	1	15	10100000	−1	15
00100001	1	13	10100001	−1	13
00100010	3	15	10100010	−3	15
00100011	3	13	10100011	−3	13
00100100	1	9	10100100	−1	9
00100101	1	11	10100101	−1	11
00100110	3	9	10100110	−3	9
00100111	3	11	10100111	−3	11
00101000	7	15	10101000	−7	15
00101001	7	13	10101001	−7	13
00101010	5	15	10101010	−5	15
00101011	5	13	10101011	−5	13
00101100	7	9	10101100	−7	9
00101101	7	11	10101101	−7	11
00101110	5	9	10101110	−5	9
00101111	5	11	10101111	−5	11
00110000	1	1	10110000	−1	1
00110001	1	3	10110001	−1	3
00110010	3	1	10110010	−3	1
00110011	3	3	10110011	−3	3
00110100	1	7	10110100	−1	7
00110101	1	5	10110101	−1	5
00110110	3	7	10110110	−3	7
00110111	3	5	10110111	−3	5
00111000	7	1	10111000	−7	1
00111001	7	3	10111001	−7	3
00111010	5	1	10111010	−5	1
00111011	5	3	10111011	−5	3
00111100	7	7	10111100	−7	7
00111101	7	5	10111101	−7	5
00111110	5	7	10111110	−5	7
00111111	5	5	10111111	−5	5
01000000	15	−15	11000000	−15	−15
01000001	15	−13	11000001	−15	−13
01000010	13	−15	11000010	−13	−15
01000011	13	−13	11000011	−13	−13
01000100	15	−9	11000100	−15	−9
01000101	15	−11	11000101	−15	−11
01000110	13	−9	11000110	−13	−9
01000111	13	−11	11000111	−13	−11

Table B.7 – 256QAM

$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
01001000	9	−15	11001000	−9	−15
01001001	9	−13	11001001	−9	−13
01001010	11	−15	11001010	−11	−15
01001011	11	−13	11001011	−11	−13
01001100	9	−9	11001100	−9	−9
01001101	9	−11	11001101	−9	−11
01001110	11	−9	11001110	−11	−9
01001111	11	−11	11001111	−11	−11
01010000	15	−1	11010000	−15	−1
01010001	15	−3	11010001	−15	−3
01010010	13	−1	11010010	−13	−1
01010011	13	−3	11010011	−13	−3
01010100	15	−7	11010100	−15	−7
01010101	15	−5	11010101	−15	−5
01010110	13	−7	11010110	−13	−7
01010111	13	−5	11010111	−13	−5
01011000	9	−1	11011000	−9	−1
01011001	9	−3	11011001	−9	−3
01011010	11	−1	11011010	−11	−1
01011011	11	−3	11011011	−11	−3
01011100	9	−7	11011100	−9	−7
01011101	9	−5	11011101	−9	−5
01011110	11	−7	11011110	−11	−7
01011111	11	−5	11011111	−11	−5
01100000	1	−15	11100000	−1	−15
01100001	1	−13	11100001	−1	−13
01100010	3	−15	11100010	−3	−15
01100011	3	−13	11100011	−3	−13
01100100	1	−9	11100100	−1	−9
01100101	1	−11	11100101	−1	−11
01100110	3	−9	11100110	−3	−9
01100111	3	−11	11100111	−3	−11
01101000	7	−15	11101000	−7	−15
01101001	7	−13	11101001	−7	−13
01101010	5	−15	11101010	−5	−15
01101011	5	−13	11101011	−5	−13
01101100	7	−9	11101100	−7	−9
01101101	7	−11	11101101	−7	−11
01101110	5	−9	11101110	−5	−9
01101111	5	−11	11101111	−5	−11
01110000	1	−1	11110000	−1	−1
01110001	1	−3	11110001	−1	−3
01110010	3	−1	11110010	−3	−1
01110011	3	−3	11110011	−3	−3
01110100	1	−7	11110100	−1	−7

Table B.7 – 256QAM

$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
01110101	1	−5	11110101	−1	−5
01110110	3	−7	11110110	−3	−7
01110111	3	−5	11110111	−3	−5
01111000	7	−1	11111000	−7	−1
01111001	7	−3	11111001	−7	−3
01111010	5	−1	11111010	−5	−1
01111011	5	−3	11111011	−5	−3
01111100	7	−7	11111100	−7	−7
01111101	7	−5	11111101	−7	−5
01111110	5	−7	11111110	−5	−7
01111111	5	−5	11111111	−5	−5
Normalization factor: $\sqrt{170}$					

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
000000000	23	23	100000000	−23	23
000000001	23	21	100000001	−23	21
000000010	21	19	100000010	−21	19
000000011	23	19	100000011	−23	19
000000100	21	23	100000100	−21	23
000000101	19	23	100000101	−19	23
000000110	19	19	100000110	−19	19
000000111	19	21	100000111	−19	21
000001000	23	13	100001000	−23	13
000001001	23	15	100001001	−23	15
000001010	21	17	100001010	−21	17
000001011	23	17	100001011	−23	17
000001100	21	13	100001100	−21	13
000001101	19	13	100001101	−19	13
000001110	19	17	100001110	−19	17
000001111	19	15	100001111	−19	15
000010000	13	23	100010000	−13	23
000010001	13	21	100010001	−13	21
000010010	15	19	100010010	−15	19
000010011	13	19	100010011	−13	19
000010100	15	23	100010100	−15	23
000010101	17	23	100010101	−17	23
000010110	17	19	100010110	−17	19
000010111	17	21	100010111	−17	21
000011000	13	13	100011000	−13	13
000011001	13	15	100011001	−13	15
000011010	15	17	100011010	−15	17

