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(71) Applicant: **HUAWEI TECHNOLOGIES CO., LTD.**
[CN/CN]; Huawei Administration Building, Bantian,
Longgang District, Shenzhen, Guangdong 518129 (CN).(72) Inventors: **MONTORSI, Guido**; Politecnico di orino, Di-
partimento di Elettronica, Corso Duca degli Abruzzi 24,
10129 Torino (IT). **BENEDETTO, Sergio**; Politecnico di
orino, Dipartimento di Elettronica, Corso Duca degli Ab-
ruzzi 24, 10129 Torino (IT). **XIN, Yan**; 1384 Halton Ter-
race, Kanata, Ontario K2K 2R1 (CA). **YAN, Min**; Huawei
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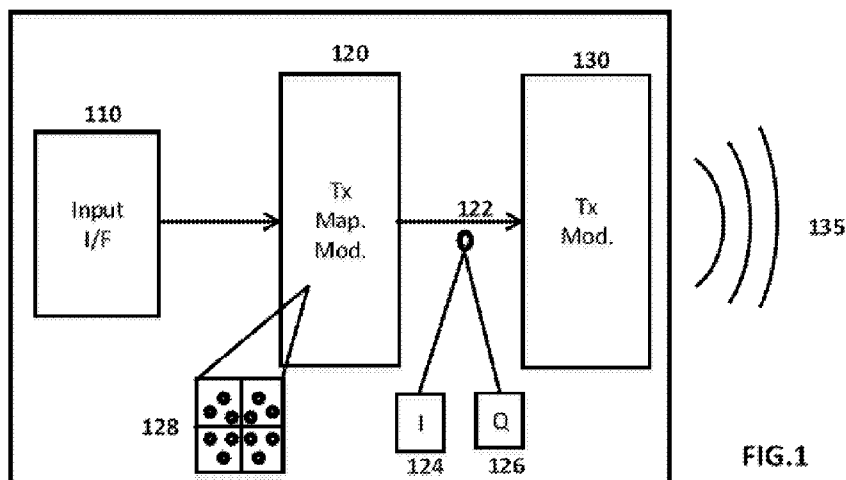


FIG.1

(57) Abstract: Methods and apparatus for facilitating wireless communication using digital Quadrature Amplitude Modulation are disclosed. A mapping module electronic component of a wireless communication device utilizes a signal constellation for quadrature modulating a signal for transmission or quadrature demodulating a received signal. The signal constellation includes multiple constellation symbols and associated bit sequences. Specific signal constellations are disclosed. The signal constellations may be obtained through an optimization procedure which accounts for both phase noise and power amplifier nonlinearity.

METHOD AND APPARATUS FOR QUADRATURE SIGNAL MODULATION

FIELD OF THE INVENTION

[0001] The present invention pertains to the field of wireless communications, and in particular to a method and apparatus for performing quadrature amplitude modulation, using particular quadrature amplitude modulation constellations.

BACKGROUND

[0002] Quadrature amplitude modulation (QAM) has found extensive applications in wired and wireless digital communications systems. In a digital QAM scheme, the QAM constellations are specified by both their amplitude and phase in a quadrature coordination. Phase-shift keying (PSK) modulation can be considered as a special case of QAM where the amplitude of a PSK modulation scheme is constant and the PSK constellations are equally spaced on a circle.

[0003] The aim of digital QAM is to communicate a message from a transmitter to a receiver. However, such communication must contend with the presence of noise, such as thermal noise and phase noise, as well as other limitations such as transmitter power limitations. Phase noise (frequency offset) is particularly problematic at higher frequencies, such as 60 GHz and above, and can be generated due to imperfect oscillators in both transmitter and receiver. Use of higher-order QAM in the presence of thermal noise, phase noise, and other limitations, can result in unacceptably high error rates, particularly for higher-frequency communication systems.

[0004] Therefore, there is a need for a method and apparatus for quadrature amplitude modulation that obviates or mitigates one or more limitations of the prior art.

[0005] This background information is provided to reveal information believed by the applicant to be of possible relevance to the present invention. No admission is necessarily intended, nor should be construed, that any of the preceding information constitutes prior art against the present invention.

SUMMARY

[0006] An object of embodiments of the present invention is to provide a method and apparatus for quadrature signal modulation in a wireless communication system. In accordance with embodiments of the present invention, there is provided a method for facilitating wireless communication using digital Quadrature Amplitude Modulation, the method comprising: translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a signal constellation having a specified number of constellation points, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both, wherein each of the constellation symbols is specified in a row of one of Tables 17- 26C as set forth herein, wherein normalized magnitudes of in-phase components of the constellation symbols are specified in one of the “X” and “Y” columns of said one of the tables and normalized magnitudes of quadrature components of the constellation symbols are specified to a in a different one of the “X” and “Y” columns of said one of the tables. In various embodiments, the signal constellation is specified by the values in the Tables as rounded or truncated to three, four, five or six decimal places. In some embodiments, the signal constellation may be selected from one of a plurality of Tables 17-26C. In various embodiments, the particular bit sequences associated with the constellation symbols are as listed in Tables 17-26C, or are derived from the bit sequences listed in Tables 17-26C by adding a constant binary value to the listed bit sequences, by applying consistent bit reordering operation to the listed bit sequences, or both.

[0007] In accordance with embodiments of the present invention, there is provided an apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation, the apparatus comprising: a mapping module electronic component configured to translate between bit sequences and corresponding constellation symbols in accordance with a signal constellation having a specified number of constellation points, the constellation symbols used in generating a signal for transmission or detected in a received signal, or both, wherein each of the constellation symbols is specified in a row of a one of Tables 17- 26C as set forth herein, wherein normalized magnitudes of in-phase components of the constellation symbols

are specified in one of the “X” and “Y” columns of said one of the tables and normalized magnitudes of quadrature components of the constellation symbols are specified to a in a different one of the “X” and “Y” columns of said one of the tables. In various embodiments, the signal constellation is specified by the values in the tables as rounded or truncated to three, four, five or six decimal places. In some embodiments, the signal constellation may be selected from one of a plurality of Tables 17-26C. In various embodiments, the particular bit sequences associated with the constellation symbols are as listed in Tables 17-26C, or are derived from the bit sequences listed in Tables 17-26C by adding a constant binary value to the listed bit sequences, by applying consistent bit reordering operation to the listed bit sequences, or both.

BRIEF DESCRIPTION OF THE FIGURES

- [0008] Further features and advantages of the present invention will become apparent from the following detailed description, taken in combination with the appended drawings, in which:
- 15 [0009] FIG. 1 illustrates a wireless transmitter communication apparatus in accordance with an embodiment of the present invention.
- [0010] FIG. 2 illustrates a wireless receiver communication apparatus in accordance with another embodiment of the present invention.
- 20 [0011] FIG. 3 illustrates a method for wireless transmission of QAM symbols, in accordance with an embodiment of the present invention.
- [0012] FIG. 4 illustrates a method for wireless reception of QAM symbols, in accordance with an embodiment of the present invention.
- [0013] FIG. 5 illustrates a mapping module electronic component in accordance with embodiments of the present invention.
- 25 [0014] FIG. 6 illustrates the generation of a physical layer protocol data unit (PPDU) from a physical layer service data unit (PSDU) in a single carrier physical layer, in accordance with an IEEE 802.11ad wireless communication approach which may be utilized in embodiments of the present invention.

[0015] FIG. 7 illustrates an IEEE 802.11ad single carrier physical layer frame format and associated block structure which may be utilized in accordance with embodiments of the present invention.

5 [0016] FIG. 8 illustrates a 16-point signal constellation in accordance with an embodiment of the present invention.

[0017] FIG. 9 illustrates a 32-point signal constellation in accordance with an embodiment of the present invention.

[0018] FIG. 10A illustrates a 64-point signal constellation in accordance with an embodiment of the present invention.

10 [0019] FIG. 10B illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

[0020] FIG. 10C illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

15 [0021] FIG. 10D illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

[0022] FIG. 11A illustrates the first quadrant of a 128-point signal constellation in accordance with an embodiment of the present invention.

[0023] FIG. 11B illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

20 [0024] FIG. 11C illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

[0025] FIG. 11D illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

25 [0026] FIG. 12A illustrates the first quadrant of a 256-point signal constellation in accordance with an embodiment of the present invention.

[0027] FIG. 12B illustrates the first quadrant of a 256-point signal constellation in accordance with another embodiment of the present invention.

[0028] FIG. 12C illustrates the first quadrant of a 256-point signal constellation in accordance with another embodiment of the present invention.

[0029] FIG. 13 illustrates a 16-point signal constellation in accordance with another embodiment of the present invention.

5 [0030] FIG. 14 illustrates a 32-point signal constellation in accordance with another embodiment of the present invention.

[0031] FIG. 15A illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

10 [0032] FIG. 15B illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

[0033] FIG. 15C illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

[0034] FIG. 15D illustrates a 64-point signal constellation in accordance with another embodiment of the present invention.

15 [0035] FIG. 16A illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

[0036] FIG. 16B illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

20 [0037] FIG. 16C illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

[0038] FIG. 16D illustrates the first quadrant of a 128-point signal constellation in accordance with another embodiment of the present invention.

[0039] FIG. 17A illustrates the first quadrant of a 256-point signal constellation in accordance with another embodiment of the present invention.

25 [0040] FIG. 17B illustrates the first quadrant of a 256-point signal constellation in accordance with another embodiment of the present invention.

[0041] FIG. 17C illustrates the first quadrant of a 256-point signal constellation in accordance with another embodiment of the present invention.

[0042] FIG. 18 illustrates the standard derivation of residual phase noise vs. SNR using a linear interpolation phase noise mitigation method in accordance with an
5 embodiment of the present invention.

[0043] FIG. 19 illustrates transmitter and receiver systems in accordance with an embodiment of the present invention.

[0044] FIG. 20 illustrates a simplified soft limiter for enforcing a peak power constraint, in accordance with an embodiment of the present invention.

10 [0045] FIG. 21 illustrates a theoretical spectral efficiency according to an embodiment of the present invention.

[0046] FIG. 22 illustrates a theoretical spectral efficiency according to another embodiment of the present invention.

[0047] FIG. 23 illustrates a constellation optimization procedure according to an
15 embodiment of the present invention.

[0048] It will be noted that throughout the appended drawings, like features are identified by like reference numerals.

DETAILED DESCRIPTION

[0049] Embodiments of the present invention are directed to a method and apparatus
20 for wireless communication using a digital QAM signal constellation as described herein. The method includes modulating and/or demodulating a signal according to the described constellation, using a wireless transmitter and/or receiver, or associated signal processing electronics. The apparatus includes a wireless transmitter and/or receiver, or associated signal processing electronics, configured to modulate and/or demodulate a
25 signal according to the described constellation. As used herein, QAM refers generally to any amplitude modulation which includes an in-phase component and a quadrature component, for modulating two carrier signals which are in quadrature with each other. For example, phase-shift keying is regarded as a particular form of QAM.

- [0050] Embodiments of the present invention may be used to wirelessly communicate information between a transmitter and receiver. The information can include control plane data, application data, or user messaging data, for example. On the transmitter side, the information is initially represented as a plurality of binary digits (bits), and modulating the signal comprises mapping a given number m of bits at a time to a corresponding symbol in the signal constellation. On the receiver side, the information is represented via a quadrature modulated waveform, and demodulating the signal comprises mapping portions of the waveform corresponding to a symbol in the signal constellation to an associated sequence of m bits.
- 10 [0051] Embodiments of the present invention apply high order modulation schemes, in which each of $M=2^m$ symbols in a QAM modulation represents multiple ($m>1$) bits. Table 1 shows the spectral efficiency $r=mr_c$ and required minimum Signal to Noise Ratio (SNR) based on the Shannon capacity limit, corresponding to different code rates r_c and to different cardinalities of constellation sets $M=2^m$, $m=2, \dots, 8$.

		m													
		2		3		4		5		6		7		8	
		r	$\min$ SNR	r	$\min$ SNR	r	$\min$ SNR	r	$\min$ SNR	r	$\min$ SNR	r	$\min$ SNR	r	$\min$ SNR
r_c	1/2	1.00	0.0	1.50	2.6	2.00	4.8	2.50	6.7	3.00	8.5	3.50	10.1	4.00	11.8
	5/8	1.25	1.4	1.88	4.3	2.50	6.7	3.13	8.9	3.75	11.0	4.38	13.0	5.00	14.9
	3/4	1.50	2.6	2.25	5.7	3.00	8.5	3.75	11.0	4.50	13.4	5.25	15.7	6.00	18.0
	7/8	1.75	3.7	2.63	7.1	3.50	10.1	4.38	13.0	5.25	15.7	6.13	18.4	7.00	21.0

Table 1

- [0052] In accordance with embodiments of the present invention, and with reference to FIG. 1, a wireless communication apparatus comprising an input interface **110**, a transmitter mapping module **120**, and a transmitter module **130** is disclosed. The input interface **110** is configured to receive data to be wirelessly transmitted. The data may be represented in binary, and may include at least m bits, where m is the base-2 logarithm of the modulation order of the quadrature modulation constellation being used. The transmitter mapping module **120** is configured to receive one or more bit sequences. Each bit sequence is representative of a portion of the data of length m . A bit sequence may correspond directly to m contiguous bits of the data, or it may be derived from the data by applying operations such as scrambling, interleaving, channel coding, etc. The transmitter mapping module is further configured to generate, for each bit sequence, a

corresponding constellation symbol **122** having an in-phase component **124** and a quadrature component **126**. Correspondence between a bit sequence and the generated constellation symbol is given according to a particular signal constellation **128**, as described herein. Typically, multiple bit sequences representative of the input data are used to generate a sequence of constellation symbols. The transmitter module **130** is configured to generate and transmit a wireless signal **135** based on the constellation symbols generated by the mapping module.

[0053] Generation of wireless signals based on constellation symbols can be performed in a manner as would be readily understood by a worker skilled in the art. For example, a sequence of in-phase components can be used to amplitude modulate a first sinusoidal carrier signal, and a corresponding sequence of quadrature components can be used to amplitude modulate a second sinusoidal carrier signal that is out of phase (in quadrature) with the first sinusoidal signal. The sequences of in-phase and quadrature components can be represented, for example, as pulse trains or other electrical signals with amplitudes varying according to the magnitudes of the in-phase and quadrature components, for example, to be used for amplitude modulation of the carrier signals. The amplitude modulated carrier signals are then added together and transmitted.

[0054] In accordance with embodiments of the present invention, and with reference to FIG. 2, a wireless communication apparatus comprising a receiver module **210**, a receiver mapping module **220**, and an output interface **130** is disclosed. The receiver module is configured to receive a wireless signal **212** and generate constellation symbols **214** based on the wireless signal, each constellation symbol having an in-phase component **216** and a quadrature component **218**. Generation of constellation symbols based on a received wireless signal can be performed in a manner as would be readily understood by a worker skilled in the art. For example, the received signal can be multiplied by locally generated copies of the carrier signal, low-pass filtering may be applied to the result, and the output of the low-pass filtering can be sampled to recover representations of the in-phase and quadrature components of the constellation symbols. The sampling includes quantization. For hard-decision decoding, the receiver mapping module **220** is configured to receive constellation symbols **214** and generate, for each constellation symbol, a bit sequence **228** corresponding to the constellation symbol.

Correspondence between a bit sequence and a received constellation symbol is given according to a particular signal constellation **226**, as described herein. The output interface **230** is configured to provide data **238**, a portion of the data represented by the generated bit sequence **228** associated with a received constellation symbol.

- 5 Alternatively, soft-decision decoding, such as Low Density Parity Check LDPC decoding or turbo decoding may be employed, in which a demodulator outputs a sequence of log-likelihood ratios (LLRs) rather than performing direct symbol-to-bit mapping. A decoder then uses the LLR values for decoding.

[0055] The provided group of m bits may directly represent m bits of the data, or the
10 portion of data may be obtained at least partially from the generated bit sequence by applying operations such as descrambling, deinterleaving, decoding, etc. Typically, the received wireless signal is used to generate a sequence of constellation symbols which are passed to the receiver mapping module. The receiver mapping module then generates the data using hard-decision decoding or soft-decision decoding.

15 [0056] In accordance with embodiments of the present invention, and with reference to FIG. 3, there is provided a method for facilitating wireless transmission of QAM symbols. The method includes receiving **310**, via an internal input interface of a wireless communication device, data to be wirelessly transmitted. The data may include at least m bits, where m is determined by the modulation order of the quadrature
20 modulation scheme being used. The method further includes providing **320** one or more bit sequences. Each bit sequence is representative of a portion of the data, for example subsequent to operations such as but not necessarily limited to channel coding. Each bit sequence is of length m , where m is the predetermined value corresponding to the modulation order. The method further includes determining **330**, for each bit sequence,
25 a corresponding constellation symbol having an in-phase component and a quadrature component. Correspondence between a bit sequence and the provided constellation symbol is given according to a particular signal constellation, as described herein. Typically, multiple bit sequences representative of the input data are used to generate a sequence of constellation symbols. The method may further include generating and
30 transmitting **340** a wireless signal based on the determined constellation symbols. The generation of the wireless signal comprises modulating a carrier signal according to the generated sequence of constellation symbols.

[0057] In accordance with embodiments of the present invention, and with reference to FIG. 4, there is provided a method for performing wireless reception and demodulation of QAM symbols. The method includes receiving **410** a wireless signal and generating **420** received baseband symbols based on the wireless signal, each received baseband symbol having an in-phase component and a quadrature component. The received baseband symbol can either generate a bit sequence by mapping the most likely constellation symbol to a corresponding bit sequence based on the constellation mapping, or form a sequence of bit-related soft values indicating the likelihood of bit values at the specific bit positions of a bit sequence corresponding to the selected constellation symbol. As such, the method further includes providing **430** bit sequences or soft values corresponding to the received baseband symbol. A received constellation symbol is given according to a particular signal constellation, as described herein. The method further includes providing **440** data, a portion of the data represented by the provided bit sequence or a sequence of soft values associated with a received symbol. The data may be provided, for example, by performing channel decoding and other operations on the bit sequences.

[0058] Embodiments of the present invention provide for methods and apparatus for generating constellation symbols based on bit sequences and/or generating bit sequences or sequences of bit-related soft values based on constellation symbols, according to a correspondence which is specified by a signal constellation as described herein. Such embodiments may be represented in the transmitter mapping module and receiver mapping module described above, collectively referred to as mapping modules. For example, a provided apparatus may receive groups of m bits and generate constellation symbols, including in-phase and quadrature components, corresponding to the received bit sequences. Bit sequences may be represented by digital signals, such as serial or parallel digital data signals, for example. Sequences of constellation symbols may be represented, for example, by pairs of electrical signals having amplitudes which vary with the magnitudes of the in-phase and quadrature components of the constellation symbols. As another example, sequences of constellation symbols may be represented by time-varying digital or analog signals which convey instructions for use by another electronic device to generate such pairs of electrical signals. For a reception operation, a provided apparatus may receive pairs of electrical signals having amplitudes or other characteristics which are interpreted, by the apparatus, as the magnitudes of a received

sequence of in-phase and quadrature components of a received sequence of constellation symbols. The apparatus may then generate a plurality of bit sequences or plurality of bit-related soft values in a larger sequence, which correspond to the received sequence of constellation symbols.

5 **[0059]** Embodiments of the present invention therefore comprise translating, for example using mapping modules, between constellation symbols and bit sequences according to a particular signal constellation. In the case of signal transmission, the translating includes generating constellation symbols based on bit sequences. In the case of signal reception, the translating includes generating bit sequences or bit-related
10 sequences of soft values based on constellation symbols. Other aspects of signal modulation and/or demodulation, such as varying the amplitudes of carrier signals and/or processing a received signal recover constellation symbols, may be, but are not necessarily, included in the embodiments of the present invention.

[0060] FIG. 5 illustrates a mapping module electronic component **500** provided in
15 accordance with embodiments of the present invention. The electronic component may be provided as a semiconductor circuit, for example forming part or all of an integrated circuit package. The mapping module electronic component can be configured as a transmitter mapping module, a receiver mapping module, or both. The mapping module includes a first interface **510** configured to provide and/or receive groups of m bits. The
20 mapping module further includes a second interface **520** configured to receive and/or provide signals indicative of constellation symbols. In some embodiments the second interface may include a first terminal **522** for receiving and/or providing in-phase components of the constellation symbols, and a second terminal **524** for receiving and/or providing quadrature components of the constellation symbols. The mapping
25 module is configured to translate, via translation circuitry **530**, between bit sequences and constellation symbols according to a signal constellation **535**. The translation circuitry may be digital or analog circuitry. In some embodiments, the translation circuitry is preconfigured according to a certain signal constellation. In other embodiments, the translation circuitry is reconfigurable according to a signal
30 constellation which can be specified or selected via a control interface **540** of the mapping module.

[0061] Embodiments of the present invention are applied for signal modulation in millimeter wave (mmWave) wireless communication systems. Some embodiments of the present invention are applicable to signal modulation in Wi-FiTM communication systems, as specified in the IEEE 802.11 series of standards. Some embodiments of the present invention are applicable to signal modulation in wireless communication systems employing a carrier frequency around 60 GHz. It will be readily appreciated that embodiments of the present invention can be applied to other wireless communication systems, as well as to wired or optical systems, and in other communication environments.

10 [0062] FIG. 6 illustrates the generation of a physical layer protocol data unit (PPDU) from a physical layer service data unit (PSDU) in a single carrier physical layer, in accordance with a wireless communication approach which may be utilized in embodiments of the present invention. The operations illustrated in FIG. 6 are comparable to those specified in the IEEE 802.11ad wireless local area network
15 protocol, and details can be found in the IEEE 802.11ad-2012 standards document, published December, 2012 and having E-ISBN 978-0-7381-8096-0. The single carrier physical layer may employ low-density parity check (LDPC) codes, for example with a code word length of 672. The input PSDU data **605** undergoes scrambling **610**, and the scrambled bits are fragmented **615** to provide input bits **617**. The input bits are then
20 encoded **620**, for example using a LDPC code, to provide coded bits **622**. An optional interleaving operation **623** can be performed following encoding. Interleaving can include shuffling encoded bits, for example. The coded and possibly interleaved bits then optionally undergo zero padding **625**. The coded bits, with or without zero padding, are then modulated **630**. In embodiments of the present invention, modulation may be
25 performed using a signal constellation as described herein. The modulated symbols **632** then undergo symbol blocking and guard insertion **635**, thereby providing the PPDU **640**. In general, modulation operations according to the present invention may be performed after channel coding, such as LDPC coding.

[0063] FIG. 7 illustrates an IEEE 802.11ad single carrier physical layer frame format
30 **700** and associated block structure which may be utilized in accordance with embodiments of the present invention. A set of three contiguous data block structures **750a**, **750b**, **750c** are illustrated in detail. The number of data block structures can be

variable. Each data block structure **750a**, **750b**, **750c** in a PPDU includes 448 modulated data symbols **752** preceded by a guard interval (GI) **755**. For multiple contiguous blocks, groups of 448 modulated data symbols **752** are thus separated by GIs **755** of the same length-64 bipolar Golay sequence. The two GIs **755** preceding and following a given group of 448 modulated data symbols **752** form a cyclic prefix permitting FFT/IFFT operations at a receiver to perform frequency-domain equalization. In addition, the known GIs can be used for other purposes such as phase noise estimation for mitigation of phase noise.

[0064] Embodiments of the present invention relate to signal modulation and/or demodulation in single carrier systems, for example using the data block structure as illustrated in FIG. 7. Embodiments of the present invention relate to signal modulation and/or demodulation in single carrier systems with other formats of data block structure.

[0065] Embodiments of the present invention relate to signal modulation and/or demodulation in communication systems with or without phase noise. Phase noise can significantly degrade the link performance in high-frequency communication systems employing high order digital QAM modulations. The power spectral density of one model of phase noise considered for IEEE 802.11ad is shown in Eq. (1):

$$PSD(f) = PSD(0) \left[\frac{1 + (f / f_z)^2}{1 + (f / f_p)^2} \right] \quad (1).$$

[0066] The parameterization of this model as considered for IEEE 802.11ad is such that: $PSD(0) = -90$ dBc/Hz; Pole frequency $f_p = 1$ MHz; Zero frequency $f_z = 100$ MHz; Corresponding $PSD(\text{infinity}) = -130$ dBc/Hz; and impairment is modeled at both transmitter and receiver. In embodiments of the present invention, signal constellations are provided which have been configured in view of the above phase noise model.

[0067] Embodiments of the present invention relate to signal modulation and/or demodulation in communication systems with or without power amplifier nonlinearity impairments. The power constraints may include peak-to-average power ratio (PAPR) constraints. A first power amplifier nonlinearity model considered for IEEE 802.11ad is given in Equation (2):

$$G(A) = g \frac{A}{\left(1 + \left(\frac{gA}{A_{sat}}\right)^{\frac{2s}{1-s}}\right)^{\frac{1-s}{2s}}} \quad \text{in RMS Volts,} \quad (2)$$

[0068] where g is the small signal gain, s is the smoothness factor, and A_{sat} is the saturation level.

[0069] A second power amplifier nonlinearity model considered for IEEE 802.11ad is given in Equation (3):

$$\Psi(A) = \frac{\alpha A^{q_1}}{\left(1 + \left(\frac{A}{\beta}\right)^{q_2}\right)} \quad (3).$$

[0070] For Equations (2) and (3) above, CMOS power amplifier model parameters can be specified as follows. For Equation (2): $g = 4.65$, $A_{sat} = 0.58$ and $s = 0.81$. For Equation (3): $\alpha = 2560$ degrees, $\beta = 0.114$, $q_1=2.4$ and $q_2=2.3$.

[0071] In embodiments of the present invention, signal constellations are provided which have been configured in view of the above power amplifier nonlinearity model.

[0072] Embodiments of the present invention include signal constellations which have been generated according to a constellation optimization for two scenarios. The first scenario relates to single carrier systems with a linear channel and without a transmit power constraint. The second scenario relates to a non-linear channel with nonlinearity impairments. For both scenarios, sub-scenarios which include or exclude phase noise are considered. In some embodiments, constellations are optimized in view of both the transmit power and phase noise constraints. In various embodiments the phase noise model and the PA model used for the constellation optimization are given in Equations (1)-(3) above. Multiple sets of 16-, 32-, 64-, 128- and 256-point constellations may be generated using this optimization approach. Selected ones of these constellations are disclosed herein.

[0073] It is noted that a constellation that is considered optimal for a particular code rate is not limited for use with that code rate. Rather, a constellation can be used for various code rates, even if it has been optimized for use with a particular code rate. The

use of the constellation for different code rates may result in a reduction in performance and/or loss of optimality. More generally, it is noted that a constellation that is considered optimal for a particular set of conditions can be used in other conditions, with a possible reduction in performance and/or loss of optimality. However, such a performance reduction may be acceptable. Further, the reduced complexity due to the ability to use the same constellation under different conditions may result in a benefit which offsets the performance reduction.

[0074] Various signal constellations provided in accordance with embodiments of the present invention are described in detail below. Each signal constellation represents a set of constellation symbols. A signal constellation having M points is referred to as an M -point constellation. In various embodiments, the x coordinate value of a constellation symbol indicates the (normalized) magnitude of the in-phase component of the constellation symbol, and the y coordinate value of a constellation symbol indicates the (normalized) magnitude of the quadrature component of the constellation symbol. Alternatively, the x coordinate value of a constellation symbol may indicate the (normalized) magnitude of the quadrature component of the constellation symbol, and the y coordinate value of a constellation symbol indicates the (normalized) magnitude of the in-phase component of the constellation symbol. A sequence of m bits may be associated with each constellation symbol.

[0075] In some cases, only the first quadrant of a constellation is specified. As such, in some embodiments, the locations of constellation symbols in other quadrants of the constellation can be readily obtained from the constellation symbols in the first quadrant by reflection symmetry. For reflection symmetry, given constellation symbols in the first quadrant, the locations of constellation symbols in the second quadrant can be obtained by reflection in the Y (vertical) axis. More specifically, the reflection operation can include, for each constellation symbol in the first quadrant specified by vector location (x,y) , obtaining a constellation symbol in the second quadrant specified by vector location $(-x, y)$. Similarly, given constellation symbols in the first quadrant, the locations of constellation symbol in the third quadrant can be obtained by reflection in the Y axis, followed by reflection in the X (horizontal) axis. More specifically, the reflection operation can include, for each constellation symbol in the first quadrant specified by vector location (x,y) , where x and y are non-negative values, obtaining a

constellation symbol in the third quadrant specified by vector location $(-x, -y)$. Similarly, given constellation symbols in the first quadrant, the locations of constellation symbol in the fourth quadrant can be obtained by reflection in the X (horizontal) axis. More specifically, the reflection operation can include, for each constellation symbol in the first quadrant specified by vector location (x, y) , obtaining a constellation symbol in the second quadrant specified by vector location $(x, -y)$. Alternatively to obtain constellation symbols in different quadrants from those of the first quadrant by the reflection operations above, a series of reflection operations can be used. For example, the constellation symbols in the second quadrant can be obtained from those of the first quadrant by reflection in the Y axis, the constellation symbols in the third quadrant can be obtained from those of the second quadrant by reflection in the X axis, and the constellation symbols in the fourth quadrant can be obtained from those of the third quadrant by reflection in the Y axis. As used herein, the term “reflection symmetric constellation symbols” refers to a set of four constellation symbols (x, y) , $(x, -y)$, $(-x, -y)$, $(-x, y)$ for given values of x and y .

[0076] As used herein, the term “symmetric constellation symbols” refers to “reflection symmetric constellation symbols”. A constellation consisting of reflection symmetric constellation symbols may also be referred to as a reflection symmetric constellation, or as a “symmetric constellation”.

[0077] In various embodiments, the illustrated signal constellations can be scaled by a nonzero scaling factor k . Scaling of a signal constellation can be performed by mapping each constellation symbol (x, y) in the constellation to a new constellation symbol (kx, ky) . The (x, y) coordinate values illustrated in FIGs. 8-17C and specified in Tables 17-26C are nominal. In Tables 17-21C constellation magnitudes are normalized such that the average power, across all constellation symbols, is equal to one. In Tables 22-26C, constellation magnitudes are normalized such that the power of each constellation symbol is less than or equal to one. The specified coordinate values may alternatively be normalized such that the peak power, among all constellation symbols, is equal to one. The present description of the specified constellations should be understood to include other scalings or normalizations thereof, for example as would be readily understood by a worker skilled in the art.

[0078] In various embodiments, the (x,y) locations of constellation symbols in the illustrated signal constellations can be varied by a limited amount. For example, when the locations of constellation symbols are specified in one embodiment with a precision of d decimal places, another embodiment may correspond to the same general locations of constellation symbols, but specified with a precision of $d-1$ decimal places, another embodiment correspond to the same general locations of constellation symbols but specified with a precision of $d-2$ decimal places, and yet another embodiment correspond to the same general locations of constellation symbols but specified with a precision of $d-3$ decimal places. The lower precision embodiment can be obtained from the higher precision embodiment through rounding or truncation. In various embodiments, the normalized (x,y) locations of the constellation symbols can be specified to 3, 4, 5, or 6 decimal places. A magnitude that is defined by a coordinate value to at least d decimal places of precision is a magnitude which, when measured, agrees with the coordinate value to at least d decimal places of precision, further decimal places of the measurement and/or coordinate value being either discarded via truncation or subjected to a rounding operation to the d^{th} decimal place.

[0079] In some embodiments, the precision of the decimal places may be related to Error Vector Magnitude (EVM) requirement, taking into account factors such as I/Q arm amplitude and phase balance, DC offset, and phase noise. In IEEE 802.11ad, EVM is typically required to be as low as -21 dB for single carrier transmissions and -26 dB for OFDM transmissions.

[0080] As another example, when the locations of constellation symbols are specified in a first embodiment with a precision of d decimal places, a second embodiment may correspond to the same general locations of constellation symbols, but varied by up to δ units, where δ is on the order of 10^{-d} , or alternatively 10^{-d+1} or 10^{-d+2} , so that, for example, given a constellation symbol (x,y) in the first embodiment, the second embodiment may include a corresponding constellation symbol (x',y'), where $(x-\delta, y-\delta) < (x', y') < (x+\delta, y+\delta)$, or alternatively where $\|(x', y') - (x, y)\| < \delta$.

[0081] In embodiments of the present invention, the normalized magnitudes of the constellation symbols are defined by coordinates which fall anywhere within a rectangular region, including along a boundary of the rectangular region. For each constellation symbol, the rectangular region is defined by a first corner specified by a

first coordinate pair and a second corner specified by a second coordinate pair. The second corner is diagonally opposite the first corner. For a signal constellation as specified in one of Tables 17-26C, and for each listed coordinate pair in the table, the first coordinate pair (specifying the first corner of the rectangular region) can be derived from the listed coordinate pair by rounding down both X and Y values of the listed coordinate pair. The second coordinate pair (specifying the second corner of the rectangular region) can be derived from the listed coordinate pair by rounding up both X and Y values of the listed coordinate pair. In some embodiments, rounding is performed to the nearest thousandth, as would be readily understood by a worker skilled in the art. In some embodiments, rounding is performed to the nearest ten thousandth. In some embodiments, rounding is performed to the nearest hundred thousandth.

[0082] As such, for each of original Tables 17-26C, a new table can be defined in which the “X” column of the original table is replaced with a pair of columns “Xmin” and “Xmax,” and the “Y” column of the original table is replaced with a pair of columns “Ymin” and “Ymax.” The “Xmin” and “Ymin” columns list the X and Y values of the first coordinate pairs, and the “Xmax” and “Ymax” columns list the X and Y values of the second coordinate pairs. The new table indicates a set of ranges for the constellation symbols, such that the normalized magnitude of each constellation symbol has an X coordinate value lying between a value specified in a corresponding row of the “Xmin” column and a value specified in the same row of the “Xmax” column, and further such that the normalized magnitude of the constellation symbol has a Y coordinate value lying between a value specified in the same row of the “Ymin” column and a value specified in the same row of the “Ymax” column. Such new tables are not explicitly listed in the present disclosure for the sake of brevity, however they can be readily derived as described above by a person skilled in the art.