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
000011011	13	17	100011011	−13	17
000011100	15	13	100011100	−15	13
000011101	17	13	100011101	−17	13
000011110	17	17	100011110	−17	17
000011111	17	15	100011111	−17	15
000100000	23	1	100100000	−23	1
000100001	23	3	100100001	−23	3
000100010	21	5	100100010	−21	5
000100011	23	5	100100011	−23	5
000100100	21	1	100100100	−21	1
000100101	19	1	100100101	−19	1
000100110	19	5	100100110	−19	5
000100111	19	3	100100111	−19	3
000101000	23	11	100101000	−23	11
000101001	23	9	100101001	−23	9
000101010	21	7	100101010	−21	7
000101011	23	7	100101011	−23	7
000101100	21	11	100101100	−21	11
000101101	19	11	100101101	−19	11
000101110	19	7	100101110	−19	7
000101111	19	9	100101111	−19	9
000110000	13	1	100110000	−13	1
000110001	13	3	100110001	−13	3
000110010	15	5	100110010	−15	5
000110011	13	5	100110011	−13	5
000110100	15	1	100110100	−15	1
000110101	17	1	100110101	−17	1
000110110	17	5	100110110	−17	5
000110111	17	3	100110111	−17	3
000111000	13	11	100111000	−13	11
000111001	13	9	100111001	−13	9
000111010	15	7	100111010	−15	7
000111011	13	7	100111011	−13	7
000111100	15	11	100111100	−15	11
000111101	17	11	100111101	−17	11
000111110	17	7	100111110	−17	7
000111111	17	9	100111111	−17	9
001000000	1	23	101000000	−1	23
001000001	1	21	101000001	−1	21
001000010	3	19	101000010	−3	19
001000011	1	19	101000011	−1	19
001000100	3	23	101000100	−3	23
001000101	5	23	101000101	−5	23
001000110	5	19	101000110	−5	19
001000111	5	21	101000111	−5	21

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
001001000	1	13	101001000	−1	13
001001001	1	15	101001001	−1	15
001001010	3	17	101001010	−3	17
001001011	1	17	101001011	−1	17
001001100	3	13	101001100	−3	13
001001101	5	13	101001101	−5	13
001001110	5	17	101001110	−5	17
001001111	5	15	101001111	−5	15
001010000	11	23	101010000	−11	23
001010001	11	21	101010001	−11	21
001010010	9	19	101010010	−9	19
001010011	11	19	101010011	−11	19
001010100	9	23	101010100	−9	23
001010101	7	23	101010101	−7	23
001010110	7	19	101010110	−7	19
001010111	7	21	101010111	−7	21
001011000	11	13	101011000	−11	13
001011001	11	15	101011001	−11	15
001011010	9	17	101011010	−9	17
001011011	11	17	101011011	−11	17
001011100	9	13	101011100	−9	13
001011101	7	13	101011101	−7	13
001011110	7	17	101011110	−7	17
001011111	7	15	101011111	−7	15
001100000	1	1	101100000	−1	1
001100001	1	3	101100001	−1	3
001100010	3	5	101100010	−3	5
001100011	1	5	101100011	−1	5
001100100	3	1	101100100	−3	1
001100101	5	1	101100101	5	1
001100110	5	5	101100110	−5	5
001100111	5	3	101100111	−5	3
001101000	1	11	101101000	−1	11
001101001	1	9	101101001	−1	9
001101010	3	7	101101010	−3	7
001101011	1	7	101101011	−1	7
001101100	3	11	101101100	−3	11
001101101	5	11	101101101	−5	11
001101110	5	7	101101110	−5	7
001101111	5	9	101101111	−5	9
001110000	11	1	101110000	−11	1
001110001	11	3	101110001	−11	3
001110010	9	5	101110010	−9	5
001110011	11	5	101110011	−11	5
001110100	9	1	101110100	−9	1

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
001110101	7	1	101110101	−7	1
001110110	7	5	101110110	−7	5
001110111	7	3	101110111	−7	3
001111000	11	11	101111000	−11	11
001111001	11	9	101111001	−11	9
001111010	9	7	101111010	−9	7
001111011	11	7	101111011	−11	7
001111100	9	11	101111100	−9	11
001111101	7	11	101111101	−7	11
001111110	7	7	101111110	−7	7
001111111	7	9	101111111	−7	9
010000000	23	−23	110000000	−23	−23
010000001	23	−21	110000001	−23	−21
010000010	21	−19	110000010	−21	−19
010000011	23	−19	110000011	−23	−19
010000100	21	−23	110000100	−21	−23
010000101	19	−23	110000101	−19	−23
010000110	19	−19	110000110	−19	−19
010000111	19	−21	110000111	−19	−21
010001000	23	−13	110001000	−23	−13
010001001	23	−15	110001001	−23	−15
010001010	21	−17	110001010	−21	−17
010001011	23	−17	110001011	−23	−17
010001100	21	−13	110001100	−21	−13
010001101	19	−13	110001101	−19	−13
010001110	19	−17	110001110	−19	−17
010001111	19	−15	110001111	−19	−15
010010000	13	−23	110010000	−13	−23
010010001	13	−21	110010001	−13	−21
010010010	15	−19	110010010	−15	−19
010010011	13	−19	110010011	−13	−19
010010100	15	−23	110010100	−15	−23
010010101	17	−23	110010101	−17	−23
010010110	17	−19	110010110	−17	−19
010010111	17	−21	110010111	−17	−21
010011000	13	−13	110011000	−13	−13
010011001	13	−15	110011001	−13	−15
010011010	15	−17	110011010	−15	−17
010011011	13	−17	110011011	−13	−17
010011100	15	−13	110011100	−15	−13
010011101	17	−13	110011101	−17	−13
010011110	17	−17	110011110	−17	−17
010011111	17	−15	110011111	−17	−15
010100000	23	−1	110100000	−23	−1
010100001	23	−3	110100001	−23	−3

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
010100010	21	−5	110100010	−21	−5
010100011	23	−5	110100011	−23	−5
010100100	21	−1	110100100	−21	−1
010100101	19	−1	110100101	−19	−1
010100110	19	−5	110100110	−19	−5
010100111	19	−3	110100111	−19	−3
010101000	23	−11	110101000	−23	−11
010101001	23	−9	110101001	−23	−9
010101010	21	−7	110101010	−21	−7
010101011	23	−7	110101011	−23	−7
010101100	21	−11	110101100	−21	−11
010101101	19	−11	110101101	−19	−11
010101110	19	−7	110101110	−19	−7
010101111	19	−9	110101111	−19	−9
010110000	13	−1	110110000	−13	−1
010110001	13	−3	110110001	−13	−3
010110010	15	−5	110110010	−15	−5
010110011	13	−5	110110011	−13	−5
010110100	15	−1	110110100	−15	−1
010110101	17	−1	110110101	−17	−1
010110110	17	−5	110110110	−17	−5
010110111	17	−3	110110111	−17	−3
010111000	13	−11	110111000	−13	−11
010111001	13	−9	110111001	−13	−9
010111010	15	−7	110111010	−15	−7
010111011	13	−7	110111011	−13	−7
010111100	15	−11	110111100	−15	−11
010111101	17	−11	110111101	−17	−11
010111110	17	−7	110111110	−17	−7
010111111	17	−9	110111111	−17	−9
011000000	1	−23	111000000	−1	−23
011000001	1	−21	111000001	−1	−21
011000010	3	−19	111000010	−3	−19
011000011	1	−19	111000011	−1	−19
011000100	3	−23	111000100	−3	−23
011000101	5	−23	111000101	−5	−23
011000110	5	−19	111000110	−5	−19
011000111	5	−21	111000111	−5	−21
011001000	1	−13	111001000	−1	−13
011001001	1	−15	111001001	−1	−15
011001010	3	−17	111001010	−3	−17
011001011	1	−17	111001011	−1	−17
011001100	3	−13	111001100	−3	−13
011001101	5	−13	111001101	−5	−13
011001110	5	−17	111001110	−5	−17

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
011001111	5	−15	111001111	−5	−15
011010000	11	−23	111010000	−11	−23
011010001	11	−21	111010001	−11	−21
011010010	9	−19	111010010	−9	−19
011010011	11	−19	111010011	−11	−19
011010100	9	−23	111010100	−9	−23
011010101	7	−23	111010101	−7	−23
011010110	7	−19	111010110	−7	−19
011010111	7	−21	111010111	−7	−21
011011000	11	−13	111011000	−11	−13
011011001	11	−15	111011001	−11	−15
011011010	9	−17	111011010	−9	−17
011011011	11	−17	111011011	−11	−17
011011100	9	−13	111011100	−9	−13
011011101	7	−13	111011101	−7	−13
011011110	7	−17	111011110	−7	−17
011011111	7	−15	111011111	−7	−15
011100000	1	−1	111100000	−1	−1
011100001	1	−3	111100001	−1	−3
011100010	3	−5	111100010	−3	−5
011100011	1	−5	111100011	−1	−5
011100100	3	−1	111100100	−3	−1
011100101	5	−1	111100101	5	−1
011100110	5	−5	111100110	−5	−5
011100111	5	−3	111100111	−5	−3
011101000	1	−11	111101000	−1	−11
011101001	1	−9	111101001	−1	−9
011101010	3	−7	111101010	−3	−7
011101011	1	−7	111101011	−1	−7
011101100	3	−11	111101100	−3	−11
011101101	5	−11	111101101	−5	−11
011101110	5	−7	111101110	−5	−7
011101111	5	−9	111101111	−5	−9
011110000	11	−1	111110000	−11	−1
011110001	11	−3	111110001	−11	−3
011110010	9	−5	111110010	−9	−5
011110011	11	−5	111110011	−11	−5
011110100	9	−1	111110100	−9	−1
011110101	7	−1	111110101	−7	−1
011110110	7	−5	111110110	−7	−5
011110111	7	−3	111110111	−7	−3
011111000	11	−11	111111000	−11	−11
011111001	11	−9	111111001	−11	−9
011111010	9	−7	111111010	−9	−7
011111011	11	−7	111111011	−11	−7