[0083] In some embodiments, rather than determining the corners of the rectangular regions via rounding, the first corner of the rectangular region can be derived from the listed coordinate pair by subtracting a first predetermined value from the X value of the listed coordinate pair, and subtracting a second predetermined value from the Y value of the listed coordinate pair. The second coordinate pair specifying the second corner of the rectangular region can be derived from the listed coordinate pair by adding the first predetermined value to the X value of the listed coordinate pair, and adding the second

predetermined value to the Y value of the listed coordinate pair. The first and second predetermined values can be values which are less than or equal to 0.0005, for example.

[0084] In addition to specifying the vector locations of the constellation symbols in the XY plane, embodiments of the present invention specify the bit sequences
5 corresponding to each of the constellation symbols. As will be readily understood by a worker skilled in the art, given an input group of m bits, modulation includes identifying a symbol in the signal constellation corresponding to the bit sequence, and modulating a signal according to the identified symbol. Similarly, demodulation of a received signal includes identifying a symbol in the signal constellation most closely corresponding to a
10 given portion of the received signal, and outputting the bit sequence corresponding to the identified symbol or the bit-related sequence of soft values corresponding to the constellation. The correspondence between a signal and a constellation symbol may be such that, where the signal is locally describable by the function $A\cos(\omega t) + B\sin(\omega t)$, the corresponding constellation symbol is the closest constellation symbol in the XY plane
15 to point (A,B).

[0085] In various embodiments, each group of m bits includes two quadrant-specifying bits. The quadrant-specifying bits may be at fixed locations in the bit sequence. For example, the first two bits (most significant bits) of a bit sequence may be the quadrant-specifying bits. The remaining $m-2$ bits of a bit sequence are referred to
20 as quadrant non-specific bits. In some embodiments, the quadrant specifying bits corresponding to all constellation symbols in the first quadrant are 00, the quadrant specifying bits corresponding to all constellation symbols in the second quadrant are 10, the quadrant specifying bits corresponding to all constellation symbols in the third quadrant are 11, and the quadrant specifying bits corresponding to all constellation
25 symbols in the fourth quadrant are 01.

[0086] In various embodiments, the quadrant non-specific bits (for example the $m-2$ least significant bits) of each given constellation symbol may be identical to the quadrant non-specific bits of each other constellation symbol within the same set of symmetric constellation symbols as the given constellation symbol.

[0087] It will be readily understood that the correspondence between bit sequences and constellation symbols can be varied in several ways. For example, each of the

illustrated bit values inverted, such that a “0” bit becomes a “1” and vice versa. As another example, the illustrated bit positions can be re-ordered. The reordering may be a consistent bit reordering, i.e. in which the same reordering is applied to all bit sequences in a constellation. A simple example of a reordering is a reversal of all bits, for example
 5 such that group *abcd* is replaced by group *dcba*. As yet another example, a constant value can be added to each of the illustrated bit sequences using a modulo- M binary addition operation, where $M=2^m$ and m is the number of bits in each bit sequence. It is noted that bit inversion corresponds to addition of a particular constant value consisting of all binary ones. A combination of bit reordering and addition of a constant value may
 10 also be performed.

[0088] In some embodiments, for an index value k ranging from $k=1$ to $k=2^{m-2}$ inclusive, where m is the number of bits in each bit sequence: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary
 15 representation of $k-1$ added to a constant value under Modulo- 2^{m-2} addition; the binary representation of $k-1$ subjected to a consistent bit reordering, or the binary representation of $k-1$ added to a constant value under Modulo- 2^{m-2} addition and subjected to the consistent bit reordering.

[0089] It is noted that, in Tables 17-26C, the bit sequences associated with the
 20 constellation symbols correspond to binary representations of the position of the constellation symbol in the list. For example, the first-listed constellation symbol is associated with bit sequence ‘0...000’, the second-listed constellation symbol is associated with bit sequence ‘0...001’, etc.

[0090] In various embodiments, bit sequences are assigned to constellation symbols
 25 using a Gray mapping. Gray mapping comprises associating bit patterns (bit sequences) with constellation symbols, such that the bit sequences associated with adjacent constellation symbols differ by only one bit. That is, the bit sequences assigned to the constellation symbols closest to a first constellation symbol differ by one bit from the bit sequence assigned to the first constellation symbol. Two dimensional Gray mapping
 30 comprises associating bit sequences with constellation symbols, such that the bit sequences associated with adjacent constellation symbols differ by only one bit, and the bit sequences associated with the next nearest constellation symbols differ by two bits.

The term "adjacent" can be taken to mean closest in terms of a distance metric applied to constellation points in the signal constellation.

[0091] FIG. 8 illustrates a 16-point signal constellation provided in accordance with an embodiment of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIG. 8 are provided to six decimal places in Table 17. The signal constellation of FIG. 8 is optimized for use with a code rate of 3/4, and is also suitable for use with other code rates. The code rate corresponds to a channel code which is applied to the bit sequences prior to mapping to constellation symbols for transmission, and which is used for decoding to recover the coded information bits. In FIGs. 8-17C, bit sequences (according to some embodiments of the present invention) are shown generally above their corresponding constellation points. Ambiguities can be resolved by reference to the corresponding tables.

[0092] FIG. 9 illustrates a 32-point signal constellation provided in accordance with an embodiment of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIG. 9 are provided to six decimal places in Table 18. The signal constellation of FIG. 9 is optimized for use with a code rate of 3/4 and is also suitable for use with other code rates.

[0093] FIGs. 10A to 10D illustrate four different 64-point signal constellations provided in accordance with embodiments of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIGs. 10A to 10D are provided to six decimal places in Tables 19A to 19D, respectively. The signal constellation of FIG. 10A is optimized for use with a code rate of 5/8 and is also suitable for use with other code rates. The signal constellation of FIG. 10B is optimized for use with a code rate of 3/4 and is also suitable for use with other code rates. The signal constellation of FIG. 10C is optimized for use with a code rate of 13/16 and is also suitable for use with other code rates. The signal constellation of FIG. 10D is optimized for use with a code rate of 7/8 and is also suitable for use with other code rates.

[0094] FIGs. 11A to 11D illustrate the first quadrants of four different 128-point signal constellations provided in accordance with embodiments of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIGs. 11A to 11D are provided to six decimal places in Tables 20A to 20D, respectively.

The signal constellation of FIG. 11A is optimized for use with a code rate of $5/8$ and is also suitable for use with other code rates. The signal constellation of FIG. 11B is optimized for use with a code rate of $3/4$ and is also suitable for use with other code rates. The signal constellation of FIG. 11C is optimized for use with a code rate of $13/16$ and is also suitable for use with other code rates. The signal constellation of FIG. 11D is optimized for use with a code rate of $7/8$ and is also suitable for use with other code rates.

[0095] FIGs. 12A to 12C illustrate the first quadrants of three different 256-point signal constellations provided in accordance with embodiments of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIGs. 12A to 12C are provided to six decimal places in Tables 21A to 21C, respectively. The signal constellation of FIG. 12A is optimized for use with a code rate of $3/4$ and is also suitable for use with other code rates. The signal constellation of FIG. 12B is optimized for use with a code rate of $13/16$ and is also suitable for use with other code rates. The signal constellation of FIG. 12C is optimized for use with a code rate of $7/8$ and is also suitable for use with other code rates.

[0096] The constellations described above with respect to FIGs. 8-12C and Tables 17-21C were initially derived by an optimization operation which produced signal constellations optimized for single carrier scenarios exhibiting phase noise impairment, but without power amplifier nonlinearity. However, the constellations are not necessarily limited to use in such scenarios.

[0097] FIG. 13 illustrates a 16-point signal constellation provided in accordance with an embodiment of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIG. 13 are provided to six decimal places in Table 22. The signal constellation of FIG. 13 is optimized for use with a code rate of $3/4$ and is also suitable for use with other code rates.

[0098] FIG. 14 illustrates a 32-point signal constellation provided in accordance with an embodiment of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIG. 14 are provided to six decimal places in Table 23. The signal constellation of FIG. 14 is optimized for use with a code rate of $3/4$ and is also suitable for use with other code rates.

[0099] FIGs. 15A to 15D illustrate four different 64-point signal constellations provided in accordance with embodiments of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIGs. 15A to 15D are provided to six decimal places in Tables 24A to 24D, respectively. The signal constellation of FIG. 15A is optimized for use with a code rate of 5/8 and is also suitable for use with other code rates. The signal constellation of FIG. 15B is optimized for use with a code rate of 3/4 and is also suitable for use with other code rates. The signal constellation of FIG. 15C is optimized for use with a code rate of 13/16 and is also suitable for use with other code rates. The signal constellation of FIG. 15D is optimized for use with a code rate of 7/8 and is also suitable for use with other code rates.

[00100] FIGs. 16A to 16D illustrate the first quadrants of four different 128-point signal constellations provided in accordance with an embodiment of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIGs. 16A to 16D are provided to six decimal places in Tables 25A to 25D, respectively. The signal constellation of FIG. 16A is optimized for use with a code rate of 5/8 and is also suitable for use with other code rates. The signal constellation of FIG. 16B is optimized for use with a code rate of 3/4 and is also suitable for use with other code rates. The signal constellation of FIG. 16C is optimized for use with a code rate of 13/16 and is also suitable for use with other code rates. The signal constellation of FIG. 16D is optimized for use with a code rate of 7/8 and is also suitable for use with other code rates.

[00101] FIGs. 17A to 17C illustrate the first quadrants of three different 256-point signal constellation provided in accordance with embodiments of the present invention. The corresponding (x,y) coordinate values of the constellation symbols illustrated in FIGs. 17A to 17C are provided to six decimal places in Tables 26A to 26C, respectively. The signal constellation of FIG. 17A is optimized for use with a code rate of 3/4 and is also suitable for use with other code rates. The signal constellation of FIG. 17B is optimized for use with a code rate of 13/16 and is also suitable for use with other code rates. The signal constellation of FIG. 17C is optimized for use with a code rate of 7/8 and is also suitable for use with other code rates.

[00102] The constellations described above with respect to FIGs. 13-17C and Tables 22-26C were initially derived by an optimization operation which produced signal

constellations which were believed to be optimal for single carrier scenarios exhibiting both phase noise and power amplifier nonlinearity impairments. However, the constellations are not necessarily limited to use in such scenarios.

5 [00103] The (x,y) coordinate values provided in Tables 17-26C are specified to a level of precision of six decimal places. In some embodiments, the coordinate values of the constellation symbols illustrated in FIGs. 8-17C and shown in Tables 17-26C can be truncated to a level of precision of three, four, or five decimal places.

[00104] Embodiments of the present invention provide for a method and apparatus for performing wireless communication using digital Quadrature Amplitude Modulation.
10 The method and apparatus involve utilizing, by a mapping module electronic component of a wireless communication device, a signal constellation for modulating a signal for transmission or demodulating a received signal, the signal constellation comprising a plurality of constellation symbols. The signal constellation may be obtained using an optimization procedure for example as described below. It is noted that the optimization
15 procedure below is not intended to limit the disclosed signal constellations. Rather, the optimization procedure is provided as an example of how these and similar constellations may be obtained, and the circumstances under which they may be expected to perform well.

[00105] In a practical system, phase noise may be said to have a memory. That is, the
20 state of the phase noise at a given time may depend on the state of the phase noise at previous times. As such, according to embodiments of the present invention, the residual phase error caused by the imperfect cancellation for phase noise with memory is obtained based on the specified pilot distribution and the methods for phase estimation and phase noise mitigation. The residual phase error is assumed to be a white
25 random process. Therefore, with the aid of transformation of phase noise with memory to the memoryless residual phase error, methods for constellation optimization with white phase noise constraint and white Gaussian noise can be applied to constellation optimization in the presence of a constraint representing phase noise with memory.

[00106] One embodiment of the present invention provides for signal constellations
30 derived from conducting a joint signal-labeling optimization for the optimized modulation symbol constellations either with phase noise constraint only or with both

phase noise and power constraints with a simplified optimization algorithm in order to obtain the constellations of higher order modulation such those having 128 or 256 points.

[00107] Another embodiment of the present invention provides for signal constellations derived from the optimization of pilot sequence distribution in a single carrier system, which depends on a given phase noise model such as described in Equation (1) as well as particular SNR level, overhead ratio, and phase estimate and phase noise mitigation algorithms.

[00108] According to an embodiment of the present invention, a simple and efficient algorithm for the estimation of the phase noise based on the presence of a pilot field of length L every W transmitted symbols, with a pilot overhead $\text{OH} = L/W$ may be utilized. The output of the channel affected by the phase noise θ_k and thermal noise n_k may be written as:

$$r_k = e^{j\theta_k} p_k + n_k$$

[00109] If the known pilot symbols are placed in contiguous positions

$$k \in [nW-L/2, nW+L/2],$$

with arbitrary integer n , a phase estimate corresponding to the middle of the pilot field can be calculated as follows:

$$\hat{\theta}_{nW} = \tan^{-1} \left(\frac{\sum_{k=nW-L/2}^{nW+L/2-1} \Im(r_k p_k^*)}{\sum_{k=nW-L/2}^{nW+L/2-1} \Re(r_k p_k^*)} \right). \quad (4)$$

[00110] To derive a sequence of phases between two consecutive phase estimates calculated using Equation (4), that is the $(nW)^{\text{th}}$ and $((n+1)W)^{\text{th}}$ phase estimates, the following linear interpolation formula is used:

$$\hat{\theta}_{nW+m} = \left[\frac{W-m}{W} \right] \hat{\theta}_{nW} + \left[\frac{m}{W} \right] \hat{\theta}_{(n+1)W} \quad m = 1, \dots, W-1. \quad (5)$$

[00111] For a given overhead $OH = L/W$, the optimal length of the pilot field L can be obtained by trading off accuracy of the estimation Equation (4) versus accuracy of interpolation Equation (5). As shown in FIG. 7, in an IEEE 802.11ad Single Carrier (SC) block, the pilot field length $L=64$ and the single SC block length $W=512$. Therefore,
 5 $OH = 64/512 = 12.5\%$.

[00112] After mitigation of phase noise, the power spectral density (PSD) of the residual phase error is assumed to be white. Standard deviation of residual phase noise σ_ϕ is used to evaluate the phase errors after a phase noise mitigation process and is used to optimize the constellations. FIG. 18 shows the standard derivation of residual phase
 10 noise vs. SNR using the linear interpolation phase noise mitigation method (5). The standard deviation of the residual phase noise (left vertical axis) versus SNR for a system baud rate $R_s=2$ GHz, and a pilot overhead of 12.5% is shown. The solid line curve corresponds to the 802.11ad SC frame structure ($L=64$, $W=512$). The dashed curve corresponds to the optimal pilot distribution. The dotted curve shows the optimal
 15 pilot field length (to be read in the right vertical axis).

[00113] Performance of a given signal constellation over a channel under ideal detection and decoding can be computed using the Mutual Information (MI):

$$MI = E \left[\log \frac{P(Z|W)}{P(Z)} \right] \quad (6)$$

[00114] or using the Pragmatic Mutual Information (PMI):

$$20 \quad PMI = \sum_{i=1}^m E \left[\log \frac{P(Z|B_i)}{P(Z)} \right] \quad (7).$$

[00115] FIG. 19 illustrates transmitter and receiver systems bounded by the PMI. In the FIG. 19 as well as the above Equations (6) and (7), W and Z represent the input and output of channel respectively and B_i is the i^{th} bit in W . The MI provides an upper bound on the maximum spectral efficiency, defined as $r = mr_c$, where m is the number of
 25 bits associated to each modulation symbol and r_c is the binary code rate. However, in practical systems optimization of signal constellations is performed under the PMI approach. To improve the performance of pragmatic systems, the mapping of bits to constellation can be suitably optimized, for example using Gray mapping. Although the

PMI can be in general quite different from the MI, the difference can be reduced significantly when using optimized constellations and bit-to-signal mappings.

[00116] The computation of PMI can be performed with numerical techniques when the conditional distribution of the channel $P(Z|W)$ is known. When the channel is memoryless, the output at a given time instant only depends on the corresponding input at the same time and the computation of PMI becomes easier. Practical memoryless channel models include AWGN and White phase noise channels.

[00117] In channels constrained by the use of a nonlinear amplifier the optimization of the constellation may be appropriately modified. In these cases, the AM/AM curve of the non-linearity may be represented using the simplified soft limiter shown FIG. 20 by enforcing a peak power constraint. Peak power of the constellation may then become a relevant parameter.

[00118] The following system conditions were used in the computation of signal constellations according to an optimization procedure. Signal constellations with 16, 32, 64, 128 and 256 modulation points were considered. Five code rates: $r_c=1/2, 5/8, 3/4, 13/16, 7/8$ were considered. Channel scenarios were considered corresponding to AWGN without phase noise, AWGN with minimal residual phase noise corresponding to the optimal pilot distribution, AWGN with residual phase noise corresponding to the standard (64/512) pilot distribution; AWGN with non linearity, AWGN with non linearity and minimal residual phase noise corresponding to optimal pilot distribution, and AWGN with non linearity and residual phase noise corresponding to the standard (64/512) pilot distribution. The non linearity is represented using a Peak Signal-to-Noise ratio (PSNR) constraint.

[00119] According to embodiments of the present invention, for each pair of code rate and constellation size, as well as for various levels of the residual phase noise, a constellation and the corresponding binary labeling are designed to achieve a PMI larger than the target spectral efficiency $r=mr_c$ with the minimum possible SNR or PSNR.

[00120] FIG. 21 is a graph showing the loss in spectral efficiency (from the Shannon limit (in bits per dimension) as a function of the channel SNR, for square QAM type constellations ($M=2^{2q}$) with Bit Interleaved Coded Modulation (BICMm) (a Pragmatic Mutual Information (PMI) approach), according to an embodiment of the

present invention. The plot demonstrates that when using a BICM approach, each constellation set has an optimal range of SNR for practical uses.

[00121] FIG. 22 is a graph showing the loss in spectral efficiency from the Shannon limit (in bits per dimension) as a function of the spectral efficiency, according to an embodiment of the present invention. In FIG. 22 it is observed that the crossing point for optimality between the different constellation happens roughly at spectral efficiencies $r=(q-0.4)$ bit per dimension, where q is the number of bits associated to each signal of the constellation.

[00122] From this observation it is possible to determine the optimal range of coding rates for 2^{2q} QAM constellation with BICM:

$$(q-1.4)/q < r_c^q < (q-0.4)/q.$$

[00123] In some embodiments, the optimal range may be further reduced by also implementing the cross QAM constellations with size $M=2^{2q+1}$. That is, non-square QAM constellations may be utilized in addition to square QAM constellations.

[00124] In some embodiments, a 16-point constellation or a 32-point constellation, for example having a code rate of $3/4$, is used when $0.3 < r_c^q < 0.8$. In some embodiments, a 64-point constellation or a 128-point constellation, for example having a code rate of $5/8$, $3/4$, $13/16$ or $7/8$ is used when $0.53 < r_c^q < 0.87$. In some embodiments, a 256-point constellation, for example having a code rate of $3/4$, $13/16$ or $7/8$ is used when $0.65 < r_c^q < 0.9$.

[00125] Given modulation format, code rate and channel scenario, constellation and bit sequence labeling can be optimized to minimize SNR to achieve a PMI greater than the target spectral efficiency $r=mr_c$. FIG. 23 illustrates an applicable constellation optimization procedure using a simulated annealing (SA) technique, according to an embodiment of the present invention. Embodiments of the present invention involve providing a signal constellation which is derived from a simulating annealing algorithm which is applied to maximize Pragmatic Mutual Information. The algorithm may use a logarithmic, polynomial, or other cooling function. The polynomial cooling function may be particularly appropriate for higher order modulations, such as order 64 and above.

[00126] Tables 2-16 illustrate numerical results indicative of performance of the corresponding signal constellations disclosed herein in Tables 17-26C and FIGs. 8-17C, compared to the performance of conventional QAM constellations. These signal constellations were evaluated numerically to obtain the illustrated results. The results
5 were obtained under certain assumptions and are provided by way of example only, and with the understanding that performance may vary in practice.

[00127] Performance in Tables 2-16 is reported in terms of SNR or PSNR, as appropriate, to achieve the target spectral efficiencies, for the QAM and selected optimized constellations. Tables 2-4 relate to 16-point constellations, Tables 5-7 relate
10 to 32-point constellations, Tables 8-10 relate to 64-point constellations, Tables 11-13 relate to 128-point constellations, and Tables 14-16 relate to 256-point constellations. Tables 2, 5, 8, 11 and 14 show the performance of square QAM constellations used as a basis for comparison. Tables 3, 6, 9, 12 and 15 show the performance of the selected (optimized) constellations according to embodiments of the invention. Tables 4, 7, 10,
15 13 and 16 show the gains in dB of the selected (optimized) constellations disclosed herein with respect to their closest corresponding QAM constellation and each of these tables can be obtained by subtraction performed on the two tables immediately preceding it.

[00128] In Tables 2-16 each performance result has been obtained using a
20 constellation optimized for the system scenario corresponding to the phase noise, pilot signal, and power amplifier conditions indicated in the table.

[00129] Tables 2-16 show performance gains that are believed to be significant in a significant number of cases, especially in the case of PSNR.

SQUARE QAM CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	5.33	5.38	5.38	7.86	7.96	7.96
5/8	7.30	7.40	7.42	9.87	9.93	9.99
3/4	9.29	9.44	9.51	11.89	11.95	12.01
13/16	10.36	10.52	10.54	12.89	13.02	13.11
7/8	11.57	11.73	11.82	14.10	14.23	14.35

Table 2: Performance (I) of QAM versus selected optimized constellations with 16 points.

EMBODIMENT CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	5.21	5.33	5.33	6.51	6.58	6.61
5/8	7.17	7.27	7.27	8.52	8.65	8.65
3/4	9.26	9.33	9.39	10.57	10.70	10.76
13/16	10.42	10.52	10.55	11.66	11.86	11.89
7/8	11.87	11.98	12.07	12.88	13.10	13.23

Table 3: Performance (II) of QAM versus selected optimized constellations with 16 points.

5

DIFFERENCE						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	0.13	0.05	0.05	1.36	1.38	1.34
5/8	0.13	0.13	0.14	1.34	1.28	1.34
3/4	0.03	0.11	0.13	1.32	1.25	1.25
13/16	-0.05	0.00	-0.01	1.23	1.16	1.22
7/8	-0.30	-0.25	-0.25	1.23	1.13	1.13

Table 4: Performance (III) of QAM versus selected optimized constellations with 16 points.

SQUARE QAM CONSTELLATION						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	7.87	7.93	7.99	10.12	10.24	10.24
5/8	10.10	10.24	10.32	12.38	12.50	12.57
3/4	12.27	12.42	12.55	14.55	14.69	14.82
13/16	13.31	13.56	13.70	15.65	15.81	16.02
7/8	14.55	14.80	15.02	16.83	17.05	17.31

Table 5: Performance (I) of QAM versus selected optimized constellations with 32 points.

5

EMBODIMENT CONSTELLATION						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	7.37	7.49	7.49	8.99	9.12	9.12
5/8	9.50	9.62	9.69	11.32	11.49	11.57
3/4	11.77	11.89	11.95	13.80	14.05	14.27
13/16	13.02	13.18	13.27	15.27	15.59	15.95
7/8	14.57	14.77	14.89	16.94	17.52	18.27

Table 6: Performance (II) of QAM versus selected optimized constellations with 32 points.

DIFFERENCE						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	0.50	0.43	0.50	1.13	1.13	1.13
5/8	0.60	0.62	0.63	1.06	1.01	1.00
3/4	0.50	0.53	0.60	0.75	0.64	0.55
13/16	0.28	0.38	0.43	0.38	0.22	0.07
7/8	-0.02	0.03	0.13	-0.11	-0.47	-0.95

Table 7: Performance (III) of QAM versus selected optimized constellations with 32 points.

5

SQUARE QAM CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	9.44	9.56	9.64	13.14	13.20	13.26
5/8	11.92	12.14	12.17	15.64	15.77	15.89
3/4	14.41	14.66	14.83	18.07	18.29	18.54
13/16	15.71	15.99	16.26	19.37	19.59	19.96
7/8	17.06	17.42	17.91	20.75	21.03	21.55

Table 8: Performance (I) of QAM versus selected optimized constellations with 64 points.

EMBODIMENT CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	9.01	9.07	9.14	11.01	11.14	11.19
5/8	11.39	11.55	11.64	13.77	13.94	14.06
3/4	13.94	14.16	14.29	16.54	16.72	16.97
13/16	15.46	15.62	15.84	17.84	18.14	18.59
7/8	16.93	17.16	17.41	19.28	19.63	20.25

Table 9: Performance (II) of QAM versus selected optimized constellations with 64 points.

5

DIFFERENCE						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	0.42	0.49	0.50	2.13	2.06	2.08
5/8	0.53	0.59	0.53	1.88	1.83	1.83
3/4	0.47	0.50	0.55	1.53	1.56	1.57
13/16	0.25	0.38	0.42	1.53	1.45	1.38
7/8	0.13	0.27	0.50	1.47	1.41	1.30

Table 10: Performance (III) of QAM versus selected optimized constellations with 64 points.

SQUARE QAM CONSTELLATION						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	11.76	11.95	12.07	14.95	15.07	15.20
5/8	14.39	14.64	14.89	17.56	17.77	18.02
3/4	17.03	17.38	17.78	20.17	20.50	20.93
13/16	18.38	18.78	19.47	21.52	21.88	22.60
7/8	19.81	20.34	21.36	22.97	23.44	24.56

Table 11: Performance (I) of QAM versus selected optimized constellations with 128 points.

5

EMBODIMENT CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	10.70	10.85	10.88	13.24	13.45	13.49
5/8	13.52	13.64	13.77	16.17	16.39	16.64
3/4	16.41	16.63	16.88	19.28	19.63	20.13
13/16	18.10	18.35	18.72	20.72	21.10	21.72
7/8	19.73	19.98	20.47	22.24	22.69	23.72

Table 12: Performance (II) of QAM versus selected optimized constellations with 128 points.

DIFFERENCE						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	1.06	1.09	1.20	1.70	1.63	1.70
5/8	0.88	1.00	1.13	1.39	1.38	1.38
3/4	0.63	0.75	0.91	0.89	0.88	0.81
13/16	0.28	0.43	0.75	0.80	0.78	0.88
7/8	0.08	0.36	0.89	0.73	0.75	0.84

Table 13: Performance (III) of QAM versus selected optimized constellations with 128 points.

5

SQUARE QAM CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	13.32	13.48	13.60	17.50	17.63	17.82
5/8	16.26	16.60	16.91	20.48	20.73	21.13
3/4	19.31	19.73	20.56	23.49	23.85	24.81
13/16	20.83	21.46	22.71	25.08	25.50	26.96
7/8	22.48	23.26	25.51	26.66	27.35	30.00

Table 14: Performance (I) of QAM versus selected optimized constellations with 256 points.

EMBODIMENT CONSTELLATION						
CODE RATE	SNR			PSNR		
	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	12.70	12.85	12.98	15.95	16.07	16.23
5/8	15.66	15.90	16.13	19.02	19.26	19.60
3/4	18.84	19.18	19.68	22.18	22.48	23.23
13/16	20.46	20.86	21.64	23.96	24.33	25.36
7/8	22.73	23.10	24.01	25.88	26.28	27.65

Table 15: Performance (II) of QAM versus selected optimized constellations with 256 points.

5

DIFFERENCE						
	SNR			PSNR		
CODE RATE	NO PN	PN OPT	PN STD	NO PN	PN OPT	PN STD
1/2	0.63	0.63	0.63	1.55	1.56	1.59
5/8	0.60	0.70	0.77	1.45	1.47	1.53
3/4	0.47	0.55	0.88	1.31	1.38	1.58
13/16	0.38	0.59	1.07	1.13	1.17	1.59
7/8	-0.25	0.16	1.50	0.77	1.07	2.35

Table 16: Performance (III) of QAM versus selected optimized constellations with 256 points.

[00130] Tables 17-26C as referenced herein are presented below. As noted above, each table specifies a signal constellation, with each row specifying a constellation symbol in which one of the X and Y values indicates a normalized magnitude of the in-phase component of the constellation symbol and the other of the X and Y values indicates a normalized magnitude of the quadrature component of the constellation symbol. The normalized magnitudes may be scaled. The first column specifies bit sequences corresponding to the constellation symbols. In some embodiments, the entries in the first column can be reordered. In some embodiments, the entries in the second column can be varied, for example by rounding, truncating or varying by up to a predetermined amount.

SYMBOL COORDINATE BITS	X	Y
0000	0.208300	0.385859
0001	0.643529	0.210665
0010	0.453620	1.186803
0011	1.179606	0.586066
0100	0.208300	-0.385859
0101	0.643529	-0.210665
0110	0.453620	-1.186803
0111	1.179606	-0.586066
1000	-0.208300	0.385859
1001	-0.643529	0.210665
1010	-0.453620	1.186803
1011	-1.179606	0.586066
1100	-0.208300	-0.385859
1101	-0.643529	-0.210665
1110	-0.453620	-1.186803
1111	-1.179606	-0.586066

[00131]

Table 17

SYMBOL COORDINATE BITS	X	Y
00000	1.310029	0.338031
00001	0.224325	0.876872
00010	0.720578	0.336506
00011	0.269767	0.543938
00100	1.012286	0.981782
00101	0.423089	1.343637
00110	0.540439	0.139694
00111	0.159408	0.198087
01000	1.310029	-0.338031
01001	0.224325	-0.876872
01010	0.720578	-0.336506
01011	0.269767	-0.543938
01100	1.012286	-0.981782
01101	0.423089	-1.343637
01110	0.540439	-0.139694
01111	0.159408	-0.198087
10000	-1.310029	0.338031
10001	-0.224325	0.876872
10010	-0.720578	0.336506
10011	-0.269767	0.543938
10100	-1.012286	0.981782
10101	-0.423089	1.343637
10110	-0.540439	0.139694
10111	-0.159408	0.198087
11000	-1.310029	-0.338031

11001	-0.224325	-0.876872
11010	-0.720578	-0.336506
11011	-0.269767	-0.543938
11100	-1.012286	-0.981782
11101	-0.423089	-1.343637
11110	-0.540439	-0.139694
11111	-0.159408	-0.198087

[00132]

Table 18

SYMBOL COORDINATE BITS	X	Y
000000	1.469392	0.279838
000001	1.056826	0.221924
000010	0.278986	0.118028
000011	0.715494	0.159574
000100	1.278954	0.863275
000101	0.881208	0.583362
000110	0.313280	0.160867
000111	0.595671	0.362205
001000	0.295098	1.516036
001001	0.173629	1.014971
001010	0.114742	0.259617
001011	0.152038	0.700078
001100	0.785642	1.243046
001101	0.550103	0.874280
001110	0.164975	0.288326
001111	0.353214	0.596159
010000	1.469392	-0.279838
010001	1.056826	-0.221924
010010	0.278986	-0.118028
010011	0.715494	-0.159574
010100	1.278954	-0.863275
010101	0.881208	-0.583362
010110	0.313280	-0.160867
010111	0.595671	-0.362205
011000	0.295098	-1.516036
011001	0.173629	-1.014971
011010	0.114742	-0.259617
011011	0.152038	-0.700078
011100	0.785642	-1.243046
011101	0.550103	-0.874280
011110	0.164975	-0.288326
011111	0.353214	-0.596159
100000	-1.469392	0.279838
100001	-1.056826	0.221924
100010	-0.278986	0.118028
100011	-0.715494	0.159574

100100	-1.278954	0.863275
100101	-0.881208	0.583362
100110	-0.313280	0.160867
100111	-0.595671	0.362205
101000	-0.295098	1.516036
101001	-0.173629	1.014971
101010	-0.114742	0.259617
101011	-0.152038	0.700078
101100	-0.785642	1.243046
101101	-0.550103	0.874280
101110	-0.164975	0.288326
101111	-0.353214	0.596159
110000	-1.469392	-0.279838
110001	-1.056826	-0.221924
110010	-0.278986	-0.118028
110011	-0.715494	-0.159574
110100	-1.278954	-0.863275
110101	-0.881208	-0.583362
110110	-0.313280	-0.160867
110111	-0.595671	-0.362205
111000	-0.295098	-1.516036
111001	-0.173629	-1.014971
111010	-0.114742	-0.259617
111011	-0.152038	-0.700078
111100	-0.785642	-1.243046
111101	-0.550103	-0.874280
111110	-0.164975	-0.288326
111111	-0.353214	-0.596159

[00133]

Table 19A

SYMBOL COORDINATE BITS	X	Y
000000	1.492905	0.360756
000001	1.080694	0.217529
000010	0.403075	0.095458
000011	0.768391	0.154809
000100	1.206775	0.854056
000101	0.849704	0.601606
000110	0.417913	0.175906
000111	0.610015	0.376978
001000	0.309008	1.471972
001001	0.198570	1.031429
001010	0.103390	0.265338
001011	0.134876	0.685577
001100	0.824050	1.192733
001101	0.553412	0.861355
001110	0.174613	0.295716

001111	0.339582	0.576666
010000	1.492905	-0.360756
010001	1.080694	-0.217529
010010	0.403075	-0.095458
010011	0.768391	-0.154809
010100	1.206775	-0.854056
010101	0.849704	-0.601606
010110	0.417913	-0.175906
010111	0.610015	-0.376978
011000	0.309008	-1.471972
011001	0.198570	-1.031429
011010	0.103390	-0.265338
011011	0.134876	-0.685577
011100	0.824050	-1.192733
011101	0.553412	-0.861355
011110	0.174613	-0.295716
011111	0.339582	-0.576666
100000	-1.492905	0.360756
100001	-1.080694	0.217529
100010	-0.403075	0.095458
100011	-0.768391	0.154809
100100	-1.206775	0.854056
100101	-0.849704	0.601606
100110	-0.417913	0.175906
100111	-0.610015	0.376978
101000	-0.309008	1.471972
101001	-0.198570	1.031429
101010	-0.103390	0.265338
101011	-0.134876	0.685577
101100	-0.824050	1.192733
101101	-0.553412	0.861355
101110	-0.174613	0.295716
101111	-0.339582	0.576666
110000	-1.492905	-0.360756
110001	-1.080694	-0.217529
110010	-0.403075	-0.095458
110011	-0.768391	-0.154809
110100	-1.206775	-0.854056
110101	-0.849704	-0.601606
110110	-0.417913	-0.175906
110111	-0.610015	-0.376978
111000	-0.309008	-1.471972
111001	-0.198570	-1.031429
111010	-0.103390	-0.265338
111011	-0.134876	-0.685577
111100	-0.824050	-1.192733
111101	-0.553412	-0.861355
111110	-0.174613	-0.295716