Table B.8 – 512QAM

$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
011111100	9	−11	111111100	−9	−11
011111101	7	−11	111111101	−7	−11
011111110	7	−7	111111110	−7	−7
011111111	7	−9	111111111	−7	−9
Normalization factor: $\sqrt{384}$					

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0000000000	31	31	1000000000	−31	31
0000000001	31	29	1000000001	−31	29
0000000010	29	31	1000000010	−29	31
0000000011	29	29	1000000011	−29	29
0000000100	31	25	1000000100	−31	25
0000000101	31	27	1000000101	−31	27
0000000110	29	25	1000000110	−29	25
0000000111	29	27	1000000111	−29	27
0000001000	25	31	1000001000	−25	31
0000001001	25	29	1000001001	−25	29
0000001010	27	31	1000001010	−27	31
0000001011	27	29	1000001011	−27	29
0000001100	25	25	1000001100	−25	25
0000001101	25	27	1000001101	−25	27
0000001110	27	25	1000001110	−27	25
0000001111	27	27	1000001111	−27	27
0000010000	31	17	1000010000	−31	17
0000010001	31	19	1000010001	−31	19
0000010010	29	17	1000010010	−29	17
0000010011	29	19	1000010011	−29	19
0000010100	31	23	1000010100	−31	23
0000010101	31	21	1000010101	−31	21
0000010110	29	23	1000010110	−29	23
0000010111	29	21	1000010111	−29	21
0000011000	25	17	1000011000	−25	17
0000011001	25	19	1000011001	−25	19
0000011010	27	17	1000011010	−27	17
0000011011	27	19	1000011011	−27	19
0000011100	25	23	1000011100	−25	23
0000011101	25	21	1000011101	−25	21
0000011110	27	23	1000011110	−27	23

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0000011111	27	21	1000011111	−27	21
0000100000	17	31	1000100000	−17	31
0000100001	17	29	1000100001	−17	29
0000100010	19	31	1000100010	−19	31
0000100011	19	29	1000100011	−19	29
0000100100	17	25	1000100100	−17	25
0000100101	17	27	1000100101	−17	27
0000100110	19	25	1000100110	−19	25
0000100111	19	27	1000100111	−19	27
0000101000	23	31	1000101000	−23	31
0000101001	23	29	1000101001	−23	29
0000101010	21	31	1000101010	−21	31
0000101011	21	29	1000101011	−21	29
0000101100	23	25	1000101100	−23	25
0000101101	23	27	1000101101	−23	27
0000101110	21	25	1000101110	−21	25
0000101111	21	27	1000101111	−21	27
0000110000	17	17	1000110000	−17	17
0000110001	17	19	1000110001	−17	19
0000110010	19	17	1000110010	−19	17
0000110011	19	19	1000110011	−19	19
0000110100	17	23	1000110100	−17	23
0000110101	17	21	1000110101	−17	21
0000110110	19	23	1000110110	−19	23
0000110111	19	21	1000110111	−19	21
0000111000	23	17	1000111000	−23	17
0000111001	23	19	1000111001	−23	19
0000111010	21	17	1000111010	−21	17
0000111011	21	19	1000111011	−21	19
0000111100	23	23	1000111100	−23	23
0000111101	23	21	1000111101	−23	21
0000111110	21	23	1000111110	−21	23
0000111111	21	21	1000111111	−21	21
0001000000	31	1	1001000000	−31	1
0001000001	31	3	1001000001	−31	3
0001000010	29	1	1001000010	−29	1
0001000011	29	3	1001000011	−29	3
0001000100	31	7	1001000100	−31	7
0001000101	31	5	1001000101	−31	5
0001000110	29	7	1001000110	−29	7
0001000111	29	5	1001000111	−29	5

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0001001000	25	1	1001001000	−25	1
0001001001	25	3	1001001001	−25	3
0001001010	27	1	1001001010	−27	1
0001001011	27	3	1001001011	−27	3
0001001100	25	7	1001001100	−25	7
0001001101	25	5	1001001101	−25	5
0001001110	27	7	1001001110	−27	7
0001001111	27	5	1001001111	−27	5
0001010000	31	15	1001010000	−31	15
0001010001	31	13	1001010001	−31	13
0001010010	29	15	1001010010	−29	15
0001010011	29	13	1001010011	−29	13
0001010100	31	9	1001010100	−31	9
0001010101	31	11	1001010101	−31	11
0001010110	29	9	1001010110	−29	9
0001010111	29	11	1001010111	−29	11
0001011000	25	15	1001011000	−25	15
0001011001	25	13	1001011001	−25	13
0001011010	27	15	1001011010	−27	15
0001011011	27	13	1001011011	−27	13
0001011100	25	9	1001011100	−25	9
0001011101	25	11	1001011101	−25	11
0001011110	27	9	1001011110	−27	9
0001011111	27	11	1001011111	−27	11
0001100000	17	1	1001100000	−17	1
0001100001	17	3	1001100001	−17	3
0001100010	19	1	1001100010	−19	1
0001100011	19	3	1001100011	−19	3
0001100100	17	7	1001100100	−17	7
0001100101	17	5	1001100101	−17	5
0001100110	19	7	1001100110	−19	7
0001100111	19	5	1001100111	−19	5
0001101000	23	1	1001101000	−23	1
0001101001	23	3	1001101001	−23	3
0001101010	21	1	1001101010	−21	1
0001101011	21	3	1001101011	−21	3
0001101100	23	7	1001101100	−23	7
0001101101	23	5	1001101101	−23	5
0001101110	21	7	1001101110	−21	7
0001101111	21	5	1001101111	−21	5
0001110000	17	15	1001110000	−17	15