[00134]	111111	-0.339582	-0.576666
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Table 19B

SYMBOL COORDINATE BITS	X	Y
000000	1.223083	0.871183
000001	1.501110	0.301512
000010	0.977190	0.129880
000011	1.034515	0.370077
000100	0.752034	1.165798
000101	0.670194	0.763847
000110	0.622485	0.140135
000111	0.728917	0.432979
001000	0.146134	1.065653
001001	0.158150	0.688012
001010	0.128341	0.119548
001011	0.111238	0.401943
001100	0.296713	1.461668
001101	0.398918	0.653188
001110	0.386998	0.128121
001111	0.372132	0.404640
010000	1.223083	-0.871183
010001	1.501110	-0.301512
010010	0.977190	-0.129880
010011	1.034515	-0.370077
010100	0.752034	-1.165798
010101	0.670194	-0.763847
010110	0.622485	-0.140135
010111	0.728917	-0.432979
011000	0.146134	-1.065653
011001	0.158150	-0.688012
011010	0.128341	-0.119548
011011	0.111238	-0.401943
011100	0.296713	-1.461668
011101	0.398918	-0.653188
011110	0.386998	-0.128121
011111	0.372132	-0.404640
100000	-1.223083	0.871183
100001	-1.501110	0.301512
100010	-0.977190	0.129880
100011	-1.034515	0.370077
100100	-0.752034	1.165798
100101	-0.670194	0.763847
100110	-0.622485	0.140135
100111	-0.728917	0.432979
101000	-0.146134	1.065653
101001	-0.158150	0.688012

101010	-0.128341	0.119548
101011	-0.111238	0.401943
101100	-0.296713	1.461668
101101	-0.398918	0.653188
101110	-0.386998	0.128121
101111	-0.372132	0.404640
110000	-1.223083	-0.871183
110001	-1.501110	-0.301512
110010	-0.977190	-0.129880
110011	-1.034515	-0.370077
110100	-0.752034	-1.165798
110101	-0.670194	-0.763847
110110	-0.622485	-0.140135
110111	-0.728917	-0.432979
111000	-0.146134	-1.065653
111001	-0.158150	-0.688012
111010	-0.128341	-0.119548
111011	-0.111238	-0.401943
111100	-0.296713	-1.461668
111101	-0.398918	-0.653188
111110	-0.386998	-0.128121
111111	-0.372132	-0.404640

[00135]

Table 19C

SYMBOL COORDINATE BITS	X	Y
000000	1.484430	0.355657
000001	1.103689	0.241419
000010	0.483043	0.093713
000011	0.757638	0.144839
000100	1.150175	0.837105
000101	0.876141	0.599840
000110	0.335946	0.248000
000111	0.608728	0.420395
001000	0.255763	1.404577
001001	0.189712	1.014604
001010	0.088351	0.457627
001011	0.166639	0.679954
001100	0.768973	1.227892
001101	0.588939	0.901538
001110	0.105757	0.127560
001111	0.433169	0.631655
010000	1.484430	-0.355657
010001	1.103689	-0.241419
010010	0.483043	-0.093713
010011	0.757638	-0.144839
010100	1.150175	-0.837105

010101	0.876141	-0.599840
010110	0.335946	-0.248000
010111	0.608728	-0.420395
011000	0.255763	-1.404577
011001	0.189712	-1.014604
011010	0.088351	-0.457627
011011	0.166639	-0.679954
011100	0.768973	-1.227892
011101	0.588939	-0.901538
011110	0.105757	-0.127560
011111	0.433169	-0.631655
100000	-1.484430	0.355657
100001	-1.103689	0.241419
100010	-0.483043	0.093713
100011	-0.757638	0.144839
100100	-1.150175	0.837105
100101	-0.876141	0.599840
100110	-0.335946	0.248000
100111	-0.608728	0.420395
101000	-0.255763	1.404577
101001	-0.189712	1.014604
101010	-0.088351	0.457627
101011	-0.166639	0.679954
101100	-0.768973	1.227892
101101	-0.588939	0.901538
101110	-0.105757	0.127560
101111	-0.433169	0.631655
110000	-1.484430	-0.355657
110001	-1.103689	-0.241419
110010	-0.483043	-0.093713
110011	-0.757638	-0.144839
110100	-1.150175	-0.837105
110101	-0.876141	-0.599840
110110	-0.335946	-0.248000
110111	-0.608728	-0.420395
111000	-0.255763	-1.404577
111001	-0.189712	-1.014604
111010	-0.088351	-0.457627
111011	-0.166639	-0.679954
111100	-0.768973	-1.227892
111101	-0.588939	-0.901538
111110	-0.105757	-0.127560
111111	-0.433169	-0.631655

[00136]

Table 19D

SYMBOL COORDINATE BITS	X	Y
0000000	0.737273	0.315203
0000001	0.782564	0.180128
0000010	0.471801	0.125755
0000011	0.472349	0.082889
0000100	0.584038	0.424801
0000101	0.600465	0.414587
0000110	0.411169	0.162424
0000111	0.431203	0.128962
0001000	0.113326	0.576184
0001001	0.132604	0.585352
0001010	0.109346	0.231247
0001011	0.109292	0.159056
0001100	0.265381	0.483973
0001101	0.265697	0.558228
0001110	0.164357	0.264453
0001111	0.142192	0.229753
0010000	0.987276	0.501105
0010001	1.073123	0.189336
0010010	1.238487	0.575437
0010011	1.328506	0.231640
0010100	0.751918	0.674743
0010101	0.679577	0.745095
0010110	1.248964	0.961337
0010111	1.793509	0.444665
0011000	0.178513	0.836678
0011001	0.146379	1.017268
0011010	0.280870	1.717180
0011011	0.220033	1.321346
0011100	0.371932	0.779634
0011101	0.467467	0.944880
0011110	0.933089	1.379959
0011111	0.606172	1.218326
0100000	0.737273	-0.315203
0100001	0.782564	-0.180128
0100010	0.471801	-0.125755
0100011	0.472349	-0.082889
0100100	0.584038	-0.424801
0100101	0.600465	-0.414587
0100110	0.411169	-0.162424
0100111	0.431203	-0.128962
0101000	0.113326	-0.576184
0101001	0.132604	-0.585352
0101010	0.109346	-0.231247
0101011	0.109292	-0.159056
0101100	0.265381	-0.483973
0101101	0.265697	-0.558228

0101110	0.164357	-0.264453
0101111	0.142192	-0.229753
0110000	0.987276	-0.501105
0110001	1.073123	-0.189336
0110010	1.238487	-0.575437
0110011	1.328506	-0.231640
0110100	0.751918	-0.674743
0110101	0.679577	-0.745095
0110110	1.248964	-0.961337
0110111	1.793509	-0.444665
0111000	0.178513	-0.836678
0111001	0.146379	-1.017268
0111010	0.280870	-1.717180
0111011	0.220033	-1.321346
0111100	0.371932	-0.779634
0111101	0.467467	-0.944880
0111110	0.933089	-1.379959
0111111	0.606172	-1.218326
1000000	-0.737273	0.315203
1000001	-0.782564	0.180128
1000010	-0.471801	0.125755
1000011	-0.472349	0.082889
1000100	-0.584038	0.424801
1000101	-0.600465	0.414587
1000110	-0.411169	0.162424
1000111	-0.431203	0.128962
1001000	-0.113326	0.576184
1001001	-0.132604	0.585352
1001010	-0.109346	0.231247
1001011	-0.109292	0.159056
1001100	-0.265381	0.483973
1001101	-0.265697	0.558228
1001110	-0.164357	0.264453
1001111	-0.142192	0.229753
1010000	-0.987276	0.501105
1010001	-1.073123	0.189336
1010010	-1.238487	0.575437
1010011	-1.328506	0.231640
1010100	-0.751918	0.674743
1010101	-0.679577	0.745095
1010110	-1.248964	0.961337
1010111	-1.793509	0.444665
1011000	-0.178513	0.836678
1011001	-0.146379	1.017268
1011010	-0.280870	1.717180
1011011	-0.220033	1.321346
1011100	-0.371932	0.779634
1011101	-0.467467	0.944880

1011110	-0.933089	1.379959
1011111	-0.606172	1.218326
1100000	-0.737273	-0.315203
1100001	-0.782564	-0.180128
1100010	-0.471801	-0.125755
1100011	-0.472349	-0.082889
1100100	-0.584038	-0.424801
1100101	-0.600465	-0.414587
1100110	-0.411169	-0.162424
1100111	-0.431203	-0.128962
1101000	-0.113326	-0.576184
1101001	-0.132604	-0.585352
1101010	-0.109346	-0.231247
1101011	-0.109292	-0.159056
1101100	-0.265381	-0.483973
1101101	-0.265697	-0.558228
1101110	-0.164357	-0.264453
1101111	-0.142192	-0.229753
1110000	-0.987276	-0.501105
1110001	-1.073123	-0.189336
1110010	-1.238487	-0.575437
1110011	-1.328506	-0.231640
1110100	-0.751918	-0.674743
1110101	-0.679577	-0.745095
1110110	-1.248964	-0.961337
1110111	-1.793509	-0.444665
1111000	-0.178513	-0.836678
1111001	-0.146379	-1.017268
1111010	-0.280870	-1.717180
1111011	-0.220033	-1.321346
1111100	-0.371932	-0.779634
1111101	-0.467467	-0.944880
1111110	-0.933089	-1.379959
1111111	-0.606172	-1.218326

[00137]

Table 20A

SYMBOL COORDINATE BITS	X	Y
0000000	0.779391	0.338303
0000001	0.705151	0.165321
0000010	0.392817	0.073826
0000011	0.566840	0.098610
0000100	0.591096	0.495628
0000101	0.506207	0.386704
0000110	0.333309	0.129562
0000111	0.431485	0.259293
0001000	0.133150	0.720478

0001001	0.112303	0.521489
0001010	0.088988	0.094762
0001011	0.084578	0.331907
0001100	0.369721	0.688796
0001101	0.245135	0.489948
0001110	0.173144	0.142180
0001111	0.187579	0.326278
0010000	0.960305	0.408119
0010001	1.024151	0.117108
0010010	1.193232	0.494688
0010011	1.308642	0.184615
0010100	0.755084	0.676471
0010101	0.815391	0.852249
0010110	1.225372	0.896021
0010111	1.673595	0.351190
0011000	0.153929	0.914118
0011001	0.210848	1.095014
0011010	0.311339	1.668426
0011011	0.184999	1.301075
0011100	0.468118	0.850595
0011101	0.563693	0.998855
0011110	0.958825	1.358356
0011111	0.578328	1.241114
0100000	0.779391	-0.338303
0100001	0.705151	-0.165321
0100010	0.392817	-0.073826
0100011	0.566840	-0.098610
0100100	0.591096	-0.495628
0100101	0.506207	-0.386704
0100110	0.333309	-0.129562
0100111	0.431485	-0.259293
0101000	0.133150	-0.720478
0101001	0.112303	-0.521489
0101010	0.088988	-0.094762
0101011	0.084578	-0.331907
0101100	0.369721	-0.688796
0101101	0.245135	-0.489948
0101110	0.173144	-0.142180
0101111	0.187579	-0.326278
0110000	0.960305	-0.408119
0110001	1.024151	-0.117108
0110010	1.193232	-0.494688
0110011	1.308642	-0.184615
0110100	0.755084	-0.676471
0110101	0.815391	-0.852249
0110110	1.225372	-0.896021
0110111	1.673595	-0.351190
0111000	0.153929	-0.914118

0111001	0.210848	-1.095014
0111010	0.311339	-1.668426
0111011	0.184999	-1.301075
0111100	0.468118	-0.850595
0111101	0.563693	-0.998855
0111110	0.958825	-1.358356
0111111	0.578328	-1.241114
1000000	-0.779391	0.338303
1000001	-0.705151	0.165321
1000010	-0.392817	0.073826
1000011	-0.566840	0.098610
1000100	-0.591096	0.495628
1000101	-0.506207	0.386704
1000110	-0.333309	0.129562
1000111	-0.431485	0.259293
1001000	-0.133150	0.720478
1001001	-0.112303	0.521489
1001010	-0.088988	0.094762
1001011	-0.084578	0.331907
1001100	-0.369721	0.688796
1001101	-0.245135	0.489948
1001110	-0.173144	0.142180
1001111	-0.187579	0.326278
1010000	-0.960305	0.408119
1010001	-1.024151	0.117108
1010010	-1.193232	0.494688
1010011	-1.308642	0.184615
1010100	-0.755084	0.676471
1010101	-0.815391	0.852249
1010110	-1.225372	0.896021
1010111	-1.673595	0.351190
1011000	-0.153929	0.914118
1011001	-0.210848	1.095014
1011010	-0.311339	1.668426
1011011	-0.184999	1.301075
1011100	-0.468118	0.850595
1011101	-0.563693	0.998855
1011110	-0.958825	1.358356
1011111	-0.578328	1.241114
1100000	-0.779391	-0.338303
1100001	-0.705151	-0.165321
1100010	-0.392817	-0.073826
1100011	-0.566840	-0.098610
1100100	-0.591096	-0.495628
1100101	-0.506207	-0.386704
1100110	-0.333309	-0.129562
1100111	-0.431485	-0.259293
1101000	-0.133150	-0.720478

1101001	-0.112303	-0.521489
1101010	-0.088988	-0.094762
1101011	-0.084578	-0.331907
1101100	-0.369721	-0.688796
1101101	-0.245135	-0.489948
1101110	-0.173144	-0.142180
1101111	-0.187579	-0.326278
1110000	-0.960305	-0.408119
1110001	-1.024151	-0.117108
1110010	-1.193232	-0.494688
1110011	-1.308642	-0.184615
1110100	-0.755084	-0.676471
1110101	-0.815391	-0.852249
1110110	-1.225372	-0.896021
1110111	-1.673595	-0.351190
1111000	-0.153929	-0.914118
1111001	-0.210848	-1.095014
1111010	-0.311339	-1.668426
1111011	-0.184999	-1.301075
1111100	-0.468118	-0.850595
1111101	-0.563693	-0.998855
1111110	-0.958825	-1.358356
1111111	-0.578328	-1.241114

[00138]

Table 20B

SYMBOL COORDINATE BITS	X	Y
0000000	0.676205	0.590907
0000001	0.696016	0.362489
0000010	0.553277	0.064967
0000011	0.641368	0.195573
0000100	0.526012	0.596882
0000101	0.490563	0.432520
0000110	0.372395	0.089910
0000111	0.433984	0.256395
0001000	0.133129	0.680380
0001001	0.140357	0.511313
0001010	0.073689	0.113398
0001011	0.073957	0.342801
0001100	0.335239	0.697471
0001101	0.293873	0.462352
0001110	0.223478	0.122727
0001111	0.250692	0.291177
0010000	0.849307	0.605280
0010001	0.910806	0.371753
0010010	1.121469	0.096631
0010011	0.889883	0.100840

0010100	1.044658	0.689042
0010101	1.351312	0.747663
0010110	1.653554	0.212837
0010111	1.334308	0.348076
0011000	0.106020	0.847896
0011001	0.110430	1.108822
0011010	0.790965	1.102054
0011011	0.991785	1.277338
0011100	0.409035	0.918111
0011101	0.191275	1.371272
0011110	0.580772	1.045388
0011111	0.545581	1.581968
0100000	0.676205	-0.590907
0100001	0.696016	-0.362489
0100010	0.553277	-0.064967
0100011	0.641368	-0.195573
0100100	0.526012	-0.596882
0100101	0.490563	-0.432520
0100110	0.372395	-0.089910
0100111	0.433984	-0.256395
0101000	0.133129	-0.680380
0101001	0.140357	-0.511313
0101010	0.073689	-0.113398
0101011	0.073957	-0.342801
0101100	0.335239	-0.697471
0101101	0.293873	-0.462352
0101110	0.223478	-0.122727
0101111	0.250692	-0.291177
0110000	0.849307	-0.605280
0110001	0.910806	-0.371753
0110010	1.121469	-0.096631
0110011	0.889883	-0.100840
0110100	1.044658	-0.689042
0110101	1.351312	-0.747663
0110110	1.653554	-0.212837
0110111	1.334308	-0.348076
0111000	0.106020	-0.847896
0111001	0.110430	-1.108822
0111010	0.790965	-1.102054
0111011	0.991785	-1.277338
0111100	0.409035	-0.918111
0111101	0.191275	-1.371272
0111110	0.580772	-1.045388
0111111	0.545581	-1.581968
1000000	-0.676205	0.590907
1000001	-0.696016	0.362489
1000010	-0.553277	0.064967
1000011	-0.641368	0.195573

1000100	-0.526012	0.596882
1000101	-0.490563	0.432520
1000110	-0.372395	0.089910
1000111	-0.433984	0.256395
1001000	-0.133129	0.680380
1001001	-0.140357	0.511313
1001010	-0.073689	0.113398
1001011	-0.073957	0.342801
1001100	-0.335239	0.697471
1001101	-0.293873	0.462352
1001110	-0.223478	0.122727
1001111	-0.250692	0.291177
1010000	-0.849307	0.605280
1010001	-0.910806	0.371753
1010010	-1.121469	0.096631
1010011	-0.889883	0.100840
1010100	-1.044658	0.689042
1010101	-1.351312	0.747663
1010110	-1.653554	0.212837
1010111	-1.334308	0.348076
1011000	-0.106020	0.847896
1011001	-0.110430	1.108822
1011010	-0.790965	1.102054
1011011	-0.991785	1.277338
1011100	-0.409035	0.918111
1011101	-0.191275	1.371272
1011110	-0.580772	1.045388
1011111	-0.545581	1.581968
1100000	-0.676205	-0.590907
1100001	-0.696016	-0.362489
1100010	-0.553277	-0.064967
1100011	-0.641368	-0.195573
1100100	-0.526012	-0.596882
1100101	-0.490563	-0.432520
1100110	-0.372395	-0.089910
1100111	-0.433984	-0.256395
1101000	-0.133129	-0.680380
1101001	-0.140357	-0.511313
1101010	-0.073689	-0.113398
1101011	-0.073957	-0.342801
1101100	-0.335239	-0.697471
1101101	-0.293873	-0.462352
1101110	-0.223478	-0.122727
1101111	-0.250692	-0.291177
1110000	-0.849307	-0.605280
1110001	-0.910806	-0.371753
1110010	-1.121469	-0.096631
1110011	-0.889883	-0.100840

1110100	-1.044658	-0.689042
1110101	-1.351312	-0.747663
1110110	-1.653554	-0.212837
1110111	-1.334308	-0.348076
1111000	-0.106020	-0.847896
1111001	-0.110430	-1.108822
1111010	-0.790965	-1.102054
1111011	-0.991785	-1.277338
1111100	-0.409035	-0.918111
1111101	-0.191275	-1.371272
1111110	-0.580772	-1.045388
1111111	-0.545581	-1.581968

[00139]

Table 20C

SYMBOL COORDINATE BITS	X	Y
0000000	0.752060	0.302196
0000001	0.788983	0.113122
0000010	0.325356	0.054462
0000011	0.573961	0.098934
0000100	0.579122	0.497202
0000101	0.471776	0.396048
0000110	0.294917	0.133438
0000111	0.433938	0.245088
0001000	0.132847	0.742015
0001001	0.122253	0.604949
0001010	0.068657	0.075472
0001011	0.060983	0.445207
0001100	0.382346	0.652673
0001101	0.302064	0.494450
0001110	0.166497	0.233502
0001111	0.196116	0.340897
0010000	0.907567	0.452354
0010001	1.043922	0.158157
0010010	1.130081	0.548716
0010011	1.320594	0.181413
0010100	0.712483	0.646623
0010101	0.815526	0.865815
0010110	1.157076	0.928991
0010111	1.532471	0.508968
0011000	0.120519	0.915797
0011001	0.148259	1.123784
0011010	0.282652	1.690100
0011011	0.221465	1.387236
0011100	0.423824	0.821654
0011101	0.488704	1.037583
0011110	0.872546	1.413810

0011111	0.675009	1.247576
0100000	0.752060	-0.302196
0100001	0.788983	-0.113122
0100010	0.325356	-0.054462
0100011	0.573961	-0.098934
0100100	0.579122	-0.497202
0100101	0.471776	-0.396048
0100110	0.294917	-0.133438
0100111	0.433938	-0.245088
0101000	0.132847	-0.742015
0101001	0.122253	-0.604949
0101010	0.068657	-0.075472
0101011	0.060983	-0.445207
0101100	0.382346	-0.652673
0101101	0.302064	-0.494450
0101110	0.166497	-0.233502
0101111	0.196116	-0.340897
0110000	0.907567	-0.452354
0110001	1.043922	-0.158157
0110010	1.130081	-0.548716
0110011	1.320594	-0.181413
0110100	0.712483	-0.646623
0110101	0.815526	-0.865815
0110110	1.157076	-0.928991
0110111	1.532471	-0.508968
0111000	0.120519	-0.915797
0111001	0.148259	-1.123784
0111010	0.282652	-1.690100
0111011	0.221465	-1.387236
0111100	0.423824	-0.821654
0111101	0.488704	-1.037583
0111110	0.872546	-1.413810
0111111	0.675009	-1.247576
1000000	-0.752060	0.302196
1000001	-0.788983	0.113122
1000010	-0.325356	0.054462
1000011	-0.573961	0.098934
1000100	-0.579122	0.497202
1000101	-0.471776	0.396048
1000110	-0.294917	0.133438
1000111	-0.433938	0.245088
1001000	-0.132847	0.742015
1001001	-0.122253	0.604949
1001010	-0.068657	0.075472
1001011	-0.060983	0.445207
1001100	-0.382346	0.652673
1001101	-0.302064	0.494450
1001110	-0.166497	0.233502

1001111	-0.196116	0.340897
1010000	-0.907567	0.452354
1010001	-1.043922	0.158157
1010010	-1.130081	0.548716
1010011	-1.320594	0.181413
1010100	-0.712483	0.646623
1010101	-0.815526	0.865815
1010110	-1.157076	0.928991
1010111	-1.532471	0.508968
1011000	-0.120519	0.915797
1011001	-0.148259	1.123784
1011010	-0.282652	1.690100
1011011	-0.221465	1.387236
1011100	-0.423824	0.821654
1011101	-0.488704	1.037583
1011110	-0.872546	1.413810
1011111	-0.675009	1.247576
1100000	-0.752060	-0.302196
1100001	-0.788983	-0.113122
1100010	-0.325356	-0.054462
1100011	-0.573961	-0.098934
1100100	-0.579122	-0.497202
1100101	-0.471776	-0.396048
1100110	-0.294917	-0.133438
1100111	-0.433938	-0.245088
1101000	-0.132847	-0.742015
1101001	-0.122253	-0.604949
1101010	-0.068657	-0.075472
1101011	-0.060983	-0.445207
1101100	-0.382346	-0.652673
1101101	-0.302064	-0.494450
1101110	-0.166497	-0.233502
1101111	-0.196116	-0.340897
1110000	-0.907567	-0.452354
1110001	-1.043922	-0.158157
1110010	-1.130081	-0.548716
1110011	-1.320594	-0.181413
1110100	-0.712483	-0.646623
1110101	-0.815526	-0.865815
1110110	-1.157076	-0.928991
1110111	-1.532471	-0.508968
1111000	-0.120519	-0.915797
1111001	-0.148259	-1.123784
1111010	-0.282652	-1.690100
1111011	-0.221465	-1.387236
1111100	-0.423824	-0.821654
1111101	-0.488704	-1.037583
1111110	-0.872546	-1.413810

[00140]	1111111	-0.675009	-1.247576
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Table 20D

SYMBOL COORDINATE BITS	X	Y
00000000	1.443706	0.533189
00000001	1.269957	0.814447
00000010	1.190815	0.494955
00000011	1.099458	0.637493
00000100	1.465098	0.242389
00000101	0.756113	0.035702
00000110	1.757959	0.251458
00000111	0.780617	0.113362
00001000	1.032269	1.540287
00001001	1.450983	1.025801
00001010	1.044843	0.407507
00001011	0.920903	0.474471
00001100	1.061180	0.094137
00001101	0.942993	0.109431
00001110	1.146865	0.181476
00001111	0.863666	0.236933
00010000	1.028531	1.046265
00010001	0.903477	0.907951
00010010	0.580224	0.575049
00010011	0.741607	0.728471
00010100	0.418728	0.083169
00010101	0.537914	0.122315
00010110	0.581523	0.384883
00010111	0.655016	0.231039
00011000	0.844978	1.282582
00011001	0.713419	0.974473
00011010	0.662139	0.570492
00011011	0.764324	0.614172
00011100	0.401000	0.062964
00011101	0.510837	0.125696
00011110	0.576609	0.374709
00011111	0.692682	0.292587
00100000	0.276792	1.794144
00100001	0.158046	1.018387
00100010	0.104813	0.702356
00100011	0.124613	0.885016
00100100	0.110294	0.045410
00100101	0.068892	0.234221
00100110	0.112344	0.534452
00100111	0.089452	0.398340
00101000	0.132300	1.285556
00101001	0.180106	1.107457

00101010	0.190850	0.723373
00101011	0.170166	0.861137
00101100	0.088520	0.064328
00101101	0.063584	0.193067
00101110	0.118919	0.539605
00101111	0.097923	0.408426
00110000	0.215811	1.558150
00110001	0.404454	1.021596
00110010	0.411119	0.597529
00110011	0.429107	0.835089
00110100	0.269636	0.105598
00110101	0.260922	0.234821
00110110	0.375258	0.455253
00110111	0.242072	0.352853
00111000	0.498501	1.328103
00111001	0.496854	1.034589
00111010	0.351667	0.652324
00111011	0.454845	0.854758
00111100	0.278962	0.076488
00111101	0.267573	0.245109
00111110	0.374077	0.452024
00111111	0.248176	0.363324
01000000	1.443706	-0.533189
01000001	1.269957	-0.814447
01000010	1.190815	-0.494955
01000011	1.099458	-0.637493
01000100	1.465098	-0.242389
01000101	0.756113	-0.035702
01000110	1.757959	-0.251458
01000111	0.780617	-0.113362
01001000	1.032269	-1.540287
01001001	1.450983	-1.025801
01001010	1.044843	-0.407507
01001011	0.920903	-0.474471
01001100	1.061180	-0.094137
01001101	0.942993	-0.109431
01001110	1.146865	-0.181476
01001111	0.863666	-0.236933
01010000	1.028531	-1.046265
01010001	0.903477	-0.907951
01010010	0.580224	-0.575049
01010011	0.741607	-0.728471
01010100	0.418728	-0.083169
01010101	0.537914	-0.122315
01010110	0.581523	-0.384883
01010111	0.655016	-0.231039
01011000	0.844978	-1.282582
01011001	0.713419	-0.974473

01011010	0.662139	-0.570492
01011011	0.764324	-0.614172
01011100	0.401000	-0.062964
01011101	0.510837	-0.125696
01011110	0.576609	-0.374709
01011111	0.692682	-0.292587
01100000	0.276792	-1.794144
01100001	0.158046	-1.018387
01100010	0.104813	-0.702356
01100011	0.124613	-0.885016
01100100	0.110294	-0.045410
01100101	0.068892	-0.234221
01100110	0.112344	-0.534452
01100111	0.089452	-0.398340
01101000	0.132300	-1.285556
01101001	0.180106	-1.107457
01101010	0.190850	-0.723373
01101011	0.170166	-0.861137
01101100	0.088520	-0.064328
01101101	0.063584	-0.193067
01101110	0.118919	-0.539605
01101111	0.097923	-0.408426
01110000	0.215811	-1.558150
01110001	0.404454	-1.021596
01110010	0.411119	-0.597529
01110011	0.429107	-0.835089
01110100	0.269636	-0.105598
01110101	0.260922	-0.234821
01110110	0.375258	-0.455253
01110111	0.242072	-0.352853
01111000	0.498501	-1.328103
01111001	0.496854	-1.034589
01111010	0.351667	-0.652324
01111011	0.454845	-0.854758
01111100	0.278962	-0.076488
01111101	0.267573	-0.245109
01111110	0.374077	-0.452024
01111111	0.248176	-0.363324
10000000	-1.443706	0.533189
10000001	-1.269957	0.814447
10000010	-1.190815	0.494955
10000011	-1.099458	0.637493
10000100	-1.465098	0.242389
10000101	-0.756113	0.035702
10000110	-1.757959	0.251458
10000111	-0.780617	0.113362
10001000	-1.032269	1.540287
10001001	-1.450983	1.025801

10001010	-1.044843	0.407507
10001011	-0.920903	0.474471
10001100	-1.061180	0.094137
10001101	-0.942993	0.109431
10001110	-1.146865	0.181476
10001111	-0.863666	0.236933
10010000	-1.028531	1.046265
10010001	-0.903477	0.907951
10010010	-0.580224	0.575049
10010011	-0.741607	0.728471
10010100	-0.418728	0.083169
10010101	-0.537914	0.122315
10010110	-0.581523	0.384883
10010111	-0.655016	0.231039
10011000	-0.844978	1.282582
10011001	-0.713419	0.974473
10011010	-0.662139	0.570492
10011011	-0.764324	0.614172
10011100	-0.401000	0.062964
10011101	-0.510837	0.125696
10011110	-0.576609	0.374709
10011111	-0.692682	0.292587
10100000	-0.276792	1.794144
10100001	-0.158046	1.018387
10100010	-0.104813	0.702356
10100011	-0.124613	0.885016
10100100	-0.110294	0.045410
10100101	-0.068892	0.234221
10100110	-0.112344	0.534452
10100111	-0.089452	0.398340
10101000	-0.132300	1.285556
10101001	-0.180106	1.107457
10101010	-0.190850	0.723373
10101011	-0.170166	0.861137
10101100	-0.088520	0.064328
10101101	-0.063584	0.193067
10101110	-0.118919	0.539605
10101111	-0.097923	0.408426
10110000	-0.215811	1.558150
10110001	-0.404454	1.021596
10110010	-0.411119	0.597529
10110011	-0.429107	0.835089
10110100	-0.269636	0.105598
10110101	-0.260922	0.234821
10110110	-0.375258	0.455253
10110111	-0.242072	0.352853
10111000	-0.498501	1.328103
10111001	-0.496854	1.034589

10111010	-0.351667	0.652324
10111011	-0.454845	0.854758
10111100	-0.278962	0.076488
10111101	-0.267573	0.245109
10111110	-0.374077	0.452024
10111111	-0.248176	0.363324
11000000	-1.443706	-0.533189
11000001	-1.269957	-0.814447
11000010	-1.190815	-0.494955
11000011	-1.099458	-0.637493
11000100	-1.465098	-0.242389
11000101	-0.756113	-0.035702
11000110	-1.757959	-0.251458
11000111	-0.780617	-0.113362
11001000	-1.032269	-1.540287
11001001	-1.450983	-1.025801
11001010	-1.044843	-0.407507
11001011	-0.920903	-0.474471
11001100	-1.061180	-0.094137
11001101	-0.942993	-0.109431
11001110	-1.146865	-0.181476
11001111	-0.863666	-0.236933
11010000	-1.028531	-1.046265
11010001	-0.903477	-0.907951
11010010	-0.580224	-0.575049
11010011	-0.741607	-0.728471
11010100	-0.418728	-0.083169
11010101	-0.537914	-0.122315
11010110	-0.581523	-0.384883
11010111	-0.655016	-0.231039
11011000	-0.844978	-1.282582
11011001	-0.713419	-0.974473
11011010	-0.662139	-0.570492
11011011	-0.764324	-0.614172
11011100	-0.401000	-0.062964
11011101	-0.510837	-0.125696
11011110	-0.576609	-0.374709
11011111	-0.692682	-0.292587
11100000	-0.276792	-1.794144
11100001	-0.158046	-1.018387
11100010	-0.104813	-0.702356
11100011	-0.124613	-0.885016
11100100	-0.110294	-0.045410
11100101	-0.068892	-0.234221
11100110	-0.112344	-0.534452
11100111	-0.089452	-0.398340
11101000	-0.132300	-1.285556
11101001	-0.180106	-1.107457

11101010	-0.190850	-0.723373
11101011	-0.170166	-0.861137
11101100	-0.088520	-0.064328
11101101	-0.063584	-0.193067
11101110	-0.118919	-0.539605
11101111	-0.097923	-0.408426
11110000	-0.215811	-1.558150
11110001	-0.404454	-1.021596
11110010	-0.411119	-0.597529
11110011	-0.429107	-0.835089
11110100	-0.269636	-0.105598
11110101	-0.260922	-0.234821
11110110	-0.375258	-0.455253
11110111	-0.242072	-0.352853
11111000	-0.498501	-1.328103
11111001	-0.496854	-1.034589
11111010	-0.351667	-0.652324
11111011	-0.454845	-0.854758
11111100	-0.278962	-0.076488
11111101	-0.267573	-0.245109
11111110	-0.374077	-0.452024
11111111	-0.248176	-0.363324

[00141]

Table 21A

SYMBOL COORDINATE BITS	X	Y
00000000	0.975369	1.374032
00000001	1.481139	0.719889
00000010	1.218020	0.537432
00000011	1.572273	1.013574
00000100	1.187472	0.140021
00000101	1.528894	0.437163
00000110	1.209428	0.325388
00000111	1.451803	0.133447
00001000	1.150324	0.991883
00001001	0.920560	1.027887
00001010	1.130859	0.690274
00001011	0.935148	0.791094
00001100	1.046905	0.109020
00001101	0.905564	0.126090
00001110	0.986845	0.392801
00001111	0.888567	0.278893
00010000	0.311973	1.734362
00010001	0.529664	1.037246
00010010	0.623019	0.619800
00010011	0.545408	0.794517
00010100	0.590997	0.100302

00010101	0.593410	0.246925
00010110	0.607152	0.477790
00010111	0.629036	0.343531
00011000	0.563423	1.365187
00011001	0.710907	1.103897
00011010	0.763953	0.637666
00011011	0.728679	0.837901
00011100	0.699119	0.052387
00011101	0.778520	0.167574
00011110	0.841139	0.487476
00011111	0.768298	0.365852
00100000	0.127333	1.155716
00100001	0.307801	1.071269
00100010	0.054226	0.569000
00100011	0.045338	0.681811
00100100	0.028860	0.067281
00100101	0.073608	0.181658
00100110	0.036820	0.425876
00100111	0.052368	0.277893
00101000	0.043419	0.999378
00101001	0.134293	0.871130
00101010	0.167741	0.582866
00101011	0.144323	0.745869
00101100	0.216884	0.055250
00101101	0.186854	0.164842
00101110	0.160698	0.411437
00101111	0.184735	0.310456
00110000	0.173083	1.310422
00110001	0.373110	0.990945
00110010	0.442036	0.572513
00110011	0.450171	0.761992
00110100	0.448273	0.078434
00110101	0.429733	0.223957
00110110	0.433525	0.483009
00110111	0.442487	0.351997
00111000	0.234057	1.493126
00111001	0.245349	0.871117
00111010	0.278032	0.601780
00111011	0.299117	0.752566
00111100	0.343828	0.049983
00111101	0.307660	0.197631
00111110	0.256888	0.459299
00111111	0.301477	0.340566
01000000	0.975369	-1.374032
01000001	1.481139	-0.719889
01000010	1.218020	-0.537432
01000011	1.572273	-1.013574
01000100	1.187472	-0.140021

01000101	1.528894	-0.437163
01000110	1.209428	-0.325388
01000111	1.451803	-0.133447
01001000	1.150324	-0.991883
01001001	0.920560	-1.027887
01001010	1.130859	-0.690274
01001011	0.935148	-0.791094
01001100	1.046905	-0.109020
01001101	0.905564	-0.126090
01001110	0.986845	-0.392801
01001111	0.888567	-0.278893
01010000	0.311973	-1.734362
01010001	0.529664	-1.037246
01010010	0.623019	-0.619800
01010011	0.545408	-0.794517
01010100	0.590997	-0.100302
01010101	0.593410	-0.246925
01010110	0.607152	-0.477790
01010111	0.629036	-0.343531
01011000	0.563423	-1.365187
01011001	0.710907	-1.103897
01011010	0.763953	-0.637666
01011011	0.728679	-0.837901
01011100	0.699119	-0.052387
01011101	0.778520	-0.167574
01011110	0.841139	-0.487476
01011111	0.768298	-0.365852
01100000	0.127333	-1.155716
01100001	0.307801	-1.071269
01100010	0.054226	-0.569000
01100011	0.045338	-0.681811
01100100	0.028860	-0.067281
01100101	0.073608	-0.181658
01100110	0.036820	-0.425876
01100111	0.052368	-0.277893
01101000	0.043419	-0.999378
01101001	0.134293	-0.871130
01101010	0.167741	-0.582866
01101011	0.144323	-0.745869
01101100	0.216884	-0.055250
01101101	0.186854	-0.164842
01101110	0.160698	-0.411437
01101111	0.184735	-0.310456
01110000	0.173083	-1.310422
01110001	0.373110	-0.990945
01110010	0.442036	-0.572513
01110011	0.450171	-0.761992
01110100	0.448273	-0.078434

01110101	0.429733	-0.223957
01110110	0.433525	-0.483009
01110111	0.442487	-0.351997
01111000	0.234057	-1.493126
01111001	0.245349	-0.871117
01111010	0.278032	-0.601780
01111011	0.299117	-0.752566
01111100	0.343828	-0.049983
01111101	0.307660	-0.197631
01111110	0.256888	-0.459299
01111111	0.301477	-0.340566
10000000	-0.975369	1.374032
10000001	-1.481139	0.719889
10000010	-1.218020	0.537432
10000011	-1.572273	1.013574
10000100	-1.187472	0.140021
10000101	-1.528894	0.437163
10000110	-1.209428	0.325388
10000111	-1.451803	0.133447
10001000	-1.150324	0.991883
10001001	-0.920560	1.027887
10001010	-1.130859	0.690274
10001011	-0.935148	0.791094
10001100	-1.046905	0.109020
10001101	-0.905564	0.126090
10001110	-0.986845	0.392801
10001111	-0.888567	0.278893
10010000	-0.311973	1.734362
10010001	-0.529664	1.037246
10010010	-0.623019	0.619800
10010011	-0.545408	0.794517
10010100	-0.590997	0.100302
10010101	-0.593410	0.246925
10010110	-0.607152	0.477790
10010111	-0.629036	0.343531
10011000	-0.563423	1.365187
10011001	-0.710907	1.103897
10011010	-0.763953	0.637666
10011011	-0.728679	0.837901
10011100	-0.699119	0.052387
10011101	-0.778520	0.167574
10011110	-0.841139	0.487476
10011111	-0.768298	0.365852
10100000	-0.127333	1.155716
10100001	-0.307801	1.071269
10100010	-0.054226	0.569000
10100011	-0.045338	0.681811
10100100	-0.028860	0.067281

10100101	-0.073608	0.181658
10100110	-0.036820	0.425876
10100111	-0.052368	0.277893
10101000	-0.043419	0.999378
10101001	-0.134293	0.871130
10101010	-0.167741	0.582866
10101011	-0.144323	0.745869
10101100	-0.216884	0.055250
10101101	-0.186854	0.164842
10101110	-0.160698	0.411437
10101111	-0.184735	0.310456
10110000	-0.173083	1.310422
10110001	-0.373110	0.990945
10110010	-0.442036	0.572513
10110011	-0.450171	0.761992
10110100	-0.448273	0.078434
10110101	-0.429733	0.223957
10110110	-0.433525	0.483009
10110111	-0.442487	0.351997
10111000	-0.234057	1.493126
10111001	-0.245349	0.871117
10111010	-0.278032	0.601780
10111011	-0.299117	0.752566
10111100	-0.343828	0.049983
10111101	-0.307660	0.197631
10111110	-0.256888	0.459299
10111111	-0.301477	0.340566
11000000	-0.975369	-1.374032
11000001	-1.481139	-0.719889
11000010	-1.218020	-0.537432
11000011	-1.572273	-1.013574
11000100	-1.187472	-0.140021
11000101	-1.528894	-0.437163
11000110	-1.209428	-0.325388
11000111	-1.451803	-0.133447
11001000	-1.150324	-0.991883
11001001	-0.920560	-1.027887
11001010	-1.130859	-0.690274
11001011	-0.935148	-0.791094
11001100	-1.046905	-0.109020
11001101	-0.905564	-0.126090
11001110	-0.986845	-0.392801
11001111	-0.888567	-0.278893
11010000	-0.311973	-1.734362
11010001	-0.529664	-1.037246
11010010	-0.623019	-0.619800
11010011	-0.545408	-0.794517
11010100	-0.590997	-0.100302

11010101	-0.593410	-0.246925
11010110	-0.607152	-0.477790
11010111	-0.629036	-0.343531
11011000	-0.563423	-1.365187
11011001	-0.710907	-1.103897
11011010	-0.763953	-0.637666
11011011	-0.728679	-0.837901
11011100	-0.699119	-0.052387
11011101	-0.778520	-0.167574
11011110	-0.841139	-0.487476
11011111	-0.768298	-0.365852
11100000	-0.127333	-1.155716
11100001	-0.307801	-1.071269
11100010	-0.054226	-0.569000
11100011	-0.045338	-0.681811
11100100	-0.028860	-0.067281
11100101	-0.073608	-0.181658
11100110	-0.036820	-0.425876
11100111	-0.052368	-0.277893
11101000	-0.043419	-0.999378
11101001	-0.134293	-0.871130
11101010	-0.167741	-0.582866
11101011	-0.144323	-0.745869
11101100	-0.216884	-0.055250
11101101	-0.186854	-0.164842
11101110	-0.160698	-0.411437
11101111	-0.184735	-0.310456
11110000	-0.173083	-1.310422
11110001	-0.373110	-0.990945
11110010	-0.442036	-0.572513
11110011	-0.450171	-0.761992
11110100	-0.448273	-0.078434
11110101	-0.429733	-0.223957
11110110	-0.433525	-0.483009
11110111	-0.442487	-0.351997
11111000	-0.234057	-1.493126
11111001	-0.245349	-0.871117
11111010	-0.278032	-0.601780
11111011	-0.299117	-0.752566
11111100	-0.343828	-0.049983
11111101	-0.307660	-0.197631
11111110	-0.256888	-0.459299
11111111	-0.301477	-0.340566

[00142]

Table 21B

SYMBOL COORDINATE BITS	X	Y
00000000	1.305348	0.483686
00000001	1.385995	0.667682
00000010	1.079272	0.658809
00000011	0.952913	0.612614
00000100	1.407955	0.162208
00000101	0.743036	0.093077
00000110	1.664544	0.277796
00000111	0.700449	0.240646
00001000	1.057746	1.546204
00001001	1.364655	0.938592
00001010	1.159648	0.316961
00001011	0.982972	0.392157
00001100	0.953812	0.086185
00001101	0.865433	0.202042
00001110	1.125799	0.109188
00001111	0.884989	0.377701
00010000	0.998762	0.983475
00010001	0.752453	0.974676
00010010	0.441612	0.542222
00010011	0.762558	0.774613
00010100	0.542471	0.050180
00010101	0.566038	0.143317
00010110	0.540193	0.413002
00010111	0.564199	0.285899
00011000	0.861634	1.190812
00011001	0.496817	1.189830
00011010	0.530301	0.608420
00011011	0.692344	0.638263
00011100	0.415573	0.053395
00011101	0.452110	0.157963
00011110	0.613213	0.496838
00011111	0.742823	0.455828
00100000	0.299991	1.828537
00100001	0.234715	1.027308
00100010	0.101242	0.654205
00100011	0.216049	0.940458
00100100	0.149232	0.065752
00100101	0.079653	0.216567
00100110	0.103154	0.579257
00100111	0.075918	0.328242
00101000	0.253926	1.421727
00101001	0.068626	1.125115
00101010	0.102520	0.767709
00101011	0.074965	0.884980
00101100	0.075988	0.053940
00101101	0.026120	0.146113

00101110	0.089699	0.491963
00101111	0.071658	0.412884
00110000	0.292967	1.624754
00110001	0.492228	1.002755
00110010	0.286607	0.646480
00110011	0.503324	0.866300
00110100	0.230317	0.127990
00110101	0.244364	0.221890
00110110	0.252236	0.527795
00110111	0.199080	0.311608
00111000	0.838132	1.415418
00111001	0.163432	1.243384
00111010	0.321389	0.731153
00111011	0.426149	0.802687
00111100	0.302291	0.076239
00111101	0.350515	0.224507
00111110	0.311265	0.430253
00111111	0.333302	0.349304
01000000	1.305348	-0.483686
01000001	1.385995	-0.667682
01000010	1.079272	-0.658809
01000011	0.952913	-0.612614
01000100	1.407955	-0.162208
01000101	0.743036	-0.093077
01000110	1.664544	-0.277796
01000111	0.700449	-0.240646
01001000	1.057746	-1.546204
01001001	1.364655	-0.938592
01001010	1.159648	-0.316961
01001011	0.982972	-0.392157
01001100	0.953812	-0.086185
01001101	0.865433	-0.202042
01001110	1.125799	-0.109188
01001111	0.884989	-0.377701
01010000	0.998762	-0.983475
01010001	0.752453	-0.974676
01010010	0.441612	-0.542222
01010011	0.762558	-0.774613
01010100	0.542471	-0.050180
01010101	0.566038	-0.143317
01010110	0.540193	-0.413002
01010111	0.564199	-0.285899
01011000	0.861634	-1.190812
01011001	0.496817	-1.189830
01011010	0.530301	-0.608420
01011011	0.692344	-0.638263
01011100	0.415573	-0.053395
01011101	0.452110	-0.157963

01011110	0.613213	-0.496838
01011111	0.742823	-0.455828
01100000	0.299991	-1.828537
01100001	0.234715	-1.027308
01100010	0.101242	-0.654205
01100011	0.216049	-0.940458
01100100	0.149232	-0.065752
01100101	0.079653	-0.216567
01100110	0.103154	-0.579257
01100111	0.075918	-0.328242
01101000	0.253926	-1.421727
01101001	0.068626	-1.125115
01101010	0.102520	-0.767709
01101011	0.074965	-0.884980
01101100	0.075988	-0.053940
01101101	0.026120	-0.146113
01101110	0.089699	-0.491963
01101111	0.071658	-0.412884
01110000	0.292967	-1.624754
01110001	0.492228	-1.002755
01110010	0.286607	-0.646480
01110011	0.503324	-0.866300
01110100	0.230317	-0.127990
01110101	0.244364	-0.221890
01110110	0.252236	-0.527795
01110111	0.199080	-0.311608
01111000	0.838132	-1.415418
01111001	0.163432	-1.243384
01111010	0.321389	-0.731153
01111011	0.426149	-0.802687
01111100	0.302291	-0.076239
01111101	0.350515	-0.224507
01111110	0.311265	-0.430253
01111111	0.333302	-0.349304
10000000	-1.305348	0.483686
10000001	-1.385995	0.667682
10000010	-1.079272	0.658809
10000011	-0.952913	0.612614
10000100	-1.407955	0.162208
10000101	-0.743036	0.093077
10000110	-1.664544	0.277796
10000111	-0.700449	0.240646
10001000	-1.057746	1.546204
10001001	-1.364655	0.938592
10001010	-1.159648	0.316961
10001011	-0.982972	0.392157
10001100	-0.953812	0.086185
10001101	-0.865433	0.202042

10001110	-1.125799	0.109188
10001111	-0.884989	0.377701
10010000	-0.998762	0.983475
10010001	-0.752453	0.974676
10010010	-0.441612	0.542222
10010011	-0.762558	0.774613
10010100	-0.542471	0.050180
10010101	-0.566038	0.143317
10010110	-0.540193	0.413002
10010111	-0.564199	0.285899
10011000	-0.861634	1.190812
10011001	-0.496817	1.189830
10011010	-0.530301	0.608420
10011011	-0.692344	0.638263
10011100	-0.415573	0.053395
10011101	-0.452110	0.157963
10011110	-0.613213	0.496838
10011111	-0.742823	0.455828
10100000	-0.299991	1.828537
10100001	-0.234715	1.027308
10100010	-0.101242	0.654205
10100011	-0.216049	0.940458
10100100	-0.149232	0.065752
10100101	-0.079653	0.216567
10100110	-0.103154	0.579257
10100111	-0.075918	0.328242
10101000	-0.253926	1.421727
10101001	-0.068626	1.125115
10101010	-0.102520	0.767709
10101011	-0.074965	0.884980
10101100	-0.075988	0.053940
10101101	-0.026120	0.146113
10101110	-0.089699	0.491963
10101111	-0.071658	0.412884
10110000	-0.292967	1.624754
10110001	-0.492228	1.002755
10110010	-0.286607	0.646480
10110011	-0.503324	0.866300
10110100	-0.230317	0.127990
10110101	-0.244364	0.221890
10110110	-0.252236	0.527795
10110111	-0.199080	0.311608
10111000	-0.838132	1.415418
10111001	-0.163432	1.243384
10111010	-0.321389	0.731153
10111011	-0.426149	0.802687
10111100	-0.302291	0.076239
10111101	-0.350515	0.224507

10111110	-0.311265	0.430253
10111111	-0.333302	0.349304
11000000	-1.305348	-0.483686
11000001	-1.385995	-0.667682
11000010	-1.079272	-0.658809
11000011	-0.952913	-0.612614
11000100	-1.407955	-0.162208
11000101	-0.743036	-0.093077
11000110	-1.664544	-0.277796
11000111	-0.700449	-0.240646
11001000	-1.057746	-1.546204
11001001	-1.364655	-0.938592
11001010	-1.159648	-0.316961
11001011	-0.982972	-0.392157
11001100	-0.953812	-0.086185
11001101	-0.865433	-0.202042
11001110	-1.125799	-0.109188
11001111	-0.884989	-0.377701
11010000	-0.998762	-0.983475
11010001	-0.752453	-0.974676
11010010	-0.441612	-0.542222
11010011	-0.762558	-0.774613
11010100	-0.542471	-0.050180
11010101	-0.566038	-0.143317
11010110	-0.540193	-0.413002
11010111	-0.564199	-0.285899
11011000	-0.861634	-1.190812
11011001	-0.496817	-1.189830
11011010	-0.530301	-0.608420
11011011	-0.692344	-0.638263
11011100	-0.415573	-0.053395
11011101	-0.452110	-0.157963
11011110	-0.613213	-0.496838
11011111	-0.742823	-0.455828
11100000	-0.299991	-1.828537
11100001	-0.234715	-1.027308
11100010	-0.101242	-0.654205
11100011	-0.216049	-0.940458
11100100	-0.149232	-0.065752
11100101	-0.079653	-0.216567
11100110	-0.103154	-0.579257
11100111	-0.075918	-0.328242
11101000	-0.253926	-1.421727
11101001	-0.068626	-1.125115
11101010	-0.102520	-0.767709
11101011	-0.074965	-0.884980
11101100	-0.075988	-0.053940
11101101	-0.026120	-0.146113

11101110	-0.089699	-0.491963
11101111	-0.071658	-0.412884
11110000	-0.292967	-1.624754
11110001	-0.492228	-1.002755
11110010	-0.286607	-0.646480
11110011	-0.503324	-0.866300
11110100	-0.230317	-0.127990
11110101	-0.244364	-0.221890
11110110	-0.252236	-0.527795
11110111	-0.199080	-0.311608
11111000	-0.838132	-1.415418
11111001	-0.163432	-1.243384
11111010	-0.321389	-0.731153
11111011	-0.426149	-0.802687
11111100	-0.302291	-0.076239
11111101	-0.350515	-0.224507
11111110	-0.311265	-0.430253
11111111	-0.333302	-0.349304

[00143]

Table 21C

SYMBOL COORDINATE BITS	X	Y
0000	0.270682	0.962663
0001	0.253573	0.248544
0010	0.707302	0.706911
0011	0.961176	0.275819
0100	0.270682	-0.962663
0101	0.253573	-0.248544
0110	0.707302	-0.706911
0111	0.961176	-0.275819
1000	-0.270682	0.962663
1001	-0.253573	0.248544
1010	-0.707302	0.706911
1011	-0.961176	0.275819
1100	-0.270682	-0.962663
1101	-0.253573	-0.248544
1110	-0.707302	-0.706911
1111	-0.961176	-0.275819

[00144]

Table 22

SYMBOL COORDINATE BITS	X	Y
00000	0.358210	0.139403
00001	0.235261	0.421763
00010	0.930790	0.364753
00011	0.787656	0.614713

00100	0.125482	0.991921
00101	0.382784	0.922993
00110	0.990631	0.136566
00111	0.626638	0.778830
01000	0.358210	-0.139403
01001	0.235261	-0.421763
01010	0.930790	-0.364753
01011	0.787656	-0.614713
01100	0.125482	-0.991921
01101	0.382784	-0.922993
01110	0.990631	-0.136566
01111	0.626638	-0.778830
10000	-0.358210	0.139403
10001	-0.235261	0.421763
10010	-0.930790	0.364753
10011	-0.787656	0.614713
10100	-0.125482	0.991921
10101	-0.382784	0.922993
10110	-0.990631	0.136566
10111	-0.626638	0.778830
11000	-0.358210	-0.139403
11001	-0.235261	-0.421763
11010	-0.930790	-0.364753
11011	-0.787656	-0.614713
11100	-0.125482	-0.991921
11101	-0.382784	-0.922993
11110	-0.990631	-0.136566
11111	-0.626638	-0.778830

[00145]

Table 23

SYMBOL COORDINATE BITS	X	Y
000000	0.894480	0.445822
000001	0.890395	0.455110
000010	0.984821	0.172554
000011	0.985411	0.170142
000100	0.730858	0.679601
000101	0.731787	0.681533
000110	0.594365	0.254018
000111	0.545682	0.183541
001000	0.172908	0.983278
001001	0.144365	0.988438
001010	0.103984	0.512065
001011	0.110135	0.138733
001100	0.453133	0.891044
001101	0.458751	0.888174
001110	0.237903	0.413635

001111	0.327635	0.213996
010000	0.894480	-0.445822
010001	0.890395	-0.455110
010010	0.984821	-0.172554
010011	0.985411	-0.170142
010100	0.730858	-0.679601
010101	0.731787	-0.681533
010110	0.594365	-0.254018
010111	0.545682	-0.183541
011000	0.172908	-0.983278
011001	0.144365	-0.988438
011010	0.103984	-0.512065
011011	0.110135	-0.138733
011100	0.453133	-0.891044
011101	0.458751	-0.888174
011110	0.237903	-0.413635
011111	0.327635	-0.213996
100000	-0.894480	0.445822
100001	-0.890395	0.455110
100010	-0.984821	0.172554
100011	-0.985411	0.170142
100100	-0.730858	0.679601
100101	-0.731787	0.681533
100110	-0.594365	0.254018
100111	-0.545682	0.183541
101000	-0.172908	0.983278
101001	-0.144365	0.988438
101010	-0.103984	0.512065
101011	-0.110135	0.138733
101100	-0.453133	0.891044
101101	-0.458751	0.888174
101110	-0.237903	0.413635
101111	-0.327635	0.213996
110000	-0.894480	-0.445822
110001	-0.890395	-0.455110
110010	-0.984821	-0.172554
110011	-0.985411	-0.170142
110100	-0.730858	-0.679601
110101	-0.731787	-0.681533
110110	-0.594365	-0.254018
110111	-0.545682	-0.183541
111000	-0.172908	-0.983278
111001	-0.144365	-0.988438
111010	-0.103984	-0.512065
111011	-0.110135	-0.138733
111100	-0.453133	-0.891044
111101	-0.458751	-0.888174
111110	-0.237903	-0.413635

[00146]	111111	-0.327635	-0.213996
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Table 24A

SYMBOL COORDINATE BITS	X	Y
000000	0.847425	0.528328
000001	0.724032	0.689761
000010	0.949712	0.313126
000011	0.993100	0.116019
000100	0.561795	0.514360
000101	0.575688	0.817191
000110	0.586661	0.291101
000111	0.623692	0.093506
001000	0.114854	0.716644
001001	0.141761	0.989893
001010	0.099426	0.429732
001011	0.092178	0.159156
001100	0.344522	0.588449
001101	0.385307	0.921869
001110	0.314441	0.342702
001111	0.309723	0.111529
010000	0.847425	-0.528328
010001	0.724032	-0.689761
010010	0.949712	-0.313126
010011	0.993100	-0.116019
010100	0.561795	-0.514360
010101	0.575688	-0.817191
010110	0.586661	-0.291101
010111	0.623692	-0.093506
011000	0.114854	-0.716644
011001	0.141761	-0.989893
011010	0.099426	-0.429732
011011	0.092178	-0.159156
011100	0.344522	-0.588449
011101	0.385307	-0.921869
011110	0.314441	-0.342702
011111	0.309723	-0.111529
100000	-0.847425	0.528328
100001	-0.724032	0.689761
100010	-0.949712	0.313126
100011	-0.993100	0.116019
100100	-0.561795	0.514360
100101	-0.575688	0.817191
100110	-0.586661	0.291101
100111	-0.623692	0.093506
101000	-0.114854	0.716644
101001	-0.141761	0.989893

101010	-0.099426	0.429732
101011	-0.092178	0.159156
101100	-0.344522	0.588449
101101	-0.385307	0.921869
101110	-0.314441	0.342702
101111	-0.309723	0.111529
110000	-0.847425	-0.528328
110001	-0.724032	-0.689761
110010	-0.949712	-0.313126
110011	-0.993100	-0.116019
110100	-0.561795	-0.514360
110101	-0.575688	-0.817191
110110	-0.586661	-0.291101
110111	-0.623692	-0.093506
111000	-0.114854	-0.716644
111001	-0.141761	-0.989893
111010	-0.099426	-0.429732
111011	-0.092178	-0.159156
111100	-0.344522	-0.588449
111101	-0.385307	-0.921869
111110	-0.314441	-0.342702
111111	-0.309723	-0.111529

[00147]

Table 24B

SYMBOL COORDINATE BITS	X	Y
000000	0.089757	0.995927
000001	0.871842	0.489415
000010	0.992114	0.111242
000011	0.947926	0.318276
000100	0.624995	0.779546
000101	0.766239	0.642268
000110	0.631056	0.095979
000111	0.627559	0.304108
001000	0.276549	0.960689
001001	0.111329	0.622856
001010	0.150023	0.138919
001011	0.116201	0.363483
001100	0.453255	0.891381
001101	0.390500	0.599215
001110	0.332423	0.100418
001111	0.436529	0.401382
010000	0.089757	-0.995927
010001	0.871842	-0.489415
010010	0.992114	-0.111242
010011	0.947926	-0.318276
010100	0.624995	-0.779546

010101	0.766239	-0.642268
010110	0.631056	-0.095979
010111	0.627559	-0.304108
011000	0.276549	-0.960689
011001	0.111329	-0.622856
011010	0.150023	-0.138919
011011	0.116201	-0.363483
011100	0.453255	-0.891381
011101	0.390500	-0.599215
011110	0.332423	-0.100418
011111	0.436529	-0.401382
100000	-0.089757	0.995927
100001	-0.871842	0.489415
100010	-0.992114	0.111242
100011	-0.947926	0.318276
100100	-0.624995	0.779546
100101	-0.766239	0.642268
100110	-0.631056	0.095979
100111	-0.627559	0.304108
101000	-0.276549	0.960689
101001	-0.111329	0.622856
101010	-0.150023	0.138919
101011	-0.116201	0.363483
101100	-0.453255	0.891381
101101	-0.390500	0.599215
101110	-0.332423	0.100418
101111	-0.436529	0.401382
110000	-0.089757	-0.995927
110001	-0.871842	-0.489415
110010	-0.992114	-0.111242
110011	-0.947926	-0.318276
110100	-0.624995	-0.779546
110101	-0.766239	-0.642268
110110	-0.631056	-0.095979
110111	-0.627559	-0.304108
111000	-0.276549	-0.960689
111001	-0.111329	-0.622856
111010	-0.150023	-0.138919
111011	-0.116201	-0.363483
111100	-0.453255	-0.891381
111101	-0.390500	-0.599215
111110	-0.332423	-0.100418
111111	-0.436529	-0.401382

[00148]

Table 24C

SYMBOL COORDINATE BITS	X	Y
000000	0.825394	0.564557
000001	0.679474	0.733233
000010	0.934649	0.354296
000011	0.992113	0.124306
000100	0.547499	0.538212
000101	0.512966	0.857155
000110	0.667874	0.319131
000111	0.704023	0.112315
001000	0.105064	0.673007
001001	0.104623	0.989353
001010	0.128136	0.390102
001011	0.131864	0.120209
001100	0.337537	0.644600
001101	0.310475	0.949750
001110	0.364337	0.376712
001111	0.404674	0.115168
010000	0.825394	-0.564557
010001	0.679474	-0.733233
010010	0.934649	-0.354296
010011	0.992113	-0.124306
010100	0.547499	-0.538212
010101	0.512966	-0.857155
010110	0.667874	-0.319131
010111	0.704023	-0.112315
011000	0.105064	-0.673007
011001	0.104623	-0.989353
011010	0.128136	-0.390102
011011	0.131864	-0.120209
011100	0.337537	-0.644600
011101	0.310475	-0.949750
011110	0.364337	-0.376712
011111	0.404674	-0.115168
100000	-0.825394	0.564557
100001	-0.679474	0.733233
100010	-0.934649	0.354296
100011	-0.992113	0.124306
100100	-0.547499	0.538212
100101	-0.512966	0.857155
100110	-0.667874	0.319131
100111	-0.704023	0.112315
101000	-0.105064	0.673007
101001	-0.104623	0.989353
101010	-0.128136	0.390102
101011	-0.131864	0.120209
101100	-0.337537	0.644600
101101	-0.310475	0.949750

101110	-0.364337	0.376712
101111	-0.404674	0.115168
110000	-0.825394	-0.564557
110001	-0.679474	-0.733233
110010	-0.934649	-0.354296
110011	-0.992113	-0.124306
110100	-0.547499	-0.538212
110101	-0.512966	-0.857155
110110	-0.667874	-0.319131
110111	-0.704023	-0.112315
111000	-0.105064	-0.673007
111001	-0.104623	-0.989353
111010	-0.128136	-0.390102
111011	-0.131864	-0.120209
111100	-0.337537	-0.644600
111101	-0.310475	-0.949750
111110	-0.364337	-0.376712
111111	-0.404674	-0.115168

[00149]

Table 24D

SYMBOL COORDINATE BITS	X	Y
0000000	0.401618	0.182455
0000001	0.432271	0.238332
0000010	0.210211	0.077897
0000011	0.188527	0.106144
0000100	0.690013	0.077217
0000101	0.658899	0.105155
0000110	0.991792	0.108289
0000111	0.994471	0.097881
0001000	0.266643	0.496767
0001001	0.335273	0.407525
0001010	0.087396	0.426683
0001011	0.081485	0.285545
0001100	0.157416	0.730291
0001101	0.144214	0.989148
0001110	0.075548	0.683943
0001111	0.123780	0.992051
0010000	0.632012	0.419775
0010001	0.581779	0.400034
0010010	0.818321	0.574028
0010011	0.808932	0.585710
0010100	0.772679	0.293599
0010101	0.753516	0.255345
0010110	0.937056	0.349179
0010111	0.937889	0.344474

0011000	0.484355	0.600452
0011001	0.469372	0.569456
0011010	0.650758	0.755708
0011011	0.663597	0.743786
0011100	0.362030	0.806477
0011101	0.324343	0.942537
0011110	0.457817	0.888570
0011111	0.394670	0.918198
0100000	0.401618	-0.182455
0100001	0.432271	-0.238332
0100010	0.210211	-0.077897
0100011	0.188527	-0.106144
0100100	0.690013	-0.077217
0100101	0.658899	-0.105155
0100110	0.991792	-0.108289
0100111	0.994471	-0.097881
0101000	0.266643	-0.496767
0101001	0.335273	-0.407525
0101010	0.087396	-0.426683
0101011	0.081485	-0.285545
0101100	0.157416	-0.730291
0101101	0.144214	-0.989148
0101110	0.075548	-0.683943
0101111	0.123780	-0.992051
0110000	0.632012	-0.419775
0110001	0.581779	-0.400034
0110010	0.818321	-0.574028
0110011	0.808932	-0.585710
0110100	0.772679	-0.293599
0110101	0.753516	-0.255345
0110110	0.937056	-0.349179
0110111	0.937889	-0.344474
0111000	0.484355	-0.600452
0111001	0.469372	-0.569456
0111010	0.650758	-0.755708
0111011	0.663597	-0.743786
0111100	0.362030	-0.806477
0111101	0.324343	-0.942537
0111110	0.457817	-0.888570
0111111	0.394670	-0.918198
1000000	-0.401618	0.182455
1000001	-0.432271	0.238332
1000010	-0.210211	0.077897
1000011	-0.188527	0.106144
1000100	-0.690013	0.077217
1000101	-0.658899	0.105155
1000110	-0.991792	0.108289
1000111	-0.994471	0.097881

1001000	-0.266643	0.496767
1001001	-0.335273	0.407525
1001010	-0.087396	0.426683
1001011	-0.081485	0.285545
1001100	-0.157416	0.730291
1001101	-0.144214	0.989148
1001110	-0.075548	0.683943
1001111	-0.123780	0.992051
1010000	-0.632012	0.419775
1010001	-0.581779	0.400034
1010010	-0.818321	0.574028
1010011	-0.808932	0.585710
1010100	-0.772679	0.293599
1010101	-0.753516	0.255345
1010110	-0.937056	0.349179
1010111	-0.937889	0.344474
1011000	-0.484355	0.600452
1011001	-0.469372	0.569456
1011010	-0.650758	0.755708
1011011	-0.663597	0.743786
1011100	-0.362030	0.806477
1011101	-0.324343	0.942537
1011110	-0.457817	0.888570
1011111	-0.394670	0.918198
1100000	-0.401618	-0.182455
1100001	-0.432271	-0.238332
1100010	-0.210211	-0.077897
1100011	-0.188527	-0.106144
1100100	-0.690013	-0.077217
1100101	-0.658899	-0.105155
1100110	-0.991792	-0.108289
1100111	-0.994471	-0.097881
1101000	-0.266643	-0.496767
1101001	-0.335273	-0.407525
1101010	-0.087396	-0.426683
1101011	-0.081485	-0.285545
1101100	-0.157416	-0.730291
1101101	-0.144214	-0.989148
1101110	-0.075548	-0.683943
1101111	-0.123780	-0.992051
1110000	-0.632012	-0.419775
1110001	-0.581779	-0.400034
1110010	-0.818321	-0.574028
1110011	-0.808932	-0.585710
1110100	-0.772679	-0.293599
1110101	-0.753516	-0.255345
1110110	-0.937056	-0.349179
1110111	-0.937889	-0.344474

1111000	-0.484355	-0.600452
1111001	-0.469372	-0.569456
1111010	-0.650758	-0.755708
1111011	-0.663597	-0.743786
1111100	-0.362030	-0.806477
1111101	-0.324343	-0.942537
1111110	-0.457817	-0.888570
1111111	-0.394670	-0.918198

[00150]

Table 25A

SYMBOL COORDINATE BITS	X	Y
0000000	0.349139	0.084873
0000001	0.444253	0.223961
0000010	0.200465	0.076363
0000011	0.076729	0.165391
0000100	0.661752	0.074430
0000101	0.569082	0.152245
0000110	0.867463	0.058010
0000111	0.994165	0.101734
0001000	0.276140	0.483395
0001001	0.360395	0.354916
0001010	0.105450	0.423216
0001011	0.112712	0.306408
0001100	0.157400	0.694676
0001101	0.092859	0.872214
0001110	0.073573	0.584372
0001111	0.086593	0.996244
0010000	0.664424	0.454352
0010001	0.620132	0.459156
0010010	0.822650	0.566931
0010011	0.811832	0.583371
0010100	0.734535	0.287119
0010101	0.698954	0.273938
0010110	0.932816	0.357106
0010111	0.955383	0.292872
0011000	0.415243	0.605429
0011001	0.487527	0.551685
0011010	0.624474	0.780353
0011011	0.654058	0.755420
0011100	0.291362	0.740066
0011101	0.280086	0.955742
0011110	0.463177	0.885940
0011111	0.351608	0.935764
0100000	0.349139	-0.084873
0100001	0.444253	-0.223961
0100010	0.200465	-0.076363