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0001110001	17	13	1001110001	−17	13
0001110010	19	15	1001110010	−19	15
0001110011	19	13	1001110011	−19	13
0001110100	17	9	1001110100	−17	9
0001110101	17	11	1001110101	−17	11
0001110110	19	9	1001110110	−19	9
0001110111	19	11	1001110111	−19	11
0001111000	23	15	1001111000	−23	15
0001111001	23	13	1001111001	−23	13
0001111010	21	15	1001111010	−21	15
0001111011	21	13	1001111011	−21	13
0001111100	23	9	1001111100	−23	9
0001111101	23	11	1001111101	−23	11
0001111110	21	9	1001111110	−21	9
0001111111	21	11	1001111111	−21	11
0010000000	1	31	1010000000	−1	31
0010000001	1	29	1010000001	−1	29
0010000010	3	31	1010000010	−3	31
0010000011	3	29	1010000011	−3	29
0010000100	1	25	1010000100	−1	25
0010000101	1	27	1010000101	−1	27
0010000110	3	25	1010000110	−3	25
0010000111	3	27	1010000111	−3	27
0010001000	7	31	1010001000	−7	31
0010001001	7	29	1010001001	−7	29
0010001010	5	31	1010001010	−5	31
0010001011	5	29	1010001011	−5	29
0010001100	7	25	1010001100	−7	25
0010001101	7	27	1010001101	−7	27
0010001110	5	25	1010001110	−5	25
0010001111	5	27	1010001111	−5	27
0010010000	1	17	1010010000	−1	17
0010010001	1	19	1010010001	−1	19
0010010010	3	17	1010010010	−3	17
0010010011	3	19	1010010011	−3	19
0010010100	1	23	1010010100	−1	23
0010010101	1	21	1010010101	−1	21
0010010110	3	23	1010010110	−3	23
0010010111	3	21	1010010111	−3	21
0010011000	7	17	1010011000	−7	17
0010011001	7	19	1010011001	−7	19

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0010011010	5	17	1010011010	−5	17
0010011011	5	19	1010011011	−5	19
0010011100	7	23	1010011100	−7	23
0010011101	7	21	1010011101	−7	21
0010011110	5	23	1010011110	−5	23
0010011111	5	21	1010011111	−5	21
0010100000	15	31	1010100000	−15	31
0010100001	15	29	1010100001	−15	29
0010100010	13	31	1010100010	−13	31
0010100011	13	29	1010100011	−13	29
0010100100	15	25	1010100100	−15	25
0010100101	15	27	1010100101	−15	27
0010100110	13	25	1010100110	−13	25
0010100111	13	27	1010100111	−13	27
0010101000	9	31	1010101000	−9	31
0010101001	9	29	1010101001	−9	29
0010101010	11	31	1010101010	−11	31
0010101011	11	29	1010101011	−11	29
0010101100	9	25	1010101100	−9	25
0010101101	9	27	1010101101	−9	27
0010101110	11	25	1010101110	−11	25
0010101111	11	27	1010101111	−11	27
0010110000	15	17	1010110000	−15	17
0010110001	15	19	1010110001	−15	19
0010110010	13	17	1010110010	−13	17
0010110011	13	19	1010110011	−13	19
0010110100	15	23	1010110100	−15	23
0010110101	15	21	1010110101	−15	21
0010110110	13	23	1010110110	−13	23
0010110111	13	21	1010110111	−13	21
0010111000	9	17	1010111000	−9	17
0010111001	9	19	1010111001	−9	19
0010111010	11	17	1010111010	−11	17
0010111011	11	19	1010111011	−11	19
0010111100	9	23	1010111100	−9	23
0010111101	9	21	1010111101	−9	21
0010111110	11	23	1010111110	−11	23
0010111111	11	21	1010111111	−11	21
0011000000	1	1	1011000000	−1	1
0011000001	1	3	1011000001	−1	3
0011000010	3	1	1011000010	−3	1