0100011	0.076729	-0.165391
0100100	0.661752	-0.074430
0100101	0.569082	-0.152245
0100110	0.867463	-0.058010
0100111	0.994165	-0.101734
0101000	0.276140	-0.483395
0101001	0.360395	-0.354916
0101010	0.105450	-0.423216
0101011	0.112712	-0.306408
0101100	0.157400	-0.694676
0101101	0.092859	-0.872214
0101110	0.073573	-0.584372
0101111	0.086593	-0.996244
0110000	0.664424	-0.454352
0110001	0.620132	-0.459156
0110010	0.822650	-0.566931
0110011	0.811832	-0.583371
0110100	0.734535	-0.287119
0110101	0.698954	-0.273938
0110110	0.932816	-0.357106
0110111	0.955383	-0.292872
0111000	0.415243	-0.605429
0111001	0.487527	-0.551685
0111010	0.624474	-0.780353
0111011	0.654058	-0.755420
0111100	0.291362	-0.740066
0111101	0.280086	-0.955742
0111110	0.463177	-0.885940
0111111	0.351608	-0.935764
1000000	-0.349139	0.084873
1000001	-0.444253	0.223961
1000010	-0.200465	0.076363
1000011	-0.076729	0.165391
1000100	-0.661752	0.074430
1000101	-0.569082	0.152245
1000110	-0.867463	0.058010
1000111	-0.994165	0.101734
1001000	-0.276140	0.483395
1001001	-0.360395	0.354916
1001010	-0.105450	0.423216
1001011	-0.112712	0.306408
1001100	-0.157400	0.694676
1001101	-0.092859	0.872214
1001110	-0.073573	0.584372
1001111	-0.086593	0.996244
1010000	-0.664424	0.454352
1010001	-0.620132	0.459156
1010010	-0.822650	0.566931

1010011	-0.811832	0.583371
1010100	-0.734535	0.287119
1010101	-0.698954	0.273938
1010110	-0.932816	0.357106
1010111	-0.955383	0.292872
1011000	-0.415243	0.605429
1011001	-0.487527	0.551685
1011010	-0.624474	0.780353
1011011	-0.654058	0.755420
1011100	-0.291362	0.740066
1011101	-0.280086	0.955742
1011110	-0.463177	0.885940
1011111	-0.351608	0.935764
1100000	-0.349139	-0.084873
1100001	-0.444253	-0.223961
1100010	-0.200465	-0.076363
1100011	-0.076729	-0.165391
1100100	-0.661752	-0.074430
1100101	-0.569082	-0.152245
1100110	-0.867463	-0.058010
1100111	-0.994165	-0.101734
1101000	-0.276140	-0.483395
1101001	-0.360395	-0.354916
1101010	-0.105450	-0.423216
1101011	-0.112712	-0.306408
1101100	-0.157400	-0.694676
1101101	-0.092859	-0.872214
1101110	-0.073573	-0.584372
1101111	-0.086593	-0.996244
1110000	-0.664424	-0.454352
1110001	-0.620132	-0.459156
1110010	-0.822650	-0.566931
1110011	-0.811832	-0.583371
1110100	-0.734535	-0.287119
1110101	-0.698954	-0.273938
1110110	-0.932816	-0.357106
1110111	-0.955383	-0.292872
1111000	-0.415243	-0.605429
1111001	-0.487527	-0.551685
1111010	-0.624474	-0.780353
1111011	-0.654058	-0.755420
1111100	-0.291362	-0.740066
1111101	-0.280086	-0.955742
1111110	-0.463177	-0.885940
1111111	-0.351608	-0.935764

[00151]

Table 25B

SYMBOL COORDINATE BITS	X	Y
0000000	0.179332	0.062318
0000001	0.264529	0.196526
0000010	0.055320	0.109173
0000011	0.101863	0.235172
0000100	0.669962	0.075558
0000101	0.419174	0.070925
0000110	0.861092	0.104401
0000111	0.992390	0.118291
0001000	0.195476	0.575233
0001001	0.219531	0.412072
0001010	0.060970	0.560996
0001011	0.085387	0.369804
0001100	0.213900	0.756034
0001101	0.279980	0.959448
0001110	0.078356	0.804679
0001111	0.089502	0.994559
0010000	0.552393	0.333246
0010001	0.396346	0.273296
0010010	0.683752	0.404797
0010011	0.858560	0.511264
0010100	0.642493	0.197800
0010101	0.462109	0.164180
0010110	0.801694	0.290343
0010111	0.937916	0.339763
0011000	0.412951	0.509479
0011001	0.336567	0.413951
0011010	0.600289	0.546834
0011011	0.763765	0.644626
0011100	0.385655	0.691063
0011101	0.443902	0.896057
0011110	0.536473	0.674051
0011111	0.606478	0.795101
0100000	0.179332	-0.062318
0100001	0.264529	-0.196526
0100010	0.055320	-0.109173
0100011	0.101863	-0.235172
0100100	0.669962	-0.075558
0100101	0.419174	-0.070925
0100110	0.861092	-0.104401
0100111	0.992390	-0.118291
0101000	0.195476	-0.575233
0101001	0.219531	-0.412072
0101010	0.060970	-0.560996
0101011	0.085387	-0.369804
0101100	0.213900	-0.756034
0101101	0.279980	-0.959448

0101110	0.078356	-0.804679
0101111	0.089502	-0.994559
0110000	0.552393	-0.333246
0110001	0.396346	-0.273296
0110010	0.683752	-0.404797
0110011	0.858560	-0.511264
0110100	0.642493	-0.197800
0110101	0.462109	-0.164180
0110110	0.801694	-0.290343
0110111	0.937916	-0.339763
0111000	0.412951	-0.509479
0111001	0.336567	-0.413951
0111010	0.600289	-0.546834
0111011	0.763765	-0.644626
0111100	0.385655	-0.691063
0111101	0.443902	-0.896057
0111110	0.536473	-0.674051
0111111	0.606478	-0.795101
1000000	-0.179332	0.062318
1000001	-0.264529	0.196526
1000010	-0.055320	0.109173
1000011	-0.101863	0.235172
1000100	-0.669962	0.075558
1000101	-0.419174	0.070925
1000110	-0.861092	0.104401
1000111	-0.992390	0.118291
1001000	-0.195476	0.575233
1001001	-0.219531	0.412072
1001010	-0.060970	0.560996
1001011	-0.085387	0.369804
1001100	-0.213900	0.756034
1001101	-0.279980	0.959448
1001110	-0.078356	0.804679
1001111	-0.089502	0.994559
1010000	-0.552393	0.333246
1010001	-0.396346	0.273296
1010010	-0.683752	0.404797
1010011	-0.858560	0.511264
1010100	-0.642493	0.197800
1010101	-0.462109	0.164180
1010110	-0.801694	0.290343
1010111	-0.937916	0.339763
1011000	-0.412951	0.509479
1011001	-0.336567	0.413951
1011010	-0.600289	0.546834
1011011	-0.763765	0.644626
1011100	-0.385655	0.691063
1011101	-0.443902	0.896057

1011110	-0.536473	0.674051
1011111	-0.606478	0.795101
1100000	-0.179332	-0.062318
1100001	-0.264529	-0.196526
1100010	-0.055320	-0.109173
1100011	-0.101863	-0.235172
1100100	-0.669962	-0.075558
1100101	-0.419174	-0.070925
1100110	-0.861092	-0.104401
1100111	-0.992390	-0.118291
1101000	-0.195476	-0.575233
1101001	-0.219531	-0.412072
1101010	-0.060970	-0.560996
1101011	-0.085387	-0.369804
1101100	-0.213900	-0.756034
1101101	-0.279980	-0.959448
1101110	-0.078356	-0.804679
1101111	-0.089502	-0.994559
1110000	-0.552393	-0.333246
1110001	-0.396346	-0.273296
1110010	-0.683752	-0.404797
1110011	-0.858560	-0.511264
1110100	-0.642493	-0.197800
1110101	-0.462109	-0.164180
1110110	-0.801694	-0.290343
1110111	-0.937916	-0.339763
1111000	-0.412951	-0.509479
1111001	-0.336567	-0.413951
1111010	-0.600289	-0.546834
1111011	-0.763765	-0.644626
1111100	-0.385655	-0.691063
1111101	-0.443902	-0.896057
1111110	-0.536473	-0.674051
1111111	-0.606478	-0.795101

[00152]

Table 25C

SYMBOL COORDINATE BITS	X	Y
0000000	0.215659	0.071275
0000001	0.247193	0.239779
0000010	0.059723	0.089476
0000011	0.084352	0.256286
0000100	0.631601	0.086959
0000101	0.421425	0.060957
0000110	0.811036	0.081198
0000111	0.989141	0.115779
0001000	0.238961	0.619410

0001001	0.188755	0.432433
0001010	0.081970	0.619772
0001011	0.071916	0.446011
0001100	0.230093	0.798693
0001101	0.278409	0.959192
0001110	0.079376	0.797516
0001111	0.102980	0.994337
0010000	0.540893	0.373750
0010001	0.390688	0.300381
0010010	0.711286	0.403395
0010011	0.878402	0.477131
0010100	0.613230	0.218230
0010101	0.459120	0.180142
0010110	0.770540	0.249889
0010111	0.951364	0.303258
0011000	0.419831	0.530248
0011001	0.327094	0.416570
0011010	0.635577	0.561146
0011011	0.777941	0.627040
0011100	0.406760	0.706463
0011101	0.454097	0.890952
0011110	0.554936	0.677703
0011111	0.616155	0.785695
0100000	0.215659	-0.071275
0100001	0.247193	-0.239779
0100010	0.059723	-0.089476
0100011	0.084352	-0.256286
0100100	0.631601	-0.086959
0100101	0.421425	-0.060957
0100110	0.811036	-0.081198
0100111	0.989141	-0.115779
0101000	0.238961	-0.619410
0101001	0.188755	-0.432433
0101010	0.081970	-0.619772
0101011	0.071916	-0.446011
0101100	0.230093	-0.798693
0101101	0.278409	-0.959192
0101110	0.079376	-0.797516
0101111	0.102980	-0.994337
0110000	0.540893	-0.373750
0110001	0.390688	-0.300381
0110010	0.711286	-0.403395
0110011	0.878402	-0.477131
0110100	0.613230	-0.218230
0110101	0.459120	-0.180142
0110110	0.770540	-0.249889
0110111	0.951364	-0.303258
0111000	0.419831	-0.530248

0111001	0.327094	-0.416570
0111010	0.635577	-0.561146
0111011	0.777941	-0.627040
0111100	0.406760	-0.706463
0111101	0.454097	-0.890952
0111110	0.554936	-0.677703
0111111	0.616155	-0.785695
1000000	-0.215659	0.071275
1000001	-0.247193	0.239779
1000010	-0.059723	0.089476
1000011	-0.084352	0.256286
1000100	-0.631601	0.086959
1000101	-0.421425	0.060957
1000110	-0.811036	0.081198
1000111	-0.989141	0.115779
1001000	-0.238961	0.619410
1001001	-0.188755	0.432433
1001010	-0.081970	0.619772
1001011	-0.071916	0.446011
1001100	-0.230093	0.798693
1001101	-0.278409	0.959192
1001110	-0.079376	0.797516
1001111	-0.102980	0.994337
1010000	-0.540893	0.373750
1010001	-0.390688	0.300381
1010010	-0.711286	0.403395
1010011	-0.878402	0.477131
1010100	-0.613230	0.218230
1010101	-0.459120	0.180142
1010110	-0.770540	0.249889
1010111	-0.951364	0.303258
1011000	-0.419831	0.530248
1011001	-0.327094	0.416570
1011010	-0.635577	0.561146
1011011	-0.777941	0.627040
1011100	-0.406760	0.706463
1011101	-0.454097	0.890952
1011110	-0.554936	0.677703
1011111	-0.616155	0.785695
1100000	-0.215659	-0.071275
1100001	-0.247193	-0.239779
1100010	-0.059723	-0.089476
1100011	-0.084352	-0.256286
1100100	-0.631601	-0.086959
1100101	-0.421425	-0.060957
1100110	-0.811036	-0.081198
1100111	-0.989141	-0.115779
1101000	-0.238961	-0.619410

1101001	-0.188755	-0.432433
1101010	-0.081970	-0.619772
1101011	-0.071916	-0.446011
1101100	-0.230093	-0.798693
1101101	-0.278409	-0.959192
1101110	-0.079376	-0.797516
1101111	-0.102980	-0.994337
1110000	-0.540893	-0.373750
1110001	-0.390688	-0.300381
1110010	-0.711286	-0.403395
1110011	-0.878402	-0.477131
1110100	-0.613230	-0.218230
1110101	-0.459120	-0.180142
1110110	-0.770540	-0.249889
1110111	-0.951364	-0.303258
1111000	-0.419831	-0.530248
1111001	-0.327094	-0.416570
1111010	-0.635577	-0.561146
1111011	-0.777941	-0.627040
1111100	-0.406760	-0.706463
1111101	-0.454097	-0.890952
1111110	-0.554936	-0.677703
1111111	-0.616155	-0.785695

[00153]

Table 25D

SYMBOL COORDINATE BITS	X	Y
00000000	0.729468	0.681354
00000001	0.738514	0.673491
00000010	0.855792	0.514140
00000011	0.849844	0.515379
00000100	0.968926	0.244322
00000101	0.961654	0.274266
00000110	0.846439	0.172785
00000111	0.814534	0.289437
00001000	0.660833	0.597951
00001001	0.635704	0.601179
00001010	0.703246	0.498537
00001011	0.713555	0.458342
00001100	0.982752	0.108821
00001101	0.995743	0.075153
00001110	0.835216	0.108792
00001111	0.734334	0.299494
00010000	0.563531	0.824212
00010001	0.538599	0.841459
00010010	0.422490	0.436968

00010011	0.486743	0.460303
00010100	0.533243	0.050591
00010101	0.625049	0.049186
00010110	0.460159	0.327276
00010111	0.545204	0.349786
00011000	0.466690	0.722489
00011001	0.472883	0.710099
00011010	0.416973	0.618858
00011011	0.459806	0.568347
00011100	0.496124	0.136766
00011101	0.632908	0.115646
00011110	0.478072	0.233508
00011111	0.637346	0.269821
00100000	0.150085	0.986638
00100001	0.096333	0.982163
00100010	0.054634	0.530674
00100011	0.124963	0.483488
00100100	0.039722	0.038334
00100101	0.135172	0.056012
00100110	0.055695	0.397262
00100111	0.117755	0.376976
00101000	0.077604	0.807366
00101001	0.114272	0.876917
00101010	0.077226	0.661268
00101011	0.142363	0.599635
00101100	0.048885	0.160450
00101101	0.167945	0.151950
00101110	0.046340	0.256559
00101111	0.151392	0.268874
00110000	0.368991	0.926086
00110001	0.380645	0.924004
00110010	0.333044	0.460912
00110011	0.244729	0.473505
00110100	0.373900	0.043782
00110101	0.245282	0.046720
00110110	0.338122	0.327772
00110111	0.246479	0.355455
00111000	0.271941	0.776781
00111001	0.314659	0.780426
00111010	0.281591	0.667979
00111011	0.269267	0.631313
00111100	0.391733	0.132460
00111101	0.267292	0.162978
00111110	0.375666	0.240801
00111111	0.260740	0.241834
01000000	0.729468	-0.681354
01000001	0.738514	-0.673491
01000010	0.855792	-0.514140

01000011	0.849844	-0.515379
01000100	0.968926	-0.244322
01000101	0.961654	-0.274266
01000110	0.846439	-0.172785
01000111	0.814534	-0.289437
01001000	0.660833	-0.597951
01001001	0.635704	-0.601179
01001010	0.703246	-0.498537
01001011	0.713555	-0.458342
01001100	0.982752	-0.108821
01001101	0.995743	-0.075153
01001110	0.835216	-0.108792
01001111	0.734334	-0.299494
01010000	0.563531	-0.824212
01010001	0.538599	-0.841459
01010010	0.422490	-0.436968
01010011	0.486743	-0.460303
01010100	0.533243	-0.050591
01010101	0.625049	-0.049186
01010110	0.460159	-0.327276
01010111	0.545204	-0.349786
01011000	0.466690	-0.722489
01011001	0.472883	-0.710099
01011010	0.416973	-0.618858
01011011	0.459806	-0.568347
01011100	0.496124	-0.136766
01011101	0.632908	-0.115646
01011110	0.478072	-0.233508
01011111	0.637346	-0.269821
01100000	0.150085	-0.986638
01100001	0.096333	-0.982163
01100010	0.054634	-0.530674
01100011	0.124963	-0.483488
01100100	0.039722	-0.038334
01100101	0.135172	-0.056012
01100110	0.055695	-0.397262
01100111	0.117755	-0.376976
01101000	0.077604	-0.807366
01101001	0.114272	-0.876917
01101010	0.077226	-0.661268
01101011	0.142363	-0.599635
01101100	0.048885	-0.160450
01101101	0.167945	-0.151950
01101110	0.046340	-0.256559
01101111	0.151392	-0.268874
01110000	0.368991	-0.926086
01110001	0.380645	-0.924004
01110010	0.333044	-0.460912

01110011	0.244729	-0.473505
01110100	0.373900	-0.043782
01110101	0.245282	-0.046720
01110110	0.338122	-0.327772
01110111	0.246479	-0.355455
01111000	0.271941	-0.776781
01111001	0.314659	-0.780426
01111010	0.281591	-0.667979
01111011	0.269267	-0.631313
01111100	0.391733	-0.132460
01111101	0.267292	-0.162978
01111110	0.375666	-0.240801
01111111	0.260740	-0.241834
10000000	-0.729468	0.681354
10000001	-0.738514	0.673491
10000010	-0.855792	0.514140
10000011	-0.849844	0.515379
10000100	-0.968926	0.244322
10000101	-0.961654	0.274266
10000110	-0.846439	0.172785
10000111	-0.814534	0.289437
10001000	-0.660833	0.597951
10001001	-0.635704	0.601179
10001010	-0.703246	0.498537
10001011	-0.713555	0.458342
10001100	-0.982752	0.108821
10001101	-0.995743	0.075153
10001110	-0.835216	0.108792
10001111	-0.734334	0.299494
10010000	-0.563531	0.824212
10010001	-0.538599	0.841459
10010010	-0.422490	0.436968
10010011	-0.486743	0.460303
10010100	-0.533243	0.050591
10010101	-0.625049	0.049186
10010110	-0.460159	0.327276
10010111	-0.545204	0.349786
10011000	-0.466690	0.722489
10011001	-0.472883	0.710099
10011010	-0.416973	0.618858
10011011	-0.459806	0.568347
10011100	-0.496124	0.136766
10011101	-0.632908	0.115646
10011110	-0.478072	0.233508
10011111	-0.637346	0.269821
10100000	-0.150085	0.986638
10100001	-0.096333	0.982163
10100010	-0.054634	0.530674

10100011	-0.124963	0.483488
10100100	-0.039722	0.038334
10100101	-0.135172	0.056012
10100110	-0.055695	0.397262
10100111	-0.117755	0.376976
10101000	-0.077604	0.807366
10101001	-0.114272	0.876917
10101010	-0.077226	0.661268
10101011	-0.142363	0.599635
10101100	-0.048885	0.160450
10101101	-0.167945	0.151950
10101110	-0.046340	0.256559
10101111	-0.151392	0.268874
10110000	-0.368991	0.926086
10110001	-0.380645	0.924004
10110010	-0.333044	0.460912
10110011	-0.244729	0.473505
10110100	-0.373900	0.043782
10110101	-0.245282	0.046720
10110110	-0.338122	0.327772
10110111	-0.246479	0.355455
10111000	-0.271941	0.776781
10111001	-0.314659	0.780426
10111010	-0.281591	0.667979
10111011	-0.269267	0.631313
10111100	-0.391733	0.132460
10111101	-0.267292	0.162978
10111110	-0.375666	0.240801
10111111	-0.260740	0.241834
11000000	-0.729468	-0.681354
11000001	-0.738514	-0.673491
11000010	-0.855792	-0.514140
11000011	-0.849844	-0.515379
11000100	-0.968926	-0.244322
11000101	-0.961654	-0.274266
11000110	-0.846439	-0.172785
11000111	-0.814534	-0.289437
11001000	-0.660833	-0.597951
11001001	-0.635704	-0.601179
11001010	-0.703246	-0.498537
11001011	-0.713555	-0.458342
11001100	-0.982752	-0.108821
11001101	-0.995743	-0.075153
11001110	-0.835216	-0.108792
11001111	-0.734334	-0.299494
11010000	-0.563531	-0.824212
11010001	-0.538599	-0.841459
11010010	-0.422490	-0.436968

11010011	-0.486743	-0.460303
11010100	-0.533243	-0.050591
11010101	-0.625049	-0.049186
11010110	-0.460159	-0.327276
11010111	-0.545204	-0.349786
11011000	-0.466690	-0.722489
11011001	-0.472883	-0.710099
11011010	-0.416973	-0.618858
11011011	-0.459806	-0.568347
11011100	-0.496124	-0.136766
11011101	-0.632908	-0.115646
11011110	-0.478072	-0.233508
11011111	-0.637346	-0.269821
11100000	-0.150085	-0.986638
11100001	-0.096333	-0.982163
11100010	-0.054634	-0.530674
11100011	-0.124963	-0.483488
11100100	-0.039722	-0.038334
11100101	-0.135172	-0.056012
11100110	-0.055695	-0.397262
11100111	-0.117755	-0.376976
11101000	-0.077604	-0.807366
11101001	-0.114272	-0.876917
11101010	-0.077226	-0.661268
11101011	-0.142363	-0.599635
11101100	-0.048885	-0.160450
11101101	-0.167945	-0.151950
11101110	-0.046340	-0.256559
11101111	-0.151392	-0.268874
11110000	-0.368991	-0.926086
11110001	-0.380645	-0.924004
11110010	-0.333044	-0.460912
11110011	-0.244729	-0.473505
11110100	-0.373900	-0.043782
11110101	-0.245282	-0.046720
11110110	-0.338122	-0.327772
11110111	-0.246479	-0.355455
11111000	-0.271941	-0.776781
11111001	-0.314659	-0.780426
11111010	-0.281591	-0.667979
11111011	-0.269267	-0.631313
11111100	-0.391733	-0.132460
11111101	-0.267292	-0.162978
11111110	-0.375666	-0.240801
11111111	-0.260740	-0.241834

[00154]

Table 26A

SYMBOL COORDINATE BITS	X	Y
00000000	0.100722	0.994770
00000001	0.750351	0.661022
00000010	0.881575	0.471414
00000011	0.873252	0.483693
00000100	0.992123	0.101906
00000101	0.913440	0.102519
00000110	0.951789	0.302746
00000111	0.937645	0.339561
00001000	0.672550	0.570706
00001001	0.676544	0.624432
00001010	0.698643	0.418766
00001011	0.776531	0.393317
00001100	0.761618	0.102135
00001101	0.834592	0.108693
00001110	0.707515	0.282568
00001111	0.814401	0.272917
00010000	0.492252	0.870452
00010001	0.594583	0.796236
00010010	0.508862	0.423943
00010011	0.436952	0.512043
00010100	0.427335	0.024507
00010101	0.472640	0.103214
00010110	0.504587	0.325416
00010111	0.481372	0.201663
00011000	0.497458	0.750636
00011001	0.516303	0.690518
00011010	0.579766	0.455486
00011011	0.502377	0.570749
00011100	0.663972	0.082265
00011101	0.584150	0.076688
00011110	0.610969	0.277009
00011111	0.572290	0.199840
00100000	0.056666	0.691228
00100001	0.151272	0.675756
00100010	0.204894	0.530525
00100011	0.216699	0.584379
00100100	0.043480	0.044961
00100101	0.049099	0.162247
00100110	0.038237	0.360110
00100111	0.049416	0.284838
00101000	0.099703	0.839454
00101001	0.117273	0.821271
00101010	0.135244	0.463140
00101011	0.031880	0.529953
00101100	0.162184	0.047275
00101101	0.125789	0.162121

00101110	0.117611	0.404115
00101111	0.138289	0.256313
00110000	0.343736	0.937804
00110001	0.259185	0.697227
00110010	0.338770	0.448588
00110011	0.336399	0.578736
00110100	0.326500	0.064530
00110101	0.345811	0.144428
00110110	0.380906	0.330718
00110111	0.374826	0.247547
00111000	0.314588	0.835245
00111001	0.330246	0.739962
00111010	0.261873	0.406571
00111011	0.397693	0.622723
00111100	0.242090	0.072399
00111101	0.232395	0.167109
00111110	0.238175	0.347737
00111111	0.249935	0.249763
01000000	0.100722	-0.994770
01000001	0.750351	-0.661022
01000010	0.881575	-0.471414
01000011	0.873252	-0.483693
01000100	0.992123	-0.101906
01000101	0.913440	-0.102519
01000110	0.951789	-0.302746
01000111	0.937645	-0.339561
01001000	0.672550	-0.570706
01001001	0.676544	-0.624432
01001010	0.698643	-0.418766
01001011	0.776531	-0.393317
01001100	0.761618	-0.102135
01001101	0.834592	-0.108693
01001110	0.707515	-0.282568
01001111	0.814401	-0.272917
01010000	0.492252	-0.870452
01010001	0.594583	-0.796236
01010010	0.508862	-0.423943
01010011	0.436952	-0.512043
01010100	0.427335	-0.024507
01010101	0.472640	-0.103214
01010110	0.504587	-0.325416
01010111	0.481372	-0.201663
01011000	0.497458	-0.750636
01011001	0.516303	-0.690518
01011010	0.579766	-0.455486
01011011	0.502377	-0.570749
01011100	0.663972	-0.082265
01011101	0.584150	-0.076688

01011110	0.610969	-0.277009
01011111	0.572290	-0.199840
01100000	0.056666	-0.691228
01100001	0.151272	-0.675756
01100010	0.204894	-0.530525
01100011	0.216699	-0.584379
01100100	0.043480	-0.044961
01100101	0.049099	-0.162247
01100110	0.038237	-0.360110
01100111	0.049416	-0.284838
01101000	0.099703	-0.839454
01101001	0.117273	-0.821271
01101010	0.135244	-0.463140
01101011	0.031880	-0.529953
01101100	0.162184	-0.047275
01101101	0.125789	-0.162121
01101110	0.117611	-0.404115
01101111	0.138289	-0.256313
01110000	0.343736	-0.937804
01110001	0.259185	-0.697227
01110010	0.338770	-0.448588
01110011	0.336399	-0.578736
01110100	0.326500	-0.064530
01110101	0.345811	-0.144428
01110110	0.380906	-0.330718
01110111	0.374826	-0.247547
01111000	0.314588	-0.835245
01111001	0.330246	-0.739962
01111010	0.261873	-0.406571
01111011	0.397693	-0.622723
01111100	0.242090	-0.072399
01111101	0.232395	-0.167109
01111110	0.238175	-0.347737
01111111	0.249935	-0.249763
10000000	-0.100722	0.994770
10000001	-0.750351	0.661022
10000010	-0.881575	0.471414
10000011	-0.873252	0.483693
10000100	-0.992123	0.101906
10000101	-0.913440	0.102519
10000110	-0.951789	0.302746
10000111	-0.937645	0.339561
10001000	-0.672550	0.570706
10001001	-0.676544	0.624432
10001010	-0.698643	0.418766
10001011	-0.776531	0.393317
10001100	-0.761618	0.102135
10001101	-0.834592	0.108693

10001110	-0.707515	0.282568
10001111	-0.814401	0.272917
10010000	-0.492252	0.870452
10010001	-0.594583	0.796236
10010010	-0.508862	0.423943
10010011	-0.436952	0.512043
10010100	-0.427335	0.024507
10010101	-0.472640	0.103214
10010110	-0.504587	0.325416
10010111	-0.481372	0.201663
10011000	-0.497458	0.750636
10011001	-0.516303	0.690518
10011010	-0.579766	0.455486
10011011	-0.502377	0.570749
10011100	-0.663972	0.082265
10011101	-0.584150	0.076688
10011110	-0.610969	0.277009
10011111	-0.572290	0.199840
10100000	-0.056666	0.691228
10100001	-0.151272	0.675756
10100010	-0.204894	0.530525
10100011	-0.216699	0.584379
10100100	-0.043480	0.044961
10100101	-0.049099	0.162247
10100110	-0.038237	0.360110
10100111	-0.049416	0.284838
10101000	-0.099703	0.839454
10101001	-0.117273	0.821271
10101010	-0.135244	0.463140
10101011	-0.031880	0.529953
10101100	-0.162184	0.047275
10101101	-0.125789	0.162121
10101110	-0.117611	0.404115
10101111	-0.138289	0.256313
10110000	-0.343736	0.937804
10110001	-0.259185	0.697227
10110010	-0.338770	0.448588
10110011	-0.336399	0.578736
10110100	-0.326500	0.064530
10110101	-0.345811	0.144428
10110110	-0.380906	0.330718
10110111	-0.374826	0.247547
10111000	-0.314588	0.835245
10111001	-0.330246	0.739962
10111010	-0.261873	0.406571
10111011	-0.397693	0.622723
10111100	-0.242090	0.072399
10111101	-0.232395	0.167109

10111110	-0.238175	0.347737
10111111	-0.249935	0.249763
11000000	-0.100722	-0.994770
11000001	-0.750351	-0.661022
11000010	-0.881575	-0.471414
11000011	-0.873252	-0.483693
11000100	-0.992123	-0.101906
11000101	-0.913440	-0.102519
11000110	-0.951789	-0.302746
11000111	-0.937645	-0.339561
11001000	-0.672550	-0.570706
11001001	-0.676544	-0.624432
11001010	-0.698643	-0.418766
11001011	-0.776531	-0.393317
11001100	-0.761618	-0.102135
11001101	-0.834592	-0.108693
11001110	-0.707515	-0.282568
11001111	-0.814401	-0.272917
11010000	-0.492252	-0.870452
11010001	-0.594583	-0.796236
11010010	-0.508862	-0.423943
11010011	-0.436952	-0.512043
11010100	-0.427335	-0.024507
11010101	-0.472640	-0.103214
11010110	-0.504587	-0.325416
11010111	-0.481372	-0.201663
11011000	-0.497458	-0.750636
11011001	-0.516303	-0.690518
11011010	-0.579766	-0.455486
11011011	-0.502377	-0.570749
11011100	-0.663972	-0.082265
11011101	-0.584150	-0.076688
11011110	-0.610969	-0.277009
11011111	-0.572290	-0.199840
11100000	-0.056666	-0.691228
11100001	-0.151272	-0.675756
11100010	-0.204894	-0.530525
11100011	-0.216699	-0.584379
11100100	-0.043480	-0.044961
11100101	-0.049099	-0.162247
11100110	-0.038237	-0.360110
11100111	-0.049416	-0.284838
11101000	-0.099703	-0.839454
11101001	-0.117273	-0.821271
11101010	-0.135244	-0.463140
11101011	-0.031880	-0.529953
11101100	-0.162184	-0.047275
11101101	-0.125789	-0.162121

11101110	-0.117611	-0.404115
11101111	-0.138289	-0.256313
11110000	-0.343736	-0.937804
11110001	-0.259185	-0.697227
11110010	-0.338770	-0.448588
11110011	-0.336399	-0.578736
11110100	-0.326500	-0.064530
11110101	-0.345811	-0.144428
11110110	-0.380906	-0.330718
11110111	-0.374826	-0.247547
11111000	-0.314588	-0.835245
11111001	-0.330246	-0.739962
11111010	-0.261873	-0.406571
11111011	-0.397693	-0.622723
11111100	-0.242090	-0.072399
11111101	-0.232395	-0.167109
11111110	-0.238175	-0.347737
11111111	-0.249935	-0.249763

[00155]

Table 26B

SYMBOL COORDINATE BITS	X	Y
00000000	0.704805	0.709401
00000001	0.653485	0.647271
00000010	0.839635	0.536645
00000011	0.779762	0.466418
00000100	0.950855	0.309585
00000101	0.898873	0.237975
00000110	0.791594	0.179828
00000111	0.816680	0.306330
00001000	0.505509	0.556460
00001001	0.578086	0.594539
00001010	0.604085	0.430430
00001011	0.675607	0.467474
00001100	0.995507	0.093945
00001101	0.927144	0.066550
00001110	0.798416	0.068850
00001111	0.692878	0.075290
00010000	0.479391	0.863511
00010001	0.505225	0.774265
00010010	0.484617	0.414350
00010011	0.520888	0.310957
00010100	0.381499	0.038864
00010101	0.487670	0.092097
00010110	0.411849	0.258755
00010111	0.487732	0.202001
00011000	0.406573	0.655126

00011001	0.462736	0.718925
00011010	0.664047	0.289395
00011011	0.596484	0.264203
00011100	0.355974	0.107909
00011101	0.560999	0.039644
00011110	0.359573	0.187393
00011111	0.615102	0.131990
00100000	0.115389	0.992829
00100001	0.099077	0.892498
00100010	0.049649	0.509714
00100011	0.145149	0.483577
00100100	0.041063	0.109972
00100101	0.054519	0.039305
00100110	0.056636	0.417591
00100111	0.146141	0.395735
00101000	0.120064	0.703253
00101001	0.072859	0.801344
00101010	0.058365	0.627881
00101011	0.138895	0.590276
00101100	0.039437	0.207733
00101101	0.107948	0.211695
00101110	0.044117	0.330946
00101111	0.135942	0.306297
00110000	0.296688	0.951488
00110001	0.300001	0.845945
00110010	0.381891	0.443738
00110011	0.259783	0.465152
00110100	0.258503	0.034355
00110101	0.161844	0.058432
00110110	0.366199	0.349348
00110111	0.261819	0.363870
00111000	0.262841	0.689677
00111001	0.249677	0.780505
00111010	0.347351	0.553715
00111011	0.238875	0.569146
00111100	0.254190	0.129082
00111101	0.178447	0.154862
00111110	0.285410	0.232281
00111111	0.211277	0.280009
01000000	0.704805	-0.709401
01000001	0.653485	-0.647271
01000010	0.839635	-0.536645
01000011	0.779762	-0.466418
01000100	0.950855	-0.309585
01000101	0.898873	-0.237975
01000110	0.791594	-0.179828
01000111	0.816680	-0.306330
01001000	0.505509	-0.556460