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0011000011	3	3	1011000011	−3	3
0011000100	1	7	1011000100	−1	7
0011000101	1	5	1011000101	−1	5
0011000110	3	7	1011000110	−3	7
0011000111	3	5	1011000111	−3	5
0011001000	7	1	1011001000	−7	1
0011001001	7	3	1011001001	−7	3
0011001010	5	1	1011001010	−5	1
0011001011	5	3	1011001011	−5	3
0011001100	7	7	1011001100	−7	7
0011001101	7	5	1011001101	−7	5
0011001110	5	7	1011001110	−5	7
0011001111	5	5	1011001111	−5	5
0011010000	1	15	1011010000	−1	15
0011010001	1	13	1011010001	−1	13
0011010010	3	15	1011010010	−3	15
0011010011	3	13	1011010011	−3	13
0011010100	1	9	1011010100	−1	9
0011010101	1	11	1011010101	−1	11
0011010110	3	9	1011010110	−3	9
0011010111	3	11	1011010111	−3	11
0011011000	7	15	1011011000	−7	15
0011011001	7	13	1011011001	−7	13
0011011010	5	15	1011011010	−5	15
0011011011	5	13	1011011011	−5	13
0011011100	7	9	1011011100	−7	9
0011011101	7	11	1011011101	−7	11
0011011110	5	9	1011011110	−5	9
0011011111	5	11	1011011111	−5	11
0011100000	15	1	1011100000	−15	1
0011100001	15	3	1011100001	−15	3
0011100010	13	1	1011100010	−13	1
0011100011	13	3	1011100011	−13	3
0011100100	15	7	1011100100	−15	7
0011100101	15	5	1011100101	−15	5
0011100110	13	7	1011100110	−13	7
0011100111	13	5	1011100111	−13	5
0011101000	9	1	1011101000	−9	1
0011101001	9	3	1011101001	−9	3
0011101010	11	1	1011101010	−11	1
0011101011	11	3	1011101011	−11	3

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0011101100	9	7	1011101100	−9	7
0011101101	9	5	1011101101	−9	5
0011101110	11	7	1011101110	−11	7
0011101111	11	5	1011101111	−11	5
0011110000	15	15	1011110000	−15	15
0011110001	15	13	1011110001	−15	13
0011110010	13	15	1011110010	−13	15
0011110011	13	13	1011110011	−13	13
0011110100	15	9	1011110100	−15	9
0011110101	15	11	1011110101	−15	11
0011110110	13	9	1011110110	−13	9
0011110111	13	11	1011110111	−13	11
0011111000	9	15	1011111000	−9	15
0011111001	9	13	1011111001	−9	13
0011111010	11	15	1011111010	−11	15
0011111011	11	13	1011111011	−11	13
0011111100	9	9	1011111100	−9	9
0011111101	9	11	1011111101	−9	11
0011111110	11	9	1011111110	−11	9
0011111111	11	11	1011111111	−11	11
0100000000	31	−31	1100000000	−31	−31
0100000001	31	−29	1100000001	−31	−29
0100000010	29	−31	1100000010	−29	−31
0100000011	29	−29	1100000011	−29	−29
0100000100	31	−25	1100000100	−31	−25
0100000101	31	−27	1100000101	−31	−27
0100000110	29	−25	1100000110	−29	−25
0100000111	29	−27	1100000111	−29	−27
0100001000	25	−31	1100001000	−25	−31
0100001001	25	−29	1100001001	−25	−29
0100001010	27	−31	1100001010	−27	−31
0100001011	27	−29	1100001011	−27	−29
0100001100	25	−25	1100001100	−25	−25
0100001101	25	−27	1100001101	−25	−27
0100001110	27	−25	1100001110	−27	−25
0100001111	27	−27	1100001111	−27	−27
0100010000	31	−17	1100010000	−31	−17
0100010001	31	−19	1100010001	−31	−19
0100010010	29	−17	1100010010	−29	−17
0100010011	29	−19	1100010011	−29	−19
0100010100	31	−23	1100010100	−31	−23

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0100010101	31	−21	1100010101	−31	−21
0100010110	29	−23	1100010110	−29	−23
0100010111	29	−21	1100010111	−29	−21
0100011000	25	−17	1100011000	−25	−17
0100011001	25	−19	1100011001	−25	−19
0100011010	27	−17	1100011010	−27	−17
0100011011	27	−19	1100011011	−27	−19
0100011100	25	−23	1100011100	−25	−23
0100011101	25	−21	1100011101	−25	−21
0100011110	27	−23	1100011110	−27	−23
0100011111	27	−21	1100011111	−27	−21
0100100000	17	−31	1100100000	−17	−31
0100100001	17	−29	1100100001	−17	−29
0100100010	19	−31	1100100010	−19	−31
0100100011	19	−29	1100100011	−19	−29
0100100100	17	−25	1100100100	−17	−25
0100100101	17	−27	1100100101	−17	−27
0100100110	19	−25	1100100110	−19	−25
0100100111	19	−27	1100100111	−19	−27
0100101000	23	−31	1100101000	−23	−31
0100101001	23	−29	1100101001	−23	−29
0100101010	21	−31	1100101010	−21	−31
0100101011	21	−29	1100101011	−21	−29
0100101100	23	−25	1100101100	−23	−25
0100101101	23	−27	1100101101	−23	−27
0100101110	21	−25	1100101110	−21	−25
0100101111	21	−27	1100101111	−21	−27
0100110000	17	−17	1100110000	−17	−17
0100110001	17	−19	1100110001	−17	−19
0100110010	19	−17	1100110010	−19	−17
0100110011	19	−19	1100110011	−19	−19
0100110100	17	−23	1100110100	−17	−23
0100110101	17	−21	1100110101	−17	−21
0100110110	19	−23	1100110110	−19	−23
0100110111	19	−21	1100110111	−19	−21
0100111000	23	−17	1100111000	−23	−17
0100111001	23	−19	1100111001	−23	−19
0100111010	21	−17	1100111010	−21	−17
0100111011	21	−19	1100111011	−21	−19
0100111100	23	−23	1100111100	−23	−23
0100111101	23	−21	1100111101	−23	−21

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0100111110	21	−23	1100111110	−21	−23
0100111111	21	−21	1100111111	−21	−21
0101000000	31	−1	1101000000	−31	−1
0101000001	31	−3	1101000001	−31	−3
0101000010	29	−1	1101000010	−29	−1
0101000011	29	−3	1101000011	−29	−3
0101000100	31	−7	1101000100	−31	−7
0101000101	31	−5	1101000101	−31	−5
0101000110	29	−7	1101000110	−29	−7
0101000111	29	−5	1101000111	−29	−5
0101001000	25	−1	1101001000	−25	−1
0101001001	25	−3	1101001001	−25	−3
0101001010	27	−1	1101001010	−27	−1
0101001011	27	−3	1101001011	−27	−3
0101001100	25	−7	1101001100	−25	−7
0101001101	25	−5	1101001101	−25	−5
0101001110	27	−7	1101001110	−27	−7
0101001111	27	−5	1101001111	−27	−5
0101010000	31	−15	1101010000	−31	−15
0101010001	31	−13	1101010001	−31	−13
0101010010	29	−15	1101010010	−29	−15
0101010011	29	−13	1101010011	−29	−13
0101010100	31	−9	1101010100	−31	−9
0101010101	31	−11	1101010101	−31	−11
0101010110	29	−9	1101010110	−29	−9
0101010111	29	−11	1101010111	−29	−11
0101011000	25	−15	1101011000	−25	−15
0101011001	25	−13	1101011001	−25	−13
0101011010	27	−15	1101011010	−27	−15
0101011011	27	−13	1101011011	−27	−13
0101011100	25	−9	1101011100	−25	−9
0101011101	25	−11	1101011101	−25	−11
0101011110	27	−9	1101011110	−27	−9
0101011111	27	−11	1101011111	−27	−11
0101100000	17	−1	1101100000	−17	−1
0101100001	17	−3	1101100001	−17	−3
0101100010	19	−1	1101100010	−19	−1
0101100011	19	−3	1101100011	−19	−3
0101100100	17	−7	1101100100	−17	−7
0101100101	17	−5	1101100101	−17	−5
0101100110	19	−7	1101100110	−19	−7

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0101100111	19	−5	1101100111	−19	−5
0101101000	23	−1	1101101000	−23	−1
0101101001	23	−3	1101101001	−23	−3
0101101010	21	−1	1101101010	−21	−1
0101101011	21	−3	1101101011	−21	−3
0101101100	23	−7	1101101100	−23	−7
0101101101	23	−5	1101101101	−23	−5
0101101110	21	−7	1101101110	−21	−7
0101101111	21	−5	1101101111	−21	−5
0101110000	17	−15	1101110000	−17	−15
0101110001	17	−13	1101110001	−17	−13
0101110010	19	−15	1101110010	−19	−15
0101110011	19	−13	1101110011	−19	−13
0101110100	17	−9	1101110100	−17	−9
0101110101	17	−11	1101110101	−17	−11
0101110110	19	−9	1101110110	−19	−9
0101110111	19	−11	1101110111	−19	−11
0101111000	23	−15	1101111000	−23	−15
0101111001	23	−13	1101111001	−23	−13
0101111010	21	−15	1101111010	−21	−15
0101111011	21	−13	1101111011	−21	−13
0101111100	23	−9	1101111100	−23	−9
0101111101	23	−11	1101111101	−23	−11
0101111110	21	−9	1101111110	−21	−9
0101111111	21	−11	1101111111	−21	−11
0110000000	1	−31	1110000000	−1	−31
0110000001	1	−29	1110000001	−1	−29
0110000010	3	−31	1110000010	−3	−31
0110000011	3	−29	1110000011	−3	−29
0110000100	1	−25	1110000100	−1	−25
0110000101	1	−27	1110000101	−1	−27
0110000110	3	−25	1110000110	−3	−25
0110000111	3	−27	1110000111	−3	−27
0110001000	7	−31	1110001000	−7	−31
0110001001	7	−29	1110001001	−7	−29
0110001010	5	−31	1110001010	−5	−31
0110001011	5	−29	1110001011	−5	−29
0110001100	7	−25	1110001100	−7	−25
0110001101	7	−27	1110001101	−7	−27
0110001110	5	−25	1110001110	−5	−25
0110001111	5	−27	1110001111	−5	−27