01001001	0.578086	-0.594539
01001010	0.604085	-0.430430
01001011	0.675607	-0.467474
01001100	0.995507	-0.093945
01001101	0.927144	-0.066550
01001110	0.798416	-0.068850
01001111	0.692878	-0.075290
01010000	0.479391	-0.863511
01010001	0.505225	-0.774265
01010010	0.484617	-0.414350
01010011	0.520888	-0.310957
01010100	0.381499	-0.038864
01010101	0.487670	-0.092097
01010110	0.411849	-0.258755
01010111	0.487732	-0.202001
01011000	0.406573	-0.655126
01011001	0.462736	-0.718925
01011010	0.664047	-0.289395
01011011	0.596484	-0.264203
01011100	0.355974	-0.107909
01011101	0.560999	-0.039644
01011110	0.359573	-0.187393
01011111	0.615102	-0.131990
01100000	0.115389	-0.992829
01100001	0.099077	-0.892498
01100010	0.049649	-0.509714
01100011	0.145149	-0.483577
01100100	0.041063	-0.109972
01100101	0.054519	-0.039305
01100110	0.056636	-0.417591
01100111	0.146141	-0.395735
01101000	0.120064	-0.703253
01101001	0.072859	-0.801344
01101010	0.058365	-0.627881
01101011	0.138895	-0.590276
01101100	0.039437	-0.207733
01101101	0.107948	-0.211695
01101110	0.044117	-0.330946
01101111	0.135942	-0.306297
01110000	0.296688	-0.951488
01110001	0.300001	-0.845945
01110010	0.381891	-0.443738
01110011	0.259783	-0.465152
01110100	0.258503	-0.034355
01110101	0.161844	-0.058432
01110110	0.366199	-0.349348
01110111	0.261819	-0.363870
01111000	0.262841	-0.689677

01111001	0.249677	-0.780505
01111010	0.347351	-0.553715
01111011	0.238875	-0.569146
01111100	0.254190	-0.129082
01111101	0.178447	-0.154862
01111110	0.285410	-0.232281
01111111	0.211277	-0.280009
10000000	-0.704805	0.709401
10000001	-0.653485	0.647271
10000010	-0.839635	0.536645
10000011	-0.779762	0.466418
10000100	-0.950855	0.309585
10000101	-0.898873	0.237975
10000110	-0.791594	0.179828
10000111	-0.816680	0.306330
10001000	-0.505509	0.556460
10001001	-0.578086	0.594539
10001010	-0.604085	0.430430
10001011	-0.675607	0.467474
10001100	-0.995507	0.093945
10001101	-0.927144	0.066550
10001110	-0.798416	0.068850
10001111	-0.692878	0.075290
10010000	-0.479391	0.863511
10010001	-0.505225	0.774265
10010010	-0.484617	0.414350
10010011	-0.520888	0.310957
10010100	-0.381499	0.038864
10010101	-0.487670	0.092097
10010110	-0.411849	0.258755
10010111	-0.487732	0.202001
10011000	-0.406573	0.655126
10011001	-0.462736	0.718925
10011010	-0.664047	0.289395
10011011	-0.596484	0.264203
10011100	-0.355974	0.107909
10011101	-0.560999	0.039644
10011110	-0.359573	0.187393
10011111	-0.615102	0.131990
10100000	-0.115389	0.992829
10100001	-0.099077	0.892498
10100010	-0.049649	0.509714
10100011	-0.145149	0.483577
10100100	-0.041063	0.109972
10100101	-0.054519	0.039305
10100110	-0.056636	0.417591
10100111	-0.146141	0.395735
10101000	-0.120064	0.703253

10101001	-0.072859	0.801344
10101010	-0.058365	0.627881
10101011	-0.138895	0.590276
10101100	-0.039437	0.207733
10101101	-0.107948	0.211695
10101110	-0.044117	0.330946
10101111	-0.135942	0.306297
10110000	-0.296688	0.951488
10110001	-0.300001	0.845945
10110010	-0.381891	0.443738
10110011	-0.259783	0.465152
10110100	-0.258503	0.034355
10110101	-0.161844	0.058432
10110110	-0.366199	0.349348
10110111	-0.261819	0.363870
10111000	-0.262841	0.689677
10111001	-0.249677	0.780505
10111010	-0.347351	0.553715
10111011	-0.238875	0.569146
10111100	-0.254190	0.129082
10111101	-0.178447	0.154862
10111110	-0.285410	0.232281
10111111	-0.211277	0.280009
11000000	-0.704805	-0.709401
11000001	-0.653485	-0.647271
11000010	-0.839635	-0.536645
11000011	-0.779762	-0.466418
11000100	-0.950855	-0.309585
11000101	-0.898873	-0.237975
11000110	-0.791594	-0.179828
11000111	-0.816680	-0.306330
11001000	-0.505509	-0.556460
11001001	-0.578086	-0.594539
11001010	-0.604085	-0.430430
11001011	-0.675607	-0.467474
11001100	-0.995507	-0.093945
11001101	-0.927144	-0.066550
11001110	-0.798416	-0.068850
11001111	-0.692878	-0.075290
11010000	-0.479391	-0.863511
11010001	-0.505225	-0.774265
11010010	-0.484617	-0.414350
11010011	-0.520888	-0.310957
11010100	-0.381499	-0.038864
11010101	-0.487670	-0.092097
11010110	-0.411849	-0.258755
11010111	-0.487732	-0.202001
11011000	-0.406573	-0.655126

11011001	-0.462736	-0.718925
11011010	-0.664047	-0.289395
11011011	-0.596484	-0.264203
11011100	-0.355974	-0.107909
11011101	-0.560999	-0.039644
11011110	-0.359573	-0.187393
11011111	-0.615102	-0.131990
11100000	-0.115389	-0.992829
11100001	-0.099077	-0.892498
11100010	-0.049649	-0.509714
11100011	-0.145149	-0.483577
11100100	-0.041063	-0.109972
11100101	-0.054519	-0.039305
11100110	-0.056636	-0.417591
11100111	-0.146141	-0.395735
11101000	-0.120064	-0.703253
11101001	-0.072859	-0.801344
11101010	-0.058365	-0.627881
11101011	-0.138895	-0.590276
11101100	-0.039437	-0.207733
11101101	-0.107948	-0.211695
11101110	-0.044117	-0.330946
11101111	-0.135942	-0.306297
11110000	-0.296688	-0.951488
11110001	-0.300001	-0.845945
11110010	-0.381891	-0.443738
11110011	-0.259783	-0.465152
11110100	-0.258503	-0.034355
11110101	-0.161844	-0.058432
11110110	-0.366199	-0.349348
11110111	-0.261819	-0.363870
11111000	-0.262841	-0.689677
11111001	-0.249677	-0.780505
11111010	-0.347351	-0.553715
11111011	-0.238875	-0.569146
11111100	-0.254190	-0.129082
11111101	-0.178447	-0.154862
11111110	-0.285410	-0.232281
11111111	-0.211277	-0.280009

[00156]

Table 26C

[00157] Through the descriptions of the preceding embodiments, the present invention may be implemented by using hardware only or by using software and a necessary universal hardware platform. Based on such understandings, the technical solution of the present invention may be embodied in the form of a software product. The software product may be stored in a non-volatile or non-transitory storage medium, which can be

a compact disk read-only memory (CD-ROM), USB flash disk, or a removable hard disk. The software product includes a number of instructions that enable a computer device (personal computer, server, or network device) to execute the methods provided in the embodiments of the present invention. For example, such an execution may
5 correspond to a simulation of the logical operations as described herein. The software product may additionally or alternatively include number of instructions that enable a computer device to execute operations for configuring or programming a digital logic apparatus in accordance with embodiments of the present invention.

[00158] Although the present invention has been described with reference to specific
10 features and embodiments thereof, it is evident that various modifications and combinations can be made thereto without departing from the invention. The specification and drawings are, accordingly, to be regarded simply as an illustration of the invention as defined by the appended claims, and are contemplated to cover any and all modifications, variations, combinations or equivalents that fall within the scope of
15 the present invention.

WHAT IS CLAIMED IS:

1. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

5 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.484430	0.355657
1.103689	0.241419
0.483043	0.093713
0.757638	0.144839
1.150175	0.837105
0.876141	0.599840
0.335946	0.248000
0.608728	0.420395
0.255763	1.404577
0.189712	1.014604
0.088351	0.457627
0.166639	0.679954
0.768973	1.227892
0.588939	0.901538
0.105757	0.127560
0.433169	0.631655

2. The method of claim 1, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 64-point constellation are defined by the coordinate pairs to at least four decimal places of precision.

3. The method of claim 1, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 64-point constellation are defined by the coordinate pairs to at least five decimal places of precision.

4. The method of claim 1, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 64-point constellation are defined by the coordinate pairs to six decimal places of precision.
- 5 5. The method of claim 1, wherein the signal constellation is a reflection-symmetric constellation.
6. The method of claim 1, wherein:
the first coordinates the coordinate pairs represent normalized magnitudes of one
10 of: in-phase components; and quadrature components of the constellation symbols, and
the second coordinates of the coordinate pairs represent normalized magnitudes of the other one of the in-phase components and the quadrature components of the constellation symbols.
- 15 7. The method of claim 1, wherein the bit sequences are assigned to the constellation symbols using Gray mapping.
8. The method of claim 1, wherein each of the bit sequences is of length 6 bits,
20 including 4 quadrant non-specific bits, and wherein, for an index value k ranging from $k=1$ to $k=16$ inclusive: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary representation of $k-1$ added to a constant value under Modulo-16 addition; the
25 binary representation of $k-1$ subjected to a consistent bit reordering, or the binary representation of $k-1$ added to a constant value under Modulo-16 addition and subjected to the consistent bit reordering.
9. The method of claim 8, wherein the signal constellation is a reflection symmetric
30 constellation, and wherein bit sequences corresponding to constellation symbols within a common group of reflection symmetric constellation symbols have identical quadrant non-specific bits.

10. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

5 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.484430	0.355657
1.103689	0.241419
0.483043	0.093713
0.757638	0.144839
1.150175	0.837105
0.876141	0.599840
0.335946	0.248000
0.608728	0.420395
0.255763	1.404577
0.189712	1.014604
0.088351	0.457627
0.166639	0.679954
0.768973	1.227892
0.588939	0.901538
0.105757	0.127560
0.433169	0.631655

11. The apparatus of claim 10, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 64-point constellation are defined by the coordinate pairs to at least four decimal places of precision.
12. The apparatus of claim 10, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 64-point constellation are defined by the coordinate pairs to at least five decimal places of precision.

13. The apparatus of claim 10, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 64-point constellation are defined by the coordinate pairs to six decimal places of precision.
- 5 14. The apparatus of claim 10, wherein the signal constellation is a reflection-symmetric constellation.
- 10 15. The apparatus of claim 10, wherein the left-hand-side coordinates the coordinate pairs represent normalized magnitudes of one of: in-phase components; and quadrature components of the constellation symbols, and the right-hand-side coordinates of the coordinate pairs represent normalized magnitudes of the other one of the in-phase components and the quadrature components of the constellation symbols.
- 15 16. The apparatus of claim 10, wherein the bit sequences are assigned to the constellation symbols using Gray mapping.
- 20 17. The apparatus of claim 10, wherein each of the bit sequences is of length 6 bits, including 4 quadrant non-specific bits, and wherein, for an index value k ranging from $k=1$ to $k=16$ inclusive: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary representation of $k-1$ added to a constant value under Modulo-16 addition; the binary representation of $k-1$ subjected to a consistent bit reordering, or the binary representation of $k-1$ added to a constant value under Modulo-16 addition and subjected to the consistent bit reordering.
- 25 18. The apparatus of claim 17, wherein the signal constellation is a reflection symmetric constellation, and wherein bit sequences corresponding to constellation symbols within a common group of reflection symmetric constellation symbols have identical quadrant non-specific bits.
- 30

19. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

5 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.469392	0.279838
1.056826	0.221924
0.278986	0.118028
0.715494	0.159574
1.278954	0.863275
0.881208	0.583362
0.313280	0.160867
0.595671	0.362205
0.295098	1.516036
0.173629	1.014971
0.114742	0.259617
0.152038	0.700078
0.785642	1.243046
0.550103	0.874280
0.164975	0.288326
0.353214	0.596159

20. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

15 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.469392	0.279838
1.056826	0.221924
0.278986	0.118028
0.715494	0.159574
1.278954	0.863275
0.881208	0.583362
0.313280	0.160867
0.595671	0.362205
0.295098	1.516036
0.173629	1.014971
0.114742	0.259617
0.152038	0.700078
0.785642	1.243046
0.550103	0.874280
0.164975	0.288326
0.353214	0.596159

- 5 21. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

10 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.492905	0.360756
1.080694	0.217529
0.403075	0.095458
0.768391	0.154809
1.206775	0.854056
0.849704	0.601606
0.417913	0.175906
0.610015	0.376978

0.309008	1.471972
0.198570	1.031429
0.103390	0.265338
0.134876	0.685577
0.824050	1.192733
0.553412	0.861355
0.174613	0.295716
0.339582	0.576666

22. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

5 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.492905	0.360756
1.080694	0.217529
0.403075	0.095458
0.768391	0.154809
1.206775	0.854056
0.849704	0.601606
0.417913	0.175906
0.610015	0.376978
0.309008	1.471972
0.198570	1.031429
0.103390	0.265338
0.134876	0.685577
0.824050	1.192733
0.553412	0.861355
0.174613	0.295716
0.339582	0.576666

23. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

5 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.223083	0.871183
1.501110	0.301512
0.977190	0.129880
1.034515	0.370077
0.752034	1.165798
0.670194	0.763847
0.622485	0.140135
0.728917	0.432979
0.146134	1.065653
0.158150	0.688012
0.128341	0.119548
0.111238	0.401943
0.296713	1.461668
0.398918	0.653188
0.386998	0.128121
0.372132	0.404640

24. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

15 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.223083	0.871183
1.501110	0.301512
0.977190	0.129880
1.034515	0.370077
0.752034	1.165798
0.670194	0.763847
0.622485	0.140135
0.728917	0.432979
0.146134	1.065653
0.158150	0.688012
0.128341	0.119548
0.111238	0.401943
0.296713	1.461668
0.398918	0.653188
0.386998	0.128121
0.372132	0.404640

- 5 25. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

10 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.825394	0.564557
0.679474	0.733233
0.934649	0.354296
0.992113	0.124306
0.547499	0.538212
0.512966	0.857155
0.667874	0.319131
0.704023	0.112315

0.105064	0.673007
0.104623	0.989353
0.128136	0.390102
0.131864	0.120209
0.337537	0.644600
0.310475	0.949750
0.364337	0.376712
0.404674	0.115168

26. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

5 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.825394	0.564557
0.679474	0.733233
0.934649	0.354296
0.992113	0.124306
0.547499	0.538212
0.512966	0.857155
0.667874	0.319131
0.704023	0.112315
0.105064	0.673007
0.104623	0.989353
0.128136	0.390102
0.131864	0.120209
0.337537	0.644600
0.310475	0.949750
0.364337	0.376712
0.404674	0.115168

27. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

5 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.894480	0.445822
0.890395	0.455110
0.984821	0.172554
0.985411	0.170142
0.730858	0.679601
0.731787	0.681533
0.594365	0.254018
0.545682	0.183541
0.172908	0.983278
0.144365	0.988438
0.103984	0.512065
0.110135	0.138733
0.453133	0.891044
0.458751	0.888174
0.237903	0.413635
0.327635	0.213996

28. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

15 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.894480	0.445822
0.890395	0.455110
0.984821	0.172554
0.985411	0.170142
0.730858	0.679601
0.731787	0.681533
0.594365	0.254018
0.545682	0.183541
0.172908	0.983278
0.144365	0.988438
0.103984	0.512065
0.110135	0.138733
0.453133	0.891044
0.458751	0.888174
0.237903	0.413635
0.327635	0.213996

- 5 29. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

10 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.847425	0.528328
0.724032	0.689761
0.949712	0.313126
0.993100	0.116019
0.561795	0.514360
0.575688	0.817191
0.586661	0.291101
0.623692	0.093506

0.114854	0.716644
0.141761	0.989893
0.099426	0.429732
0.092178	0.159156
0.344522	0.588449
0.385307	0.921869
0.314441	0.342702
0.309723	0.111529

30. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

5 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.847425	0.528328
0.724032	0.689761
0.949712	0.313126
0.993100	0.116019
0.561795	0.514360
0.575688	0.817191
0.586661	0.291101
0.623692	0.093506
0.114854	0.716644
0.141761	0.989893
0.099426	0.429732
0.092178	0.159156
0.344522	0.588449
0.385307	0.921869
0.314441	0.342702
0.309723	0.111529

31. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.089757	0.995927
0.871842	0.489415
0.992114	0.111242
0.947926	0.318276
0.624995	0.779546
0.766239	0.642268
0.631056	0.095979
0.627559	0.304108
0.276549	0.960689
0.111329	0.622856
0.150023	0.138919
0.116201	0.363483
0.453255	0.891381
0.390500	0.599215
0.332423	0.100418
0.436529	0.401382

32. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 64-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 64-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.089757	0.995927
0.871842	0.489415
0.992114	0.111242
0.947926	0.318276
0.624995	0.779546
0.766239	0.642268
0.631056	0.095979
0.627559	0.304108
0.276549	0.960689
0.111329	0.622856
0.150023	0.138919
0.116201	0.363483
0.453255	0.891381
0.390500	0.599215
0.332423	0.100418
0.436529	0.401382

- 5 33. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

10 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 16-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 16-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.208300	0.385859
0.643529	0.210665
0.453620	1.186803
1.179606	0.586066

15

34. The method of claim 33, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 16-point constellation are defined by the coordinate pairs to at least four decimal places of precision.
- 5 35. The method of claim 33, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 16-point constellation are defined by the coordinate pairs to at least five decimal places of precision.
- 10 36. The method of claim 33, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 16-point constellation are defined by the coordinate pairs to six decimal places of precision.
37. The method of claim 33, wherein the signal constellation is a reflection-symmetric constellation.
- 15 38. The method of claim 33, wherein:
the first coordinates the coordinate pairs represent normalized magnitudes of one of: in-phase components; and quadrature components of the constellation symbols, and
20 the second coordinates of the coordinate pairs represent normalized magnitudes of the other one of the in-phase components and the quadrature components of the constellation symbols.
39. The method of claim 33, wherein the bit sequences are assigned to the constellation symbols using Gray mapping.
- 25 40. The method of claim 1, wherein each of the bit sequences is of length 4 bits, including 2 quadrant non-specific bits, and wherein, for an index value k ranging from $k=1$ to $k=4$ inclusive: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary representation of $k-1$ added to a constant value under Modulo-4 addition; the binary representation of $k-1$ subjected to a consistent bit reordering, or the binary
- 30

representation of $k-1$ added to a constant value under Modulo-4 addition and subjected to the consistent bit reordering.

41. The method of claim 40, wherein the signal constellation is a reflection symmetric constellation, and wherein bit sequences corresponding to constellation symbols within a common group of reflection symmetric constellation symbols have identical quadrant non-specific bits.

42. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 16-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 16-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.208300	0.385859
0.643529	0.210665
0.453620	1.186803
1.179606	0.586066

20

43. The apparatus of claim 42, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 16-point constellation are defined by the coordinate pairs to at least four decimal places of precision.

44. The apparatus of claim 42, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 16-point constellation are defined by the coordinate pairs to at least five decimal places of precision.

45. The apparatus of claim 42, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 16-point constellation are defined by the coordinate pairs to six decimal places of precision.
- 5 46. The apparatus of claim 42, wherein the signal constellation is a reflection-symmetric constellation.
47. The apparatus of claim 42, wherein the left-hand-side coordinates the coordinate pairs represent normalized magnitudes of one of: in-phase components; and
10 quadrature components of the constellation symbols, and the right-hand-side coordinates of the coordinate pairs represent normalized magnitudes of the other one of the in-phase components and the quadrature components of the constellation symbols.
- 15 48. The apparatus of claim 42, wherein the bit sequences are assigned to the constellation symbols using Gray mapping.
49. The apparatus of claim 42, wherein each of the bit sequences is of length 4 bits, including 2 quadrant non-specific bits, and wherein, for an index value k ranging
20 from $k=1$ to $k=4$ inclusive: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary representation of $k-1$ added to a constant value under Modulo-4 addition; the binary representation of $k-1$ subjected to a consistent bit reordering, or the binary
25 representation of $k-1$ added to a constant value under Modulo-4 addition and subjected to the consistent bit reordering.
50. The apparatus of claim 49, wherein the signal constellation is a reflection symmetric constellation, and wherein bit sequences corresponding to
30 constellation symbols within a common group of reflection symmetric constellation symbols have identical quadrant non-specific bits.
51. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 16-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 16-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.270682	0.962663
0.253573	0.248544
0.707302	0.706911
0.961176	0.275819

52. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 16-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 16-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.270682	0.962663
0.253573	0.248544
0.707302	0.706911
0.961176	0.275819

53. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:

translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 32-point

constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 32-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.310029	0.338031
0.224325	0.876872
0.720578	0.336506
0.269767	0.543938
1.012286	0.981782
0.423089	1.343637
0.540439	0.139694
0.159408	0.198087

54. The method of claim 53, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 32-point constellation are defined by the coordinate pairs to at least four decimal places of precision.

55. The method of claim 53, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 32-point constellation are defined by the coordinate pairs to at least five decimal places of precision.

56. The method of claim 53, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 32-point constellation are defined by the coordinate pairs to six decimal places of precision.

57. The method of claim 53, wherein the signal constellation is a reflection-symmetric constellation.

58. The method of claim 53, wherein:
the first coordinates the coordinate pairs represent normalized magnitudes of one of: in-phase components; and quadrature components of the constellation symbols, and

the second coordinates of the coordinate pairs represent normalized magnitudes of the other one of the in-phase components and the quadrature components of the constellation symbols.

5 59. The method of claim 53, wherein the bit sequences are assigned to the constellation symbols using Gray mapping.

60. The method of claim 53, wherein each of the bit sequences is of length 5 bits, including 3 quadrant non-specific bits, and wherein, for an index value k ranging from $k=1$ to $k=8$ inclusive: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary representation of $k-1$ added to a constant value under Modulo-8 addition; the binary representation of $k-1$ subjected to a consistent bit reordering, or the binary representation of $k-1$ added to a constant value under Modulo-8 addition and subjected to the consistent bit reordering.

61. The method of claim 60, wherein the signal constellation is a reflection symmetric constellation, and wherein bit sequences corresponding to constellation symbols within a common group of reflection symmetric constellation symbols have identical quadrant non-specific bits.

62. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 32-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

wherein normalized magnitudes of the constellation symbols in a first quadrant of the 32-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

1.310029	0.338031
0.224325	0.876872
0.720578	0.336506
0.269767	0.543938
1.012286	0.981782
0.423089	1.343637
0.540439	0.139694
0.159408	0.198087

63. The apparatus of claim 62, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 32-point constellation are defined by the coordinate pairs to at least four decimal places of precision.
- 5 64. The apparatus of claim 62, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 32-point constellation are defined by the coordinate pairs to at least five decimal places of precision.
- 10 65. The apparatus of claim 62, wherein normalized magnitudes of the constellation symbols in the first quadrant of the 32-point constellation are defined by the coordinate pairs to six decimal places of precision.
- 15 66. The apparatus of claim 62, wherein the signal constellation is a reflection-symmetric constellation.
67. The apparatus of claim 62, wherein the left-hand-side coordinates the coordinate pairs represent normalized magnitudes of one of: in-phase components; and quadrature components of the constellation symbols, and the right-hand-side coordinates of the coordinate pairs represent normalized magnitudes of the other one of the in-phase components and the quadrature components of the constellation symbols.
- 20 68. The apparatus of claim 62, wherein the bit sequences are assigned to the constellation symbols using Gray mapping.
- 25

69. The apparatus of claim 62, wherein each of the bit sequences is of length 5 bits, including 3 quadrant non-specific bits, and wherein, for an index value k ranging from $k=1$ to $k=8$ inclusive: the quadrant non-specific bits of the bit sequence corresponding to the constellation symbol defined by a k^{th} -listed one of the coordinate pairs are equal to: a binary representation of $k-1$; the binary representation of $k-1$ added to a constant value under Modulo-8 addition; the binary representation of $k-1$ subjected to a consistent bit reordering, or the binary representation of $k-1$ added to a constant value under Modulo-8 addition and subjected to the consistent bit reordering.
70. The apparatus of claim 69, wherein the signal constellation is a reflection symmetric constellation, and wherein bit sequences corresponding to constellation symbols within a common group of reflection symmetric constellation symbols have identical quadrant non-specific bits.
71. A method for wireless communication using digital Quadrature Amplitude Modulation (QAM), the method comprising:
 translating between constellation symbols and bit sequences corresponding to the constellation symbols using a mapping module electronic component of a wireless communication device, in accordance with a 32-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,
 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 32-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.358210	0.139403
0.235261	0.421763
0.930790	0.364753
0.787656	0.614713
0.125482	0.991921
0.382784	0.922993
0.990631	0.136566
0.626638	0.778830

72. An apparatus for a wireless communication device configured for wireless communication using digital Quadrature Amplitude Modulation (QAM), the apparatus comprising:

5 a mapping module electronic component configured to translate between constellation symbols and bit sequences corresponding to the constellation symbols in accordance with a 32-point constellation, the constellation symbols used in modulating a signal for transmission or detected in a received signal, or both,

10 wherein normalized magnitudes of the constellation symbols in a first quadrant of the 32-point constellation are defined by the following coordinate pairs to at least three decimal places of precision:

0.358210	0.139403
0.235261	0.421763
0.930790	0.364753
0.787656	0.614713
0.125482	0.991921
0.382784	0.922993
0.990631	0.136566
0.626638	0.778830

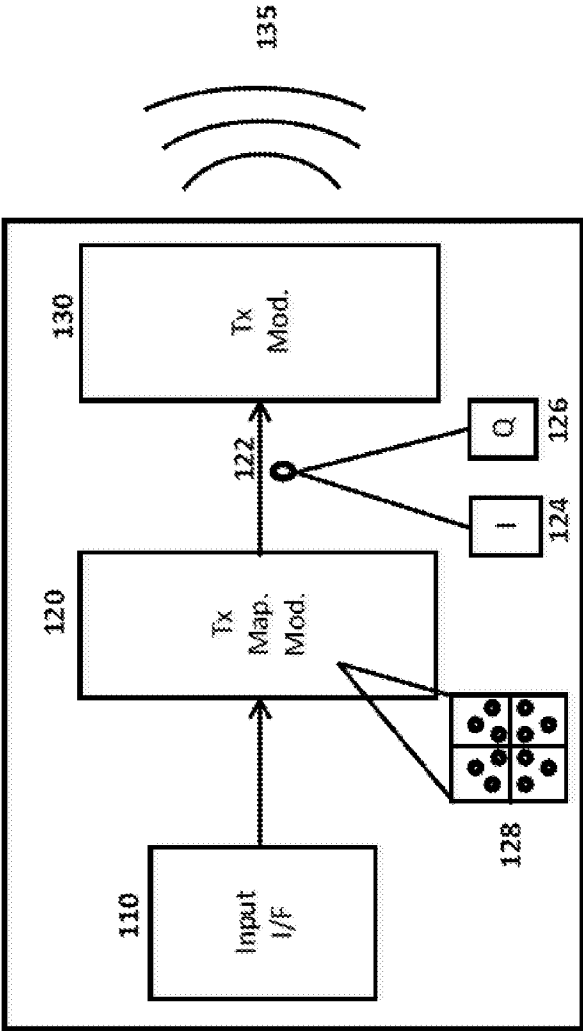


FIG.1

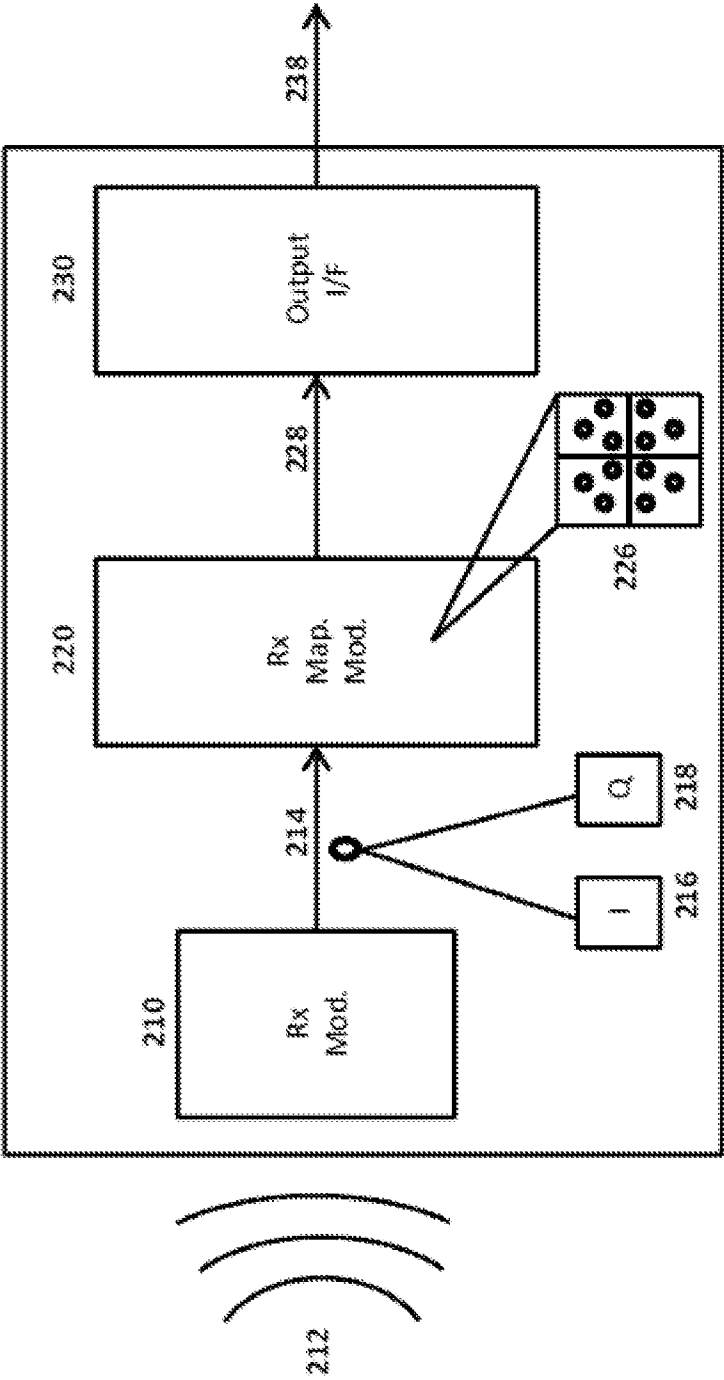


FIG.2

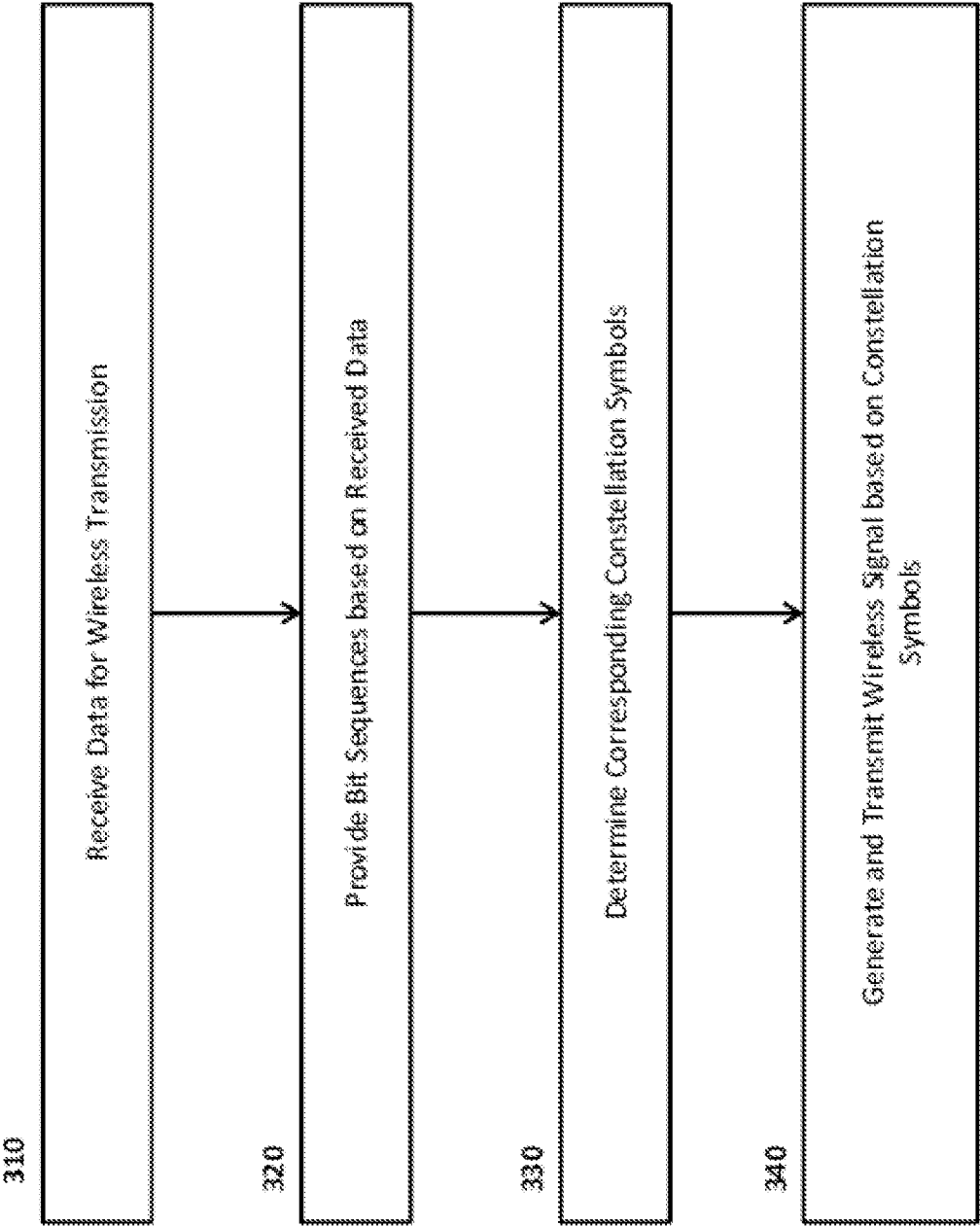


FIG.3

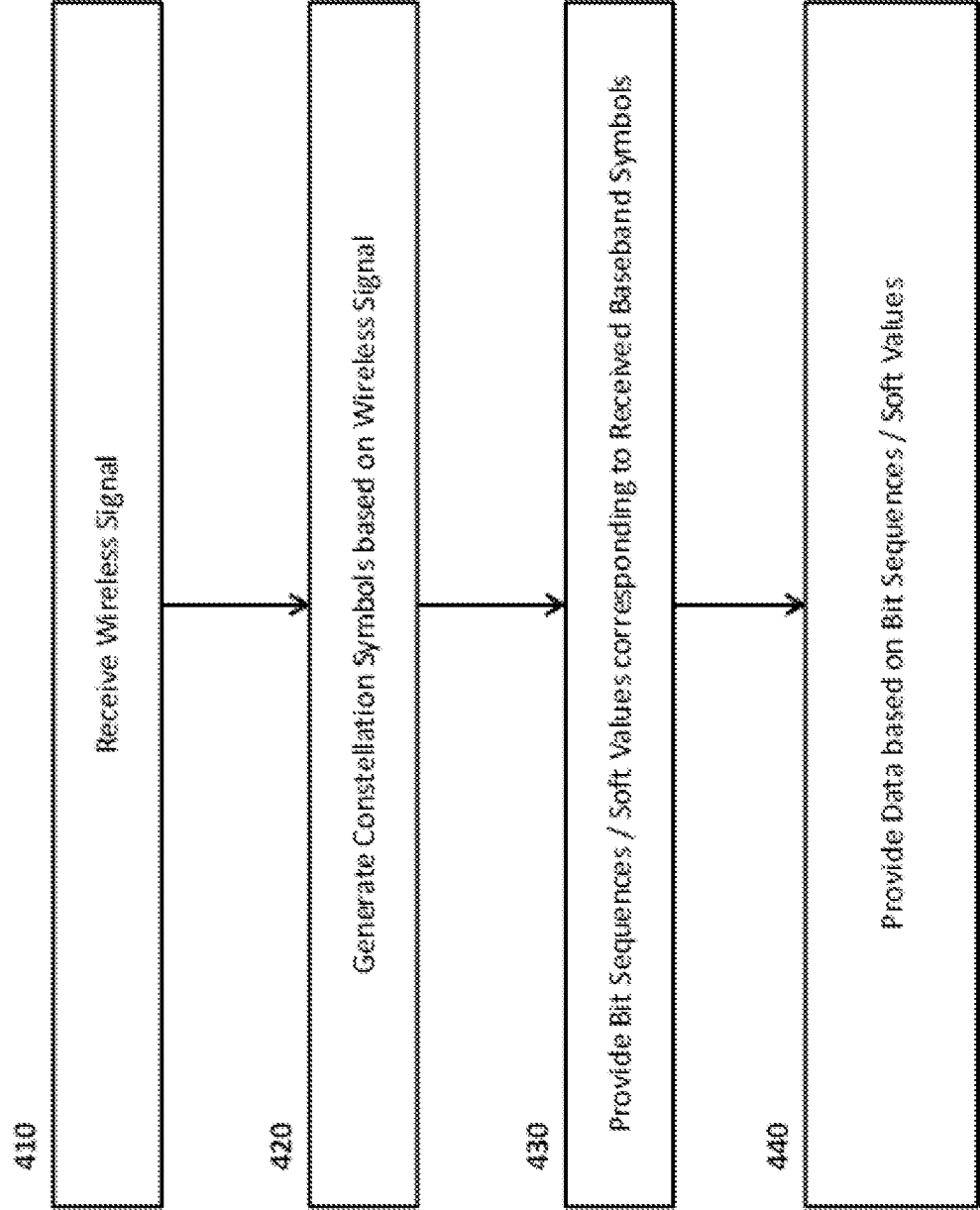


FIG.4

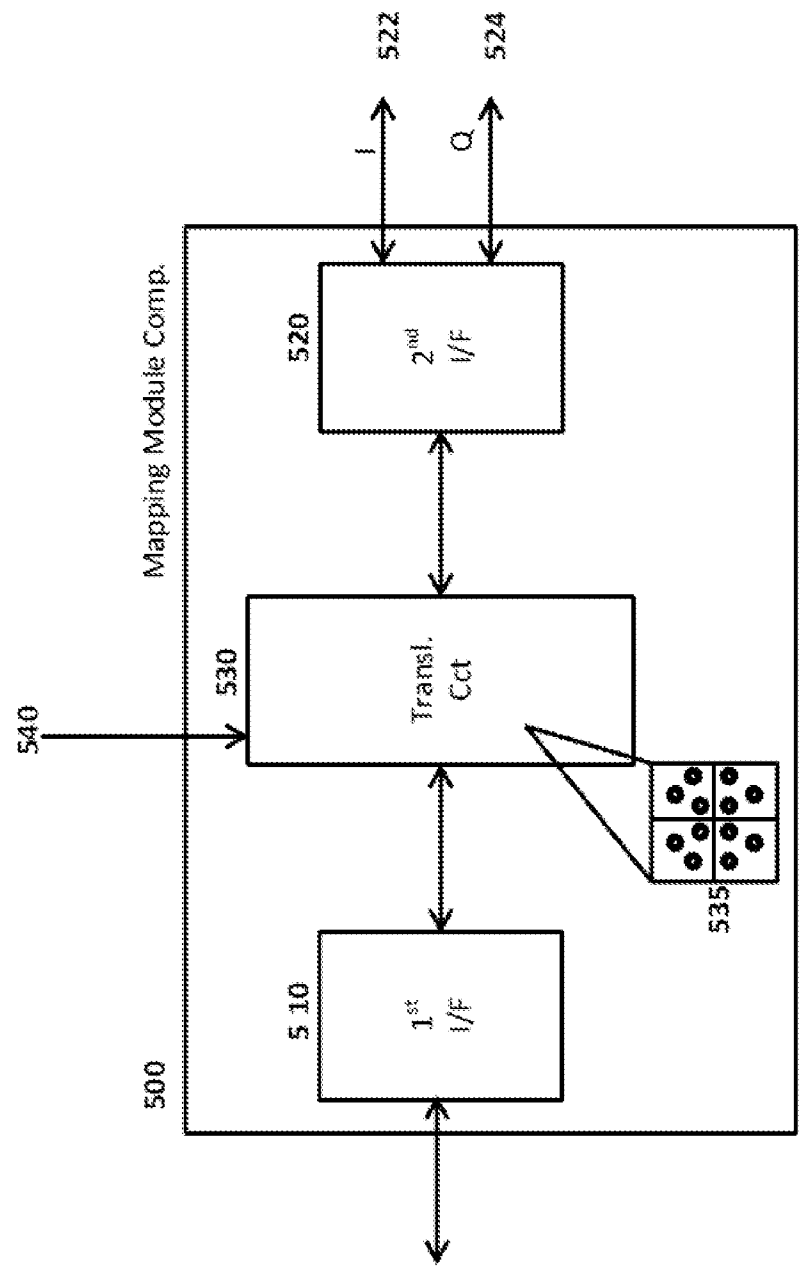


FIG.5

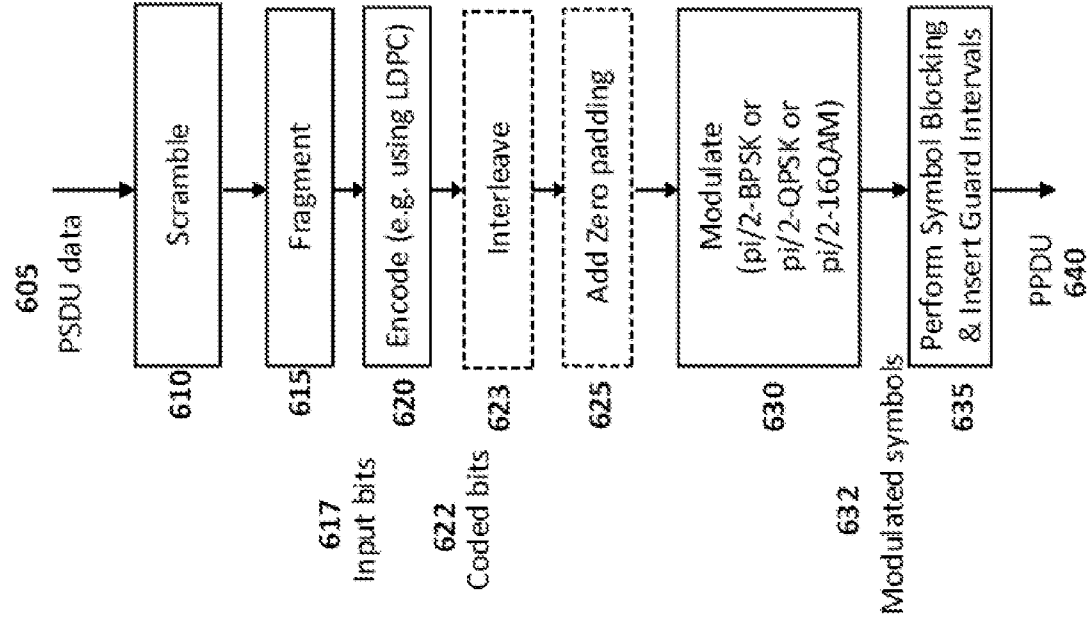


FIG.6

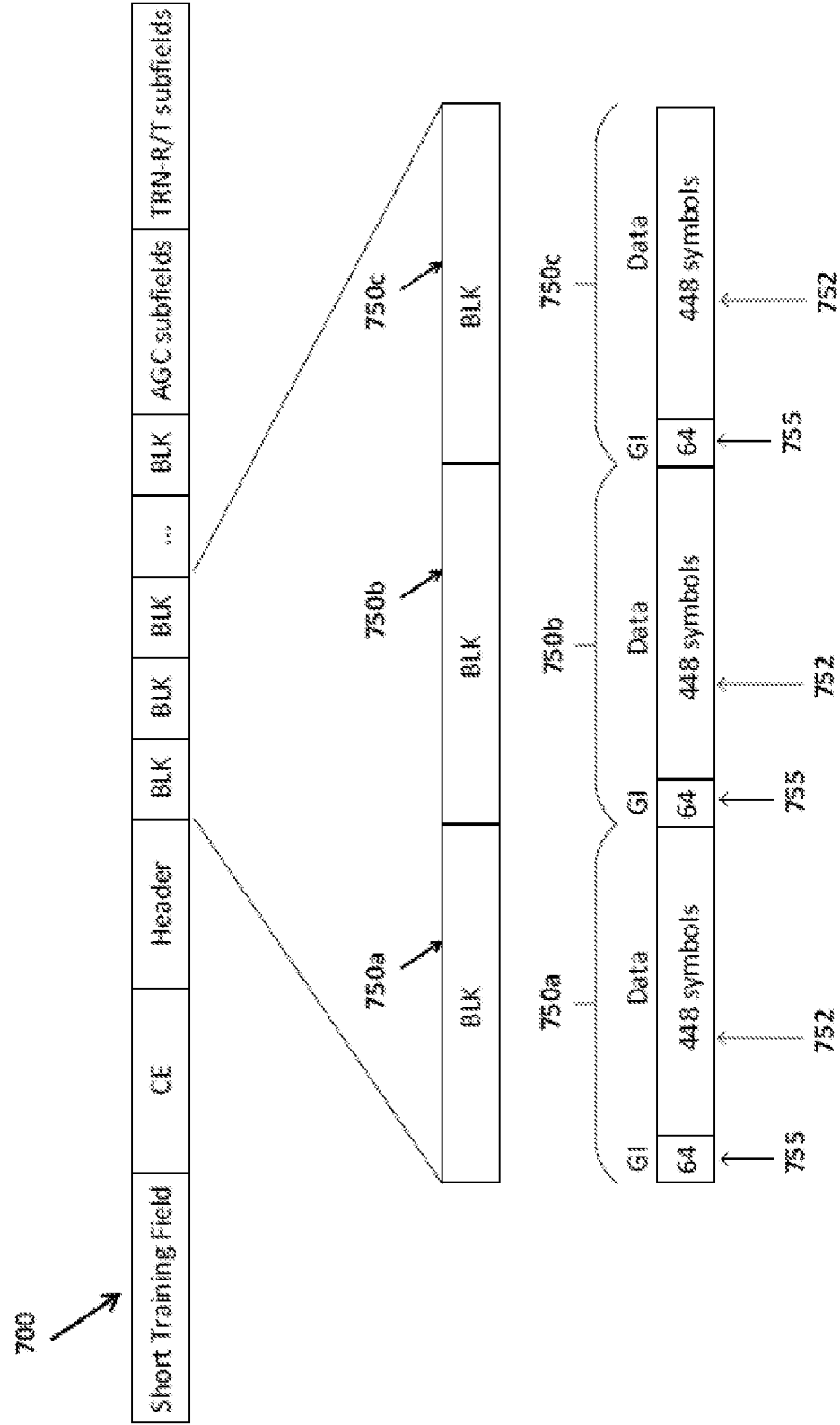


FIG.7

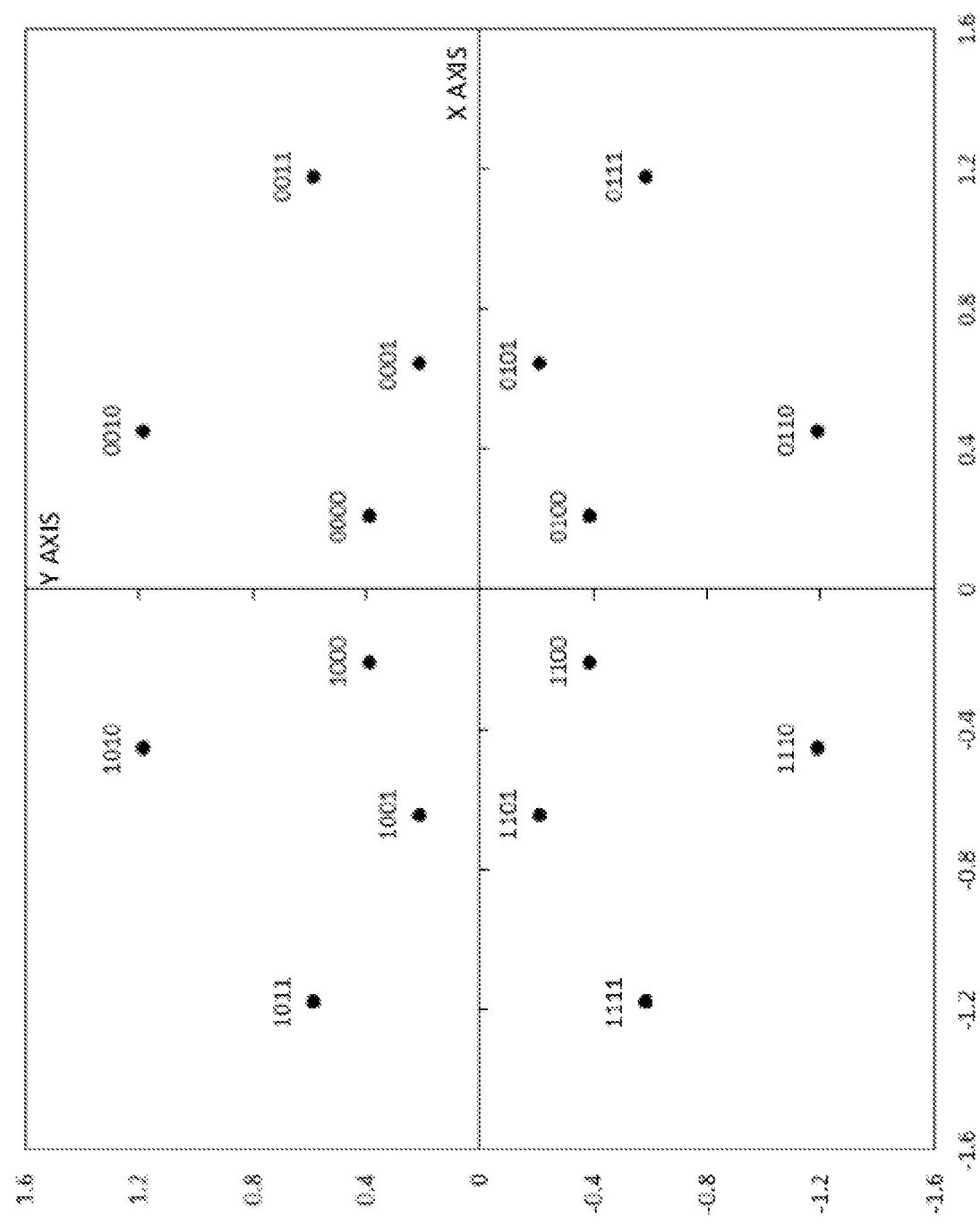


FIG.8

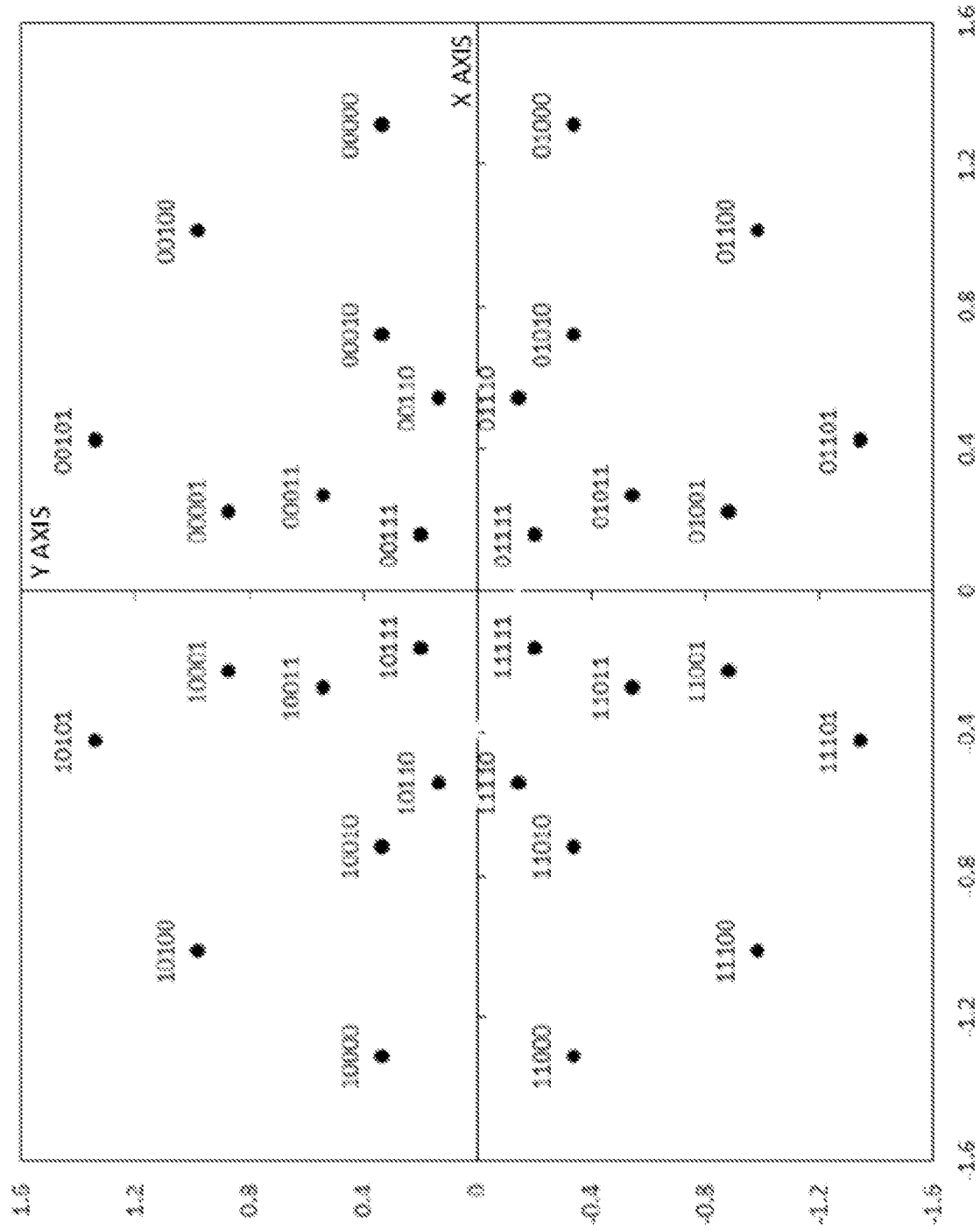


FIG.9

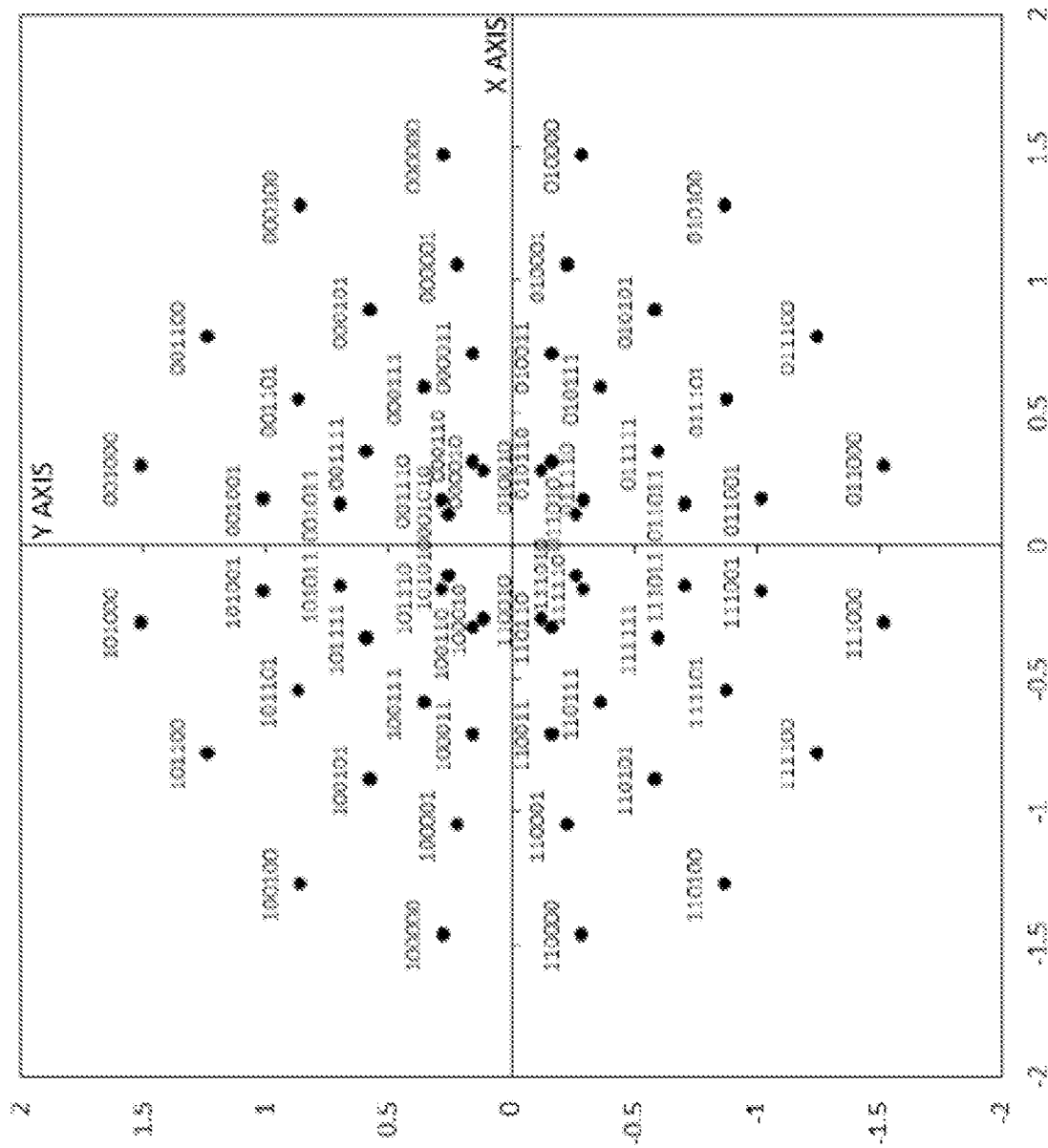
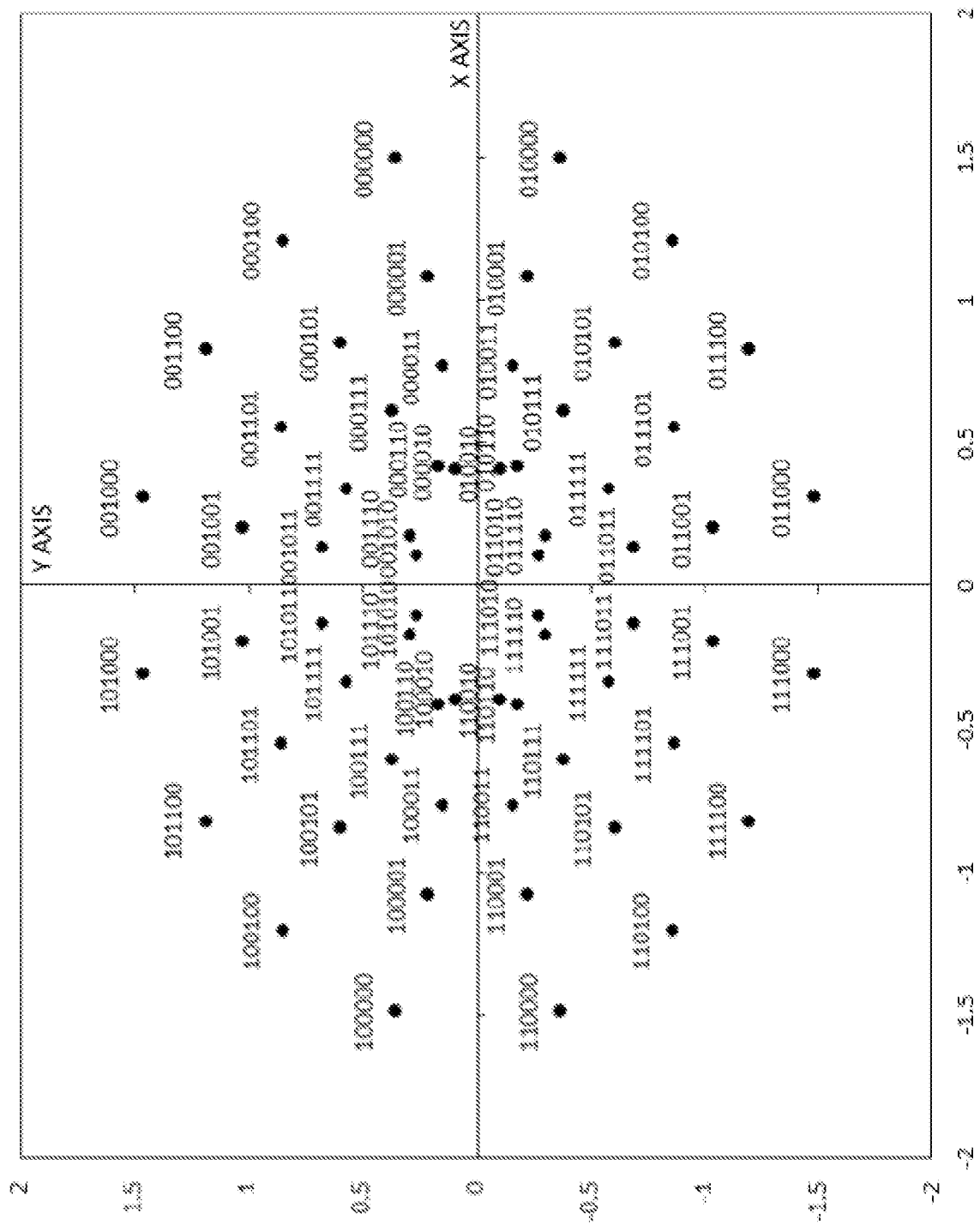


FIG.10A



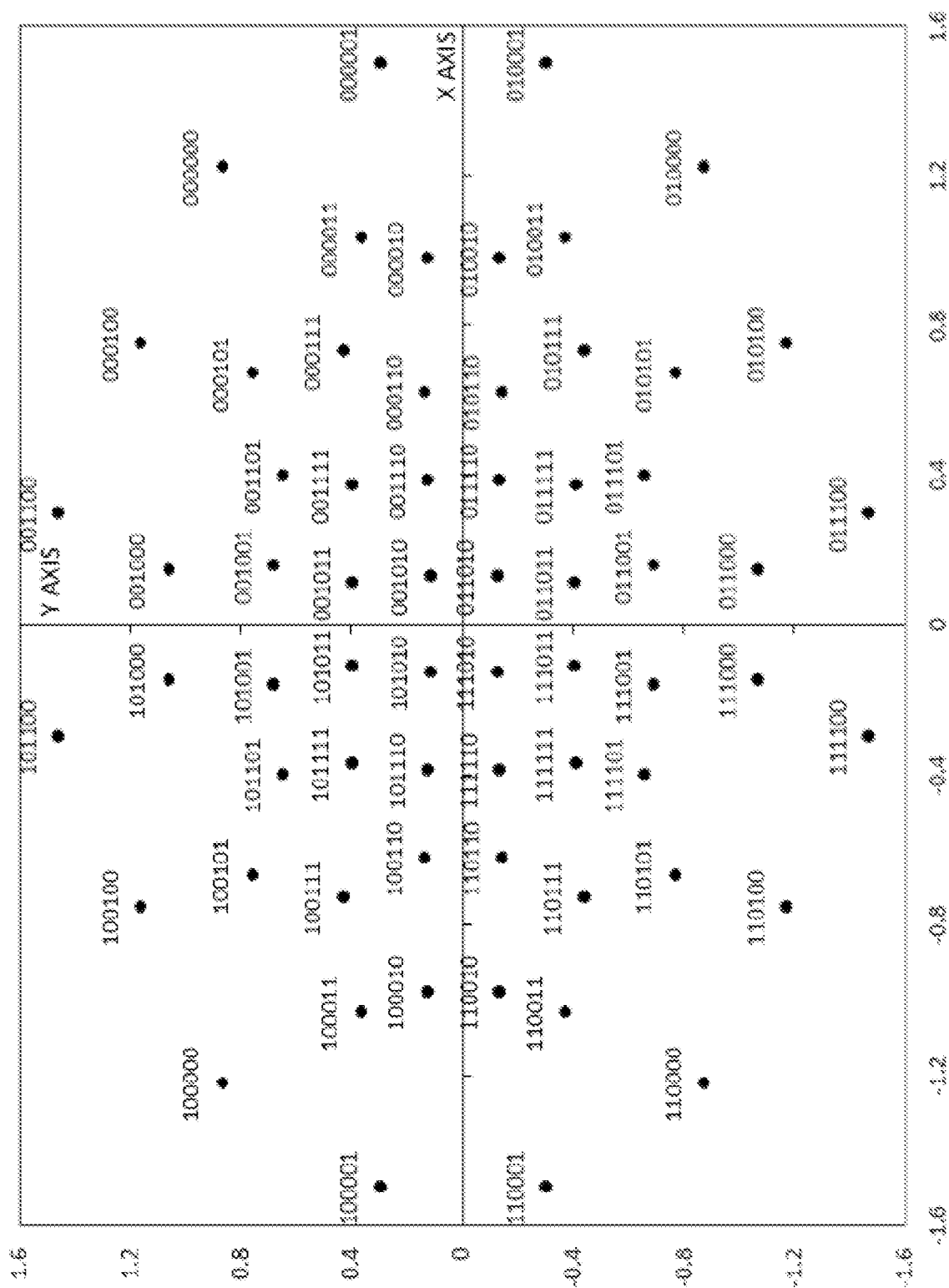


FIG.10C

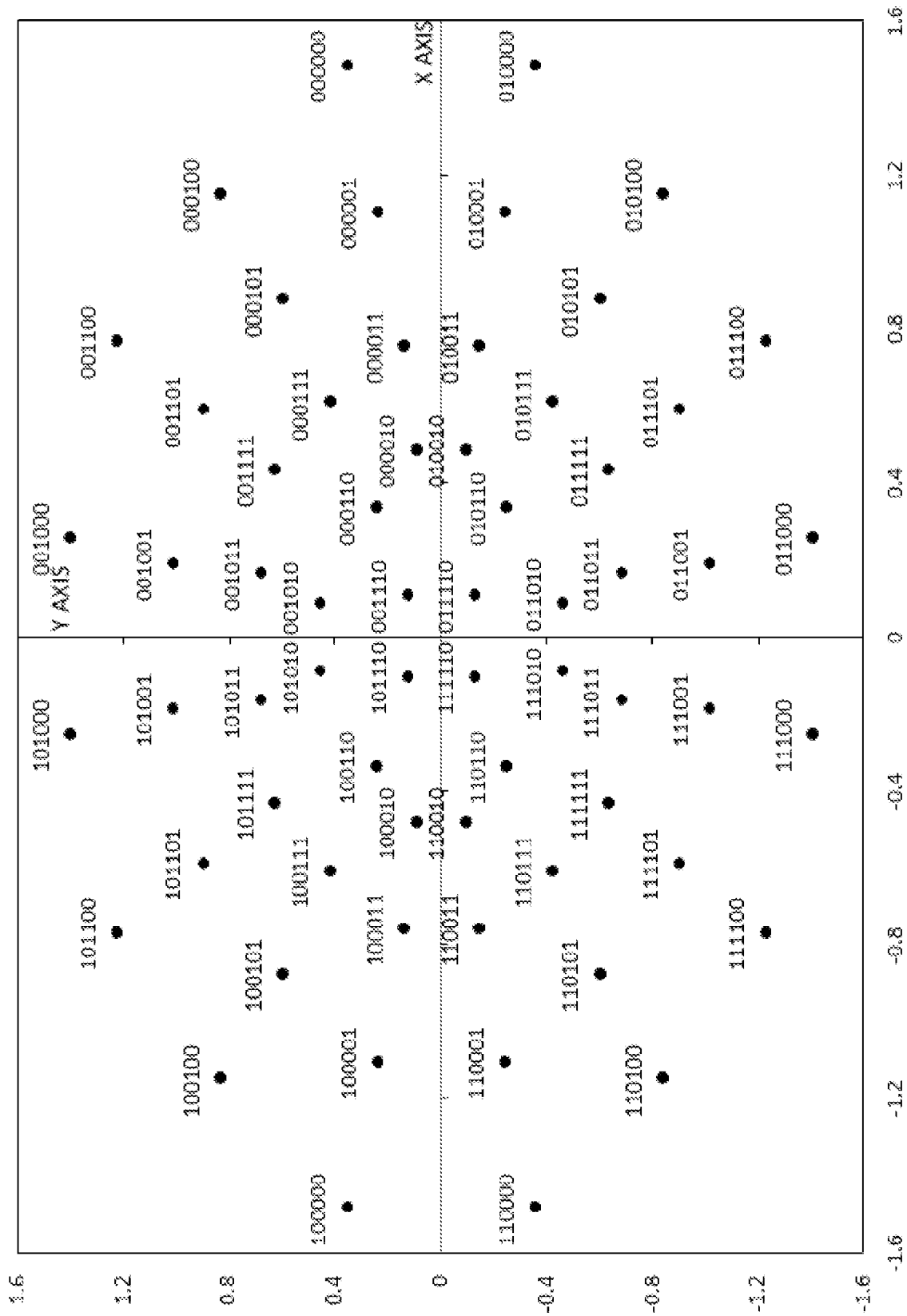


FIG.10D

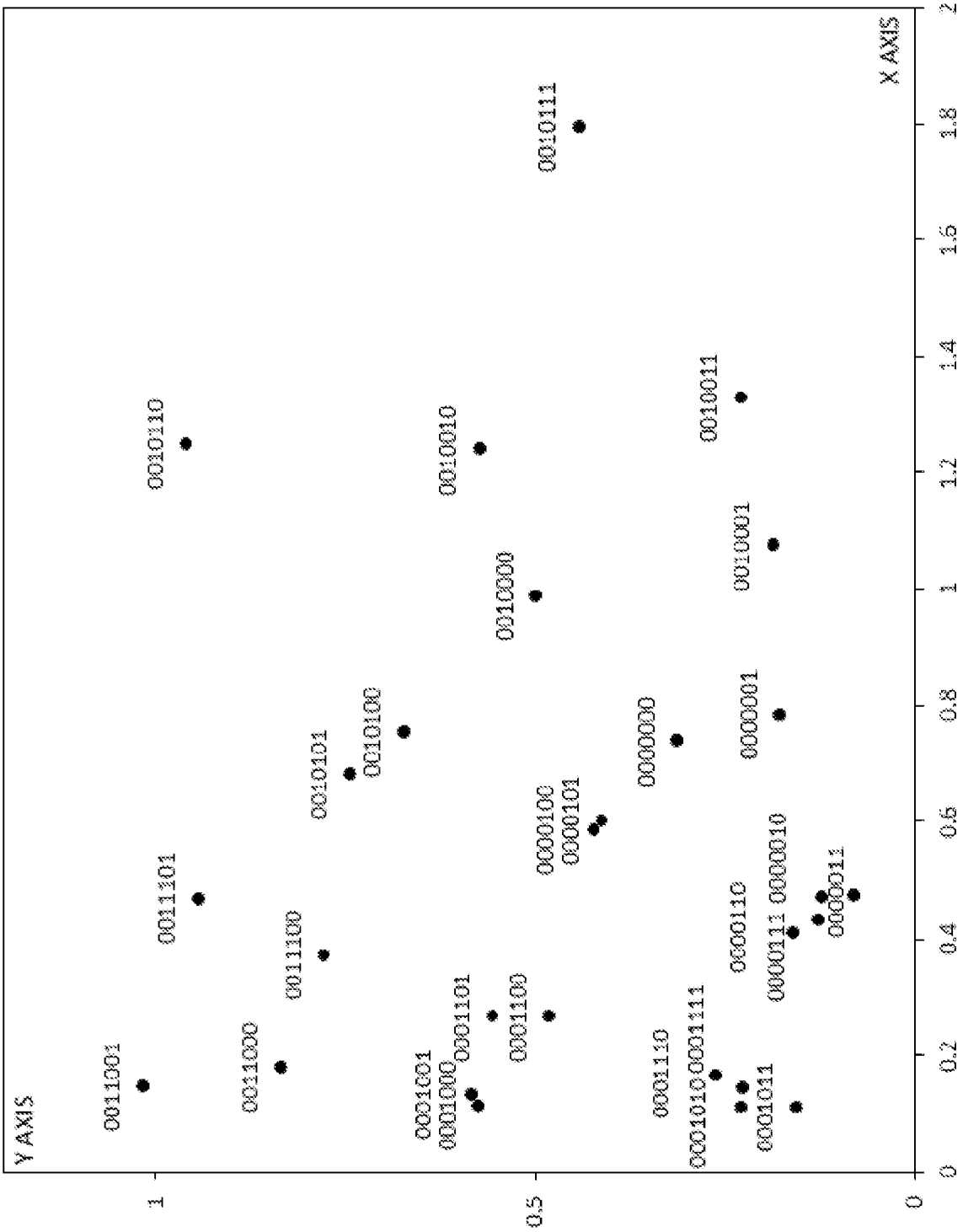


FIG.11A

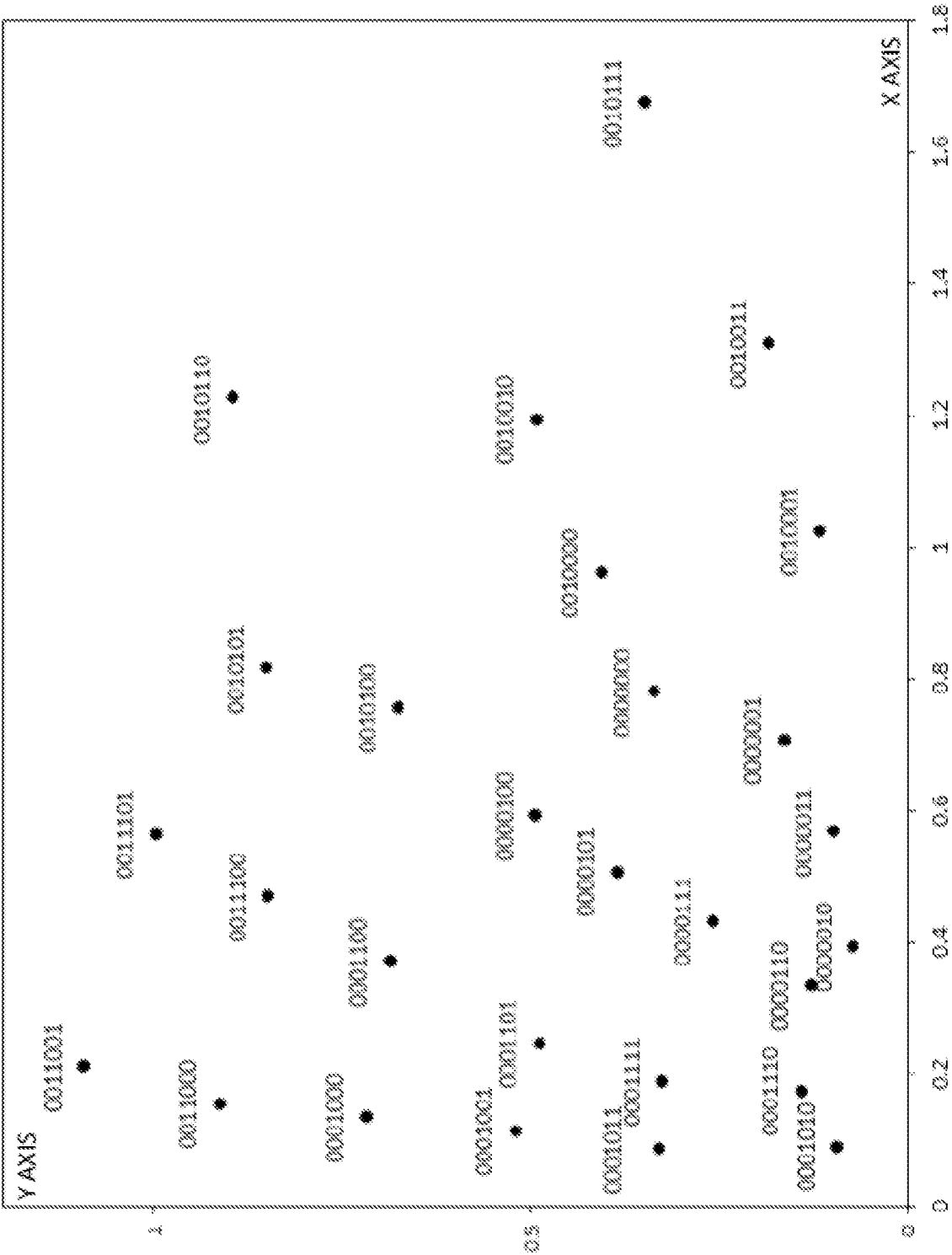


FIG.11B

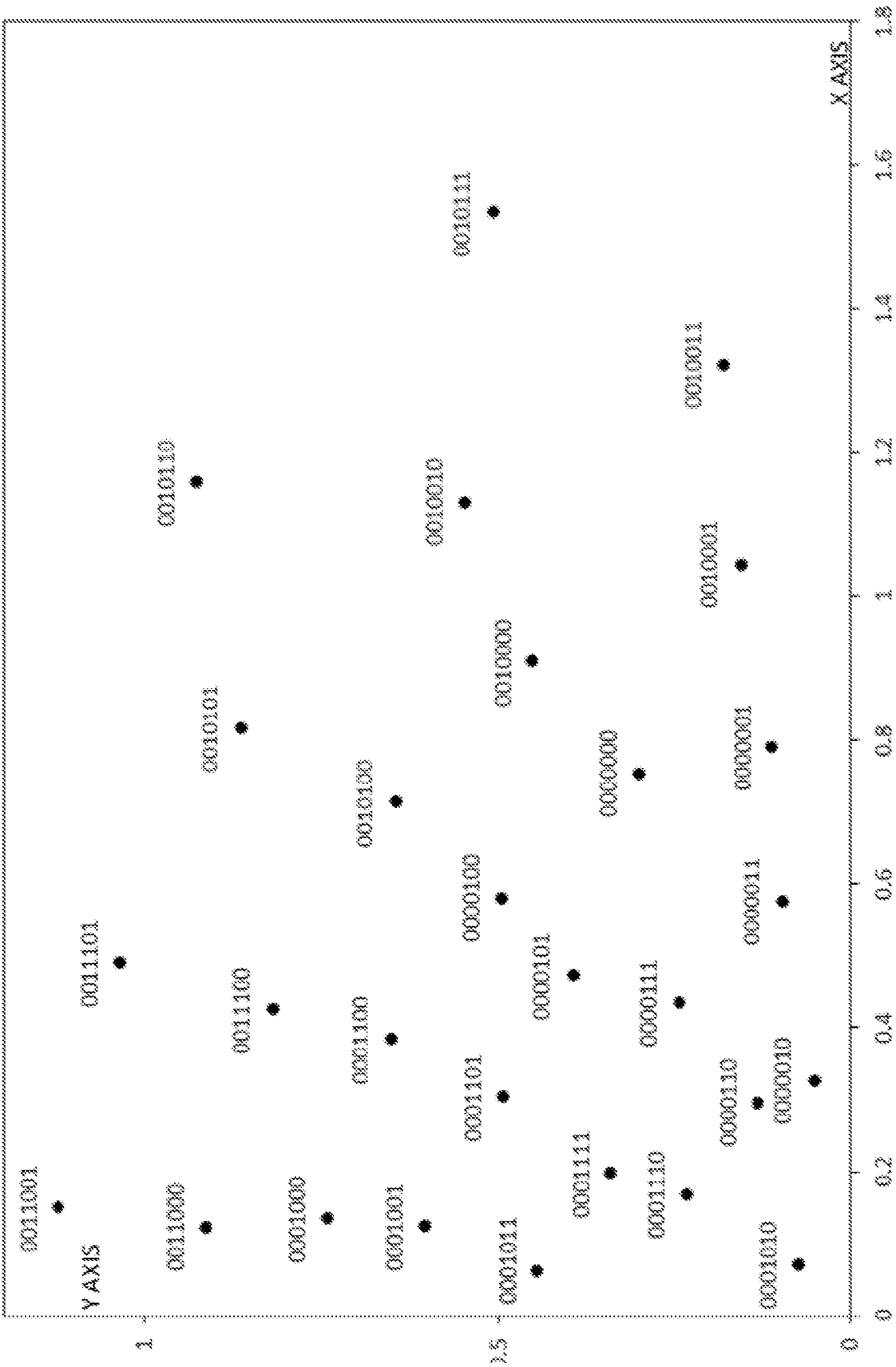


FIG.11D

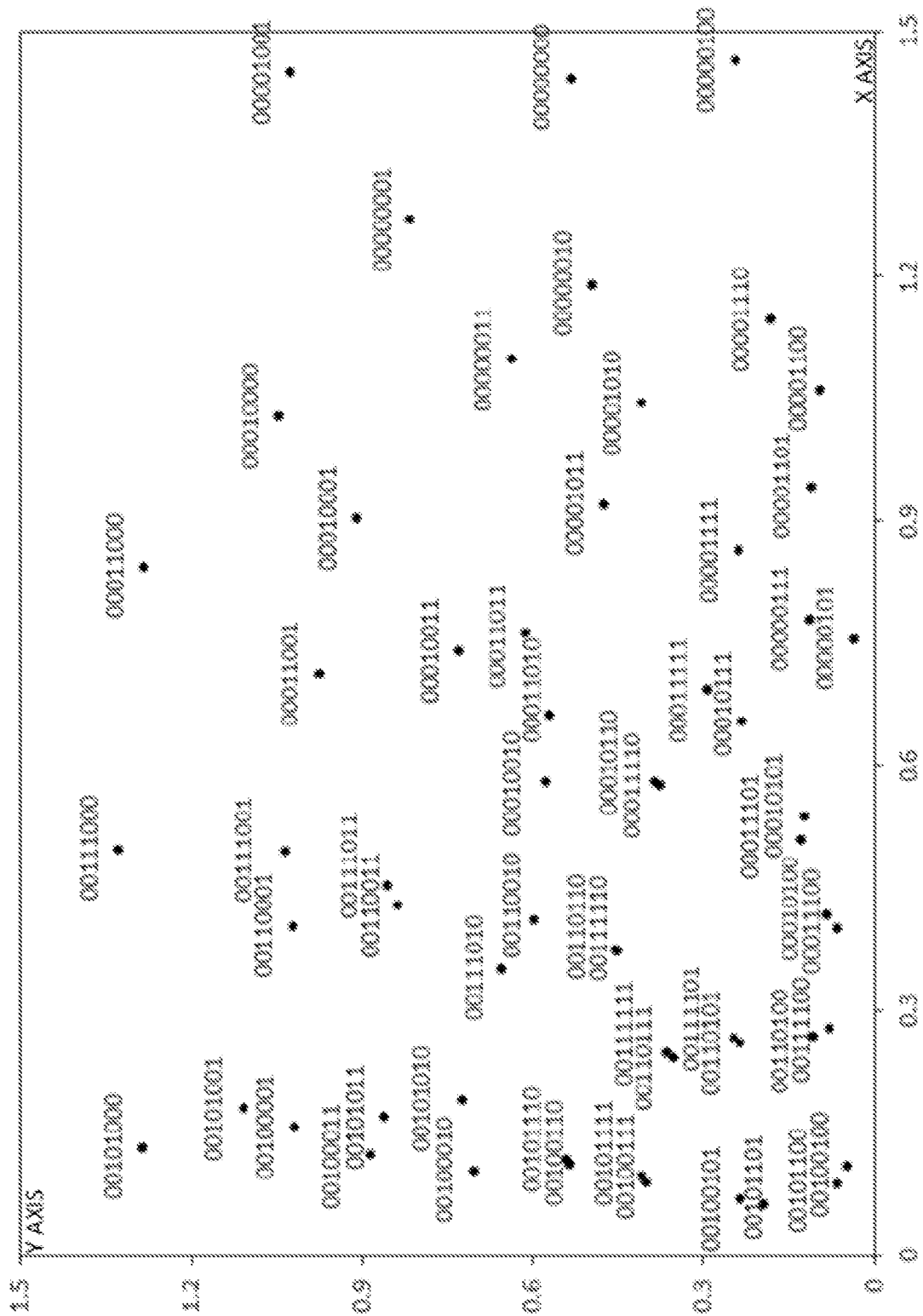


FIG.12A

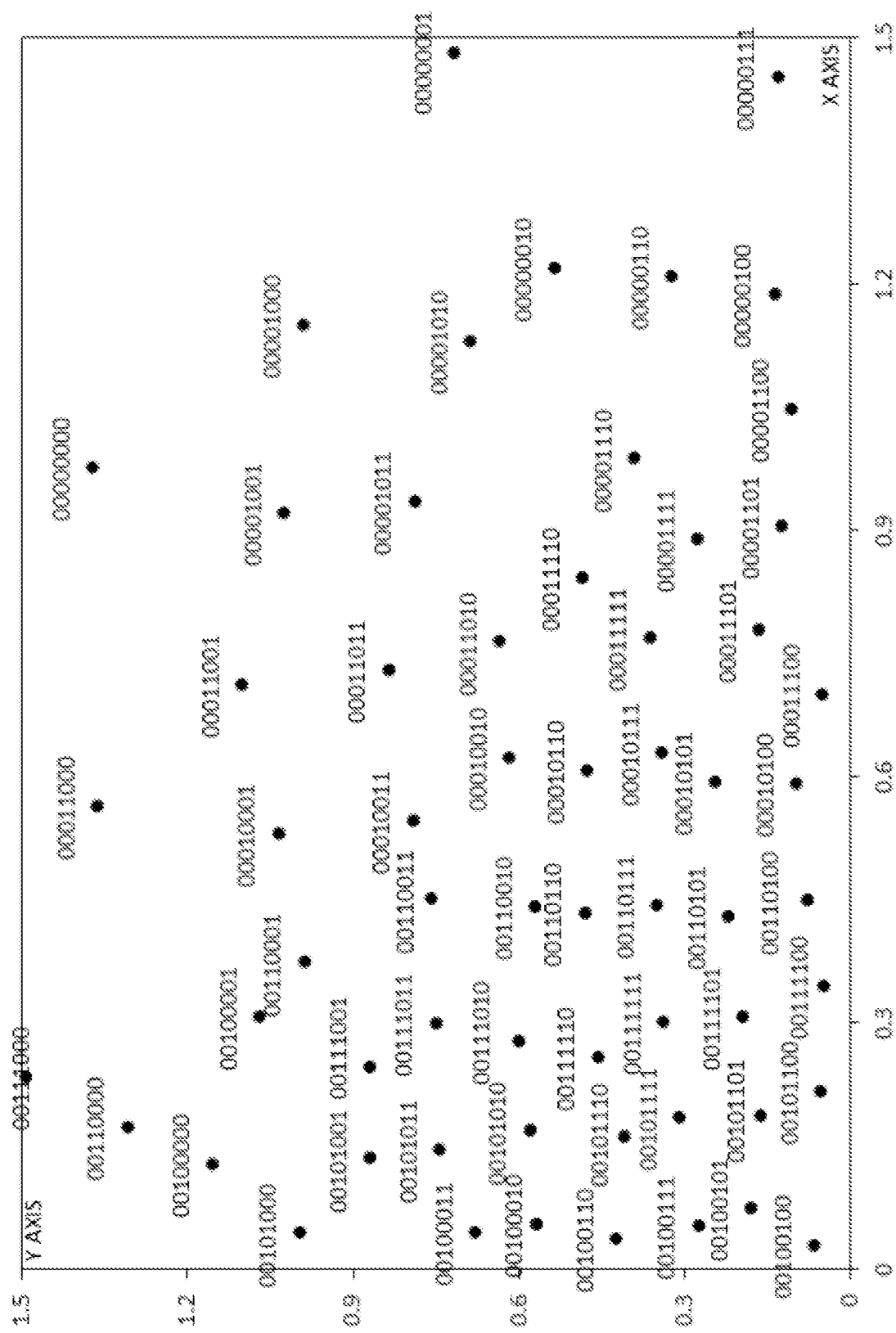


FIG.12B

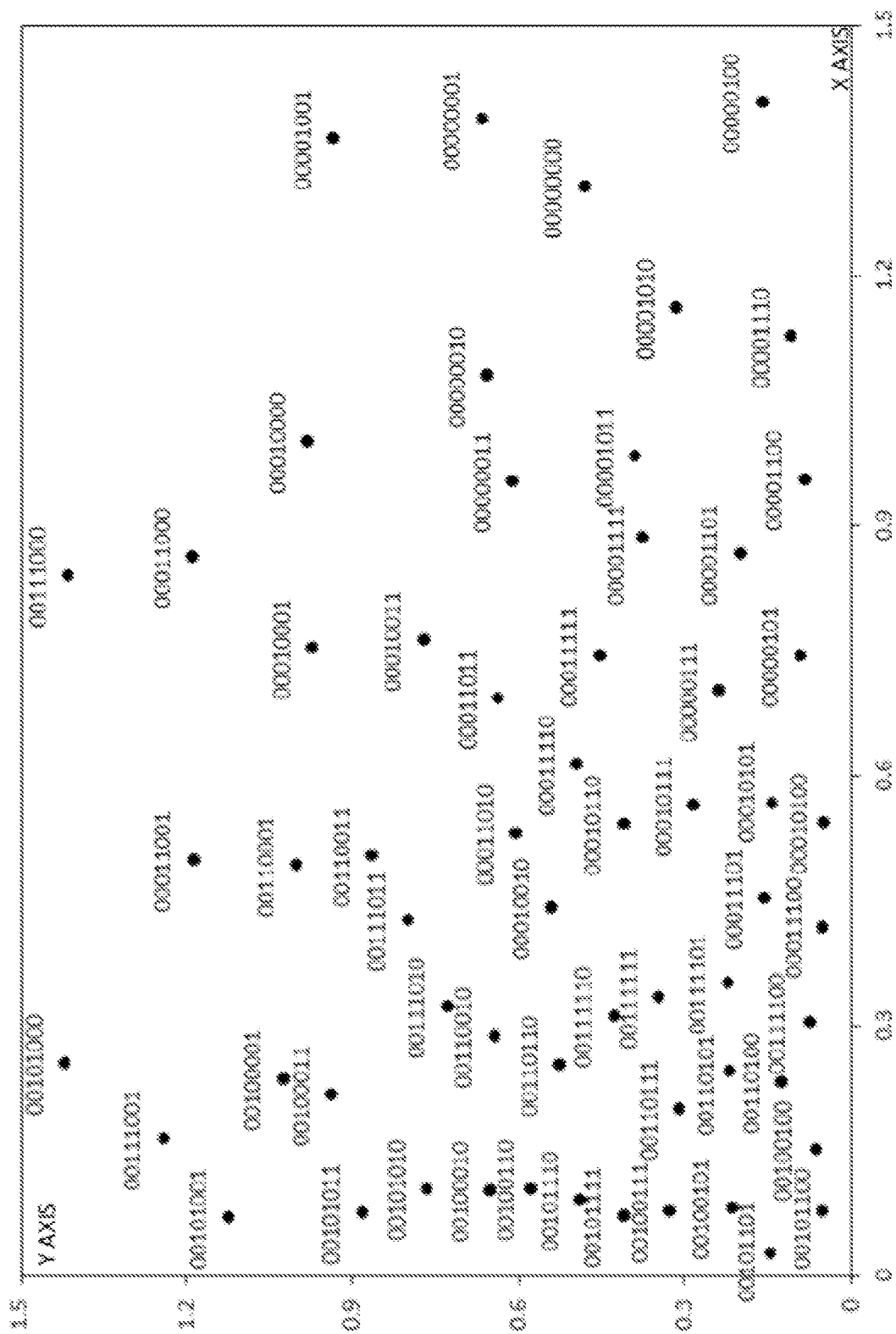


FIG.12C

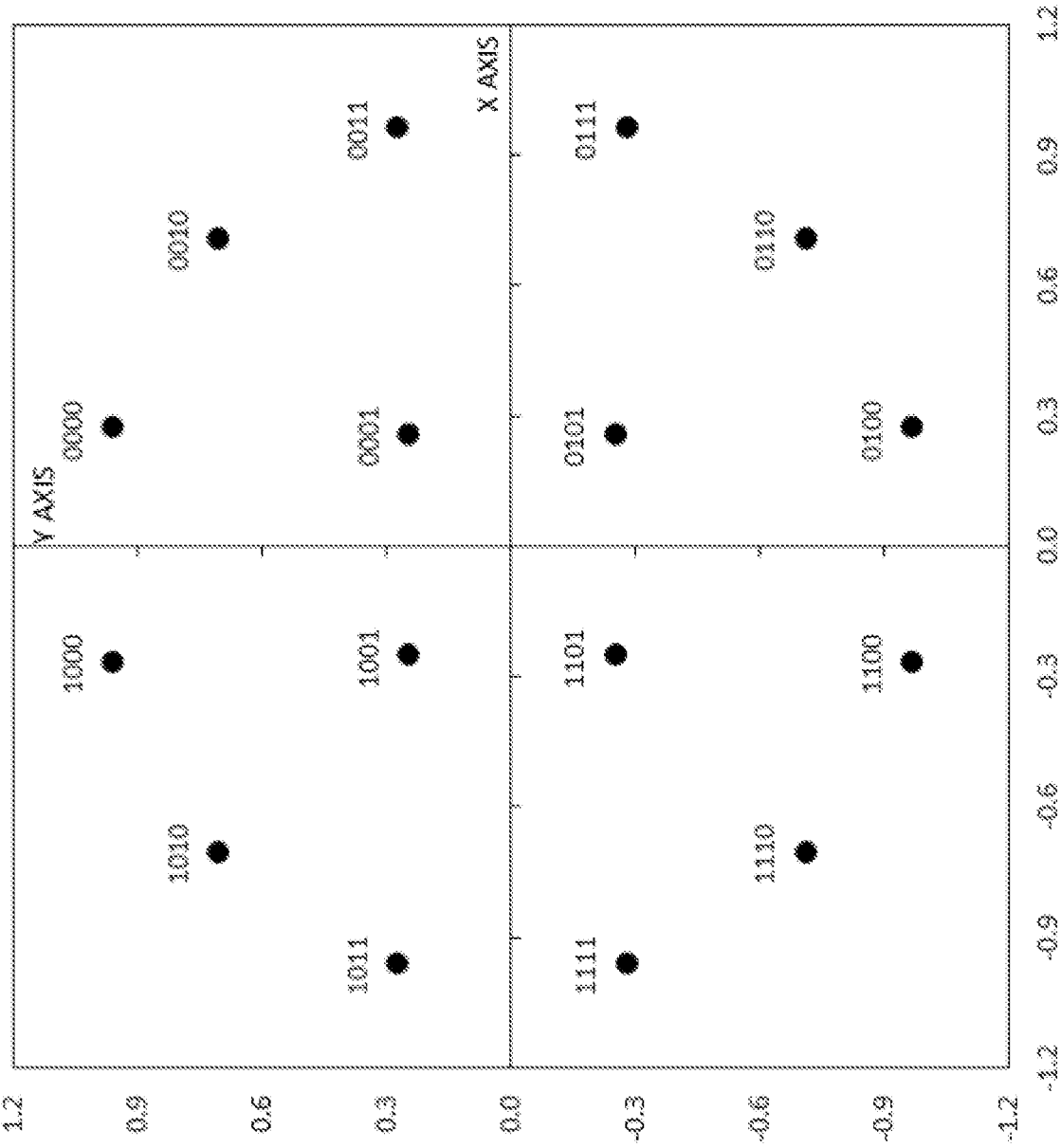


FIG.13

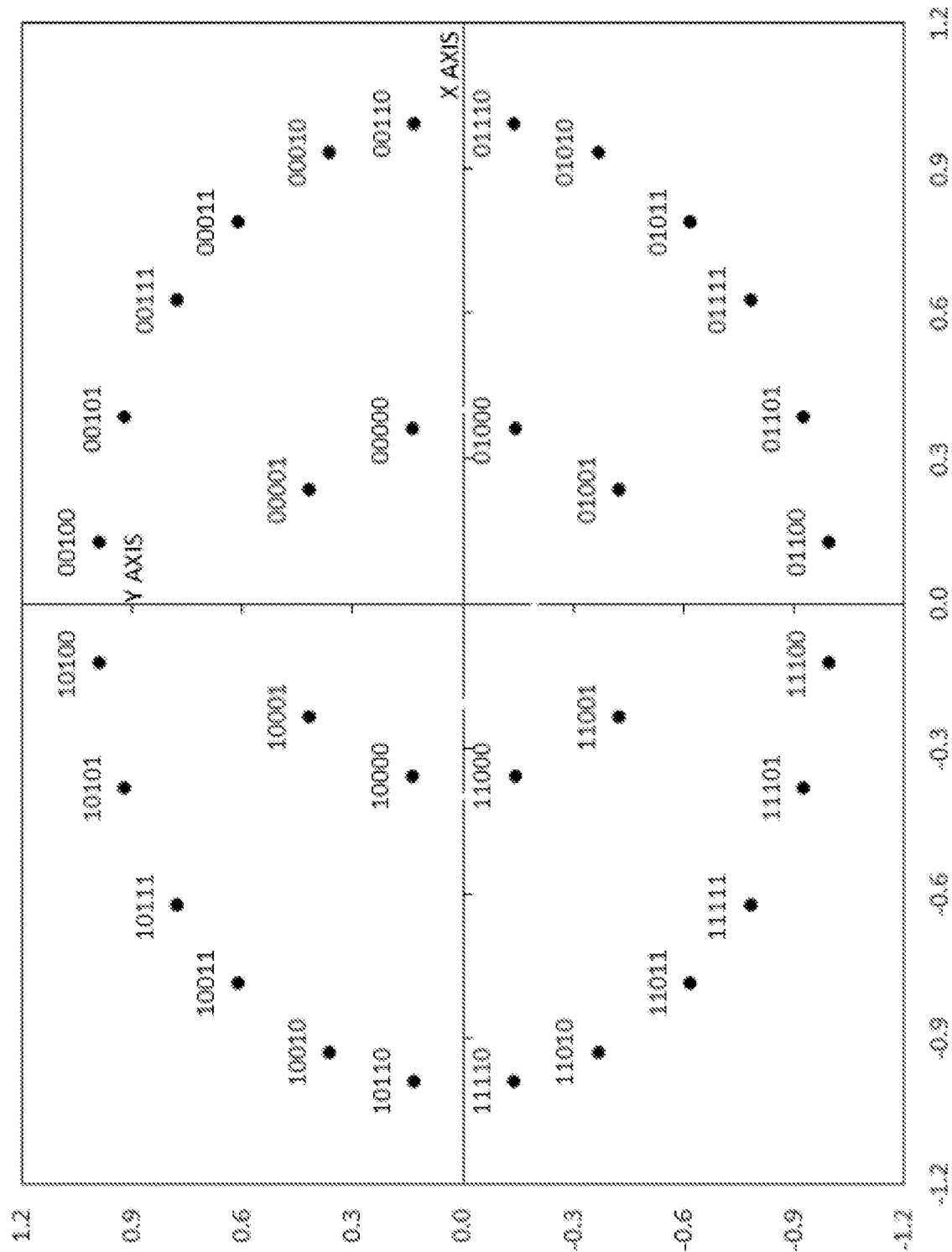


FIG.14

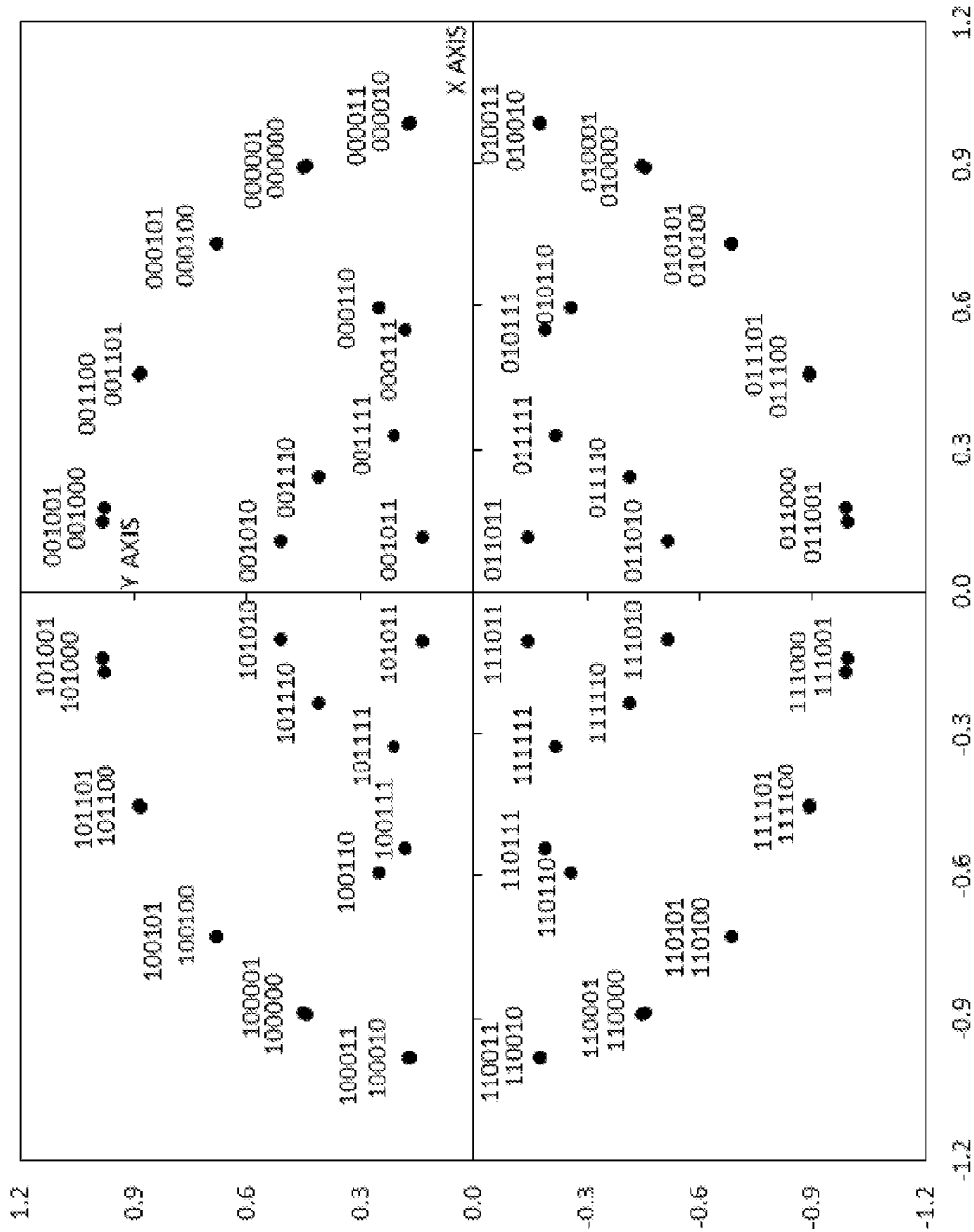