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0110010000	1	−17	1110010000	−1	−17
0110010001	1	−19	1110010001	−1	−19
0110010010	3	−17	1110010010	−3	−17
0110010011	3	−19	1110010011	−3	−19
0110010100	1	−23	1110010100	−1	−23
0110010101	1	−21	1110010101	−1	−21
0110010110	3	−23	1110010110	−3	−23
0110010111	3	−21	1110010111	−3	−21
0110011000	7	−17	1110011000	−7	−17
0110011001	7	−19	1110011001	−7	−19
0110011010	5	−17	1110011010	−5	−17
0110011011	5	−19	1110011011	−5	−19
0110011100	7	−23	1110011100	−7	−23
0110011101	7	−21	1110011101	−7	−21
0110011110	5	−23	1110011110	−5	−23
0110011111	5	−21	1110011111	−5	−21
0110100000	15	−31	1110100000	−15	−31
0110100001	15	−29	1110100001	−15	−29
0110100010	13	−31	1110100010	−13	−31
0110100011	13	−29	1110100011	−13	−29
0110100100	15	−25	1110100100	−15	−25
0110100101	15	−27	1110100101	−15	−27
0110100110	13	−25	1110100110	−13	−25
0110100111	13	−27	1110100111	−13	−27
0110101000	9	−31	1110101000	−9	−31
0110101001	9	−29	1110101001	−9	−29
0110101010	11	−31	1110101010	−11	−31
0110101011	11	−29	1110101011	−11	−29
0110101100	9	−25	1110101100	−9	−25
0110101101	9	−27	1110101101	−9	−27
0110101110	11	−25	1110101110	−11	−25
0110101111	11	−27	1110101111	−11	−27
0110110000	15	−17	1110110000	−15	−17
0110110001	15	−19	1110110001	−15	−19
0110110010	13	−17	1110110010	−13	−17
0110110011	13	−19	1110110011	−13	−19
0110110100	15	−23	1110110100	−15	−23
0110110101	15	−21	1110110101	−15	−21
0110110110	13	−23	1110110110	−13	−23
0110110111	13	−21	1110110111	−13	−21
0110111000	9	−17	1110111000	−9	−17

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3$ $b_2b_1b_0$	Re(Sn)	Im(Sn)
0110111001	9	−19	1110111001	−9	−19
0110111010	11	−17	1110111010	−11	−17
0110111011	11	−19	1110111011	−11	−19
0110111100	9	−23	1110111100	−9	−23
0110111101	9	−21	1110111101	−9	−21
0110111110	11	−23	1110111110	−11	−23
0110111111	11	−21	1110111111	−11	−21
0111000000	1	−1	1111000000	−1	−1
0111000001	1	−3	1111000001	−1	−3
0111000010	3	−1	1111000010	−3	−1
0111000011	3	−3	1111000011	−3	−3
0111000100	1	−7	1111000100	−1	−7
0111000101	1	−5	1111000101	−1	−5
0111000110	3	−7	1111000110	−3	−7
0111000111	3	−5	1111000111	−3	−5
0111001000	7	−1	1111001000	−7	−1
0111001001	7	−3	1111001001	−7	−3
0111001010	5	−1	1111001010	−5	−1
0111001011	5	−3	1111001011	−5	−3
0111001100	7	−7	1111001100	−7	−7
0111001101	7	−5	1111001101	−7	−5
0111001110	5	−7	1111001110	−5	−7
0111001111	5	−5	1111001111	−5	−5
0111010000	1	−15	1111010000	−1	−15
0111010001	1	−13	1111010001	−1	−13
0111010010	3	−15	1111010010	−3	−15
0111010011	3	−13	1111010011	−3	−13
0111010100	1	−9	1111010100	−1	−9
0111010101	1	−11	1111010101	−1	−11
0111010110	3	−9	1111010110	−3	−9
0111010111	3	−11	1111010111	−3	−11
0111011000	7	−15	1111011000	−7	−15
0111011001	7	−13	1111011001	−7	−13
0111011010	5	−15	1111011010	−5	−15
0111011011	5	−13	1111011011	−5	−13
0111011100	7	−9	1111011100	−7	−9
0111011101	7	−11	1111011101	−7	−11
0111011110	5	−9	1111011110	−5	−9
0111011111	5	−11	1111011111	−5	−11
0111100000	15	−1	1111100000	−15	−1
0111100001	15	−3	1111100001	−15	−3

Table B.9 – 1024QAM

$b_9b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)	$b_9b_8b_7b_6b_5b_4b_3b_2b_1b_0$	Re(Sn)	Im(Sn)
0111100010	13	−1	1111100010	−13	−1
0111100011	13	−3	1111100011	−13	−3
0111100100	15	−7	1111100100	−15	−7
0111100101	15	−5	1111100101	−15	−5
0111100110	13	−7	1111100110	−13	−7
0111100111	13	−5	1111100111	−13	−5
0111101000	9	−1	1111101000	−9	−1
0111101001	9	−3	1111101001	−9	−3
0111101010	11	−1	1111101010	−11	−1
0111101011	11	−3	1111101011	−11	−3
0111101100	9	−7	1111101100	−9	−7
0111101101	9	−5	1111101101	−9	−5
0111101110	11	−7	1111101110	−11	−7
0111101111	11	−5	1111101111	−11	−5
0111110000	15	−15	1111110000	−15	−15
0111110001	15	−13	1111110001	−15	−13
0111110010	13	−15	1111110010	−13	−15
0111110011	13	−13	1111110011	−13	−13
0111110100	15	−9	1111110100	−15	−9
0111110101	15	−11	1111110101	−15	−11
0111110110	13	−9	1111110110	−13	−9
0111110111	13	−11	1111110111	−13	−11
0111111000	9	−15	1111111000	−9	−15
0111111001	9	−13	1111111001	−9	−13
0111111010	11	−15	1111111010	−11	−15
0111111011	11	−13	1111111011	−11	−13
0111111100	9	−9	1111111100	−9	−9
0111111101	9	−11	1111111101	−9	−11
0111111110	11	−9	1111111110	−11	−9
0111111111	11	−11	1111111111	−11	−11
Normalization factor: $\sqrt{682}$					

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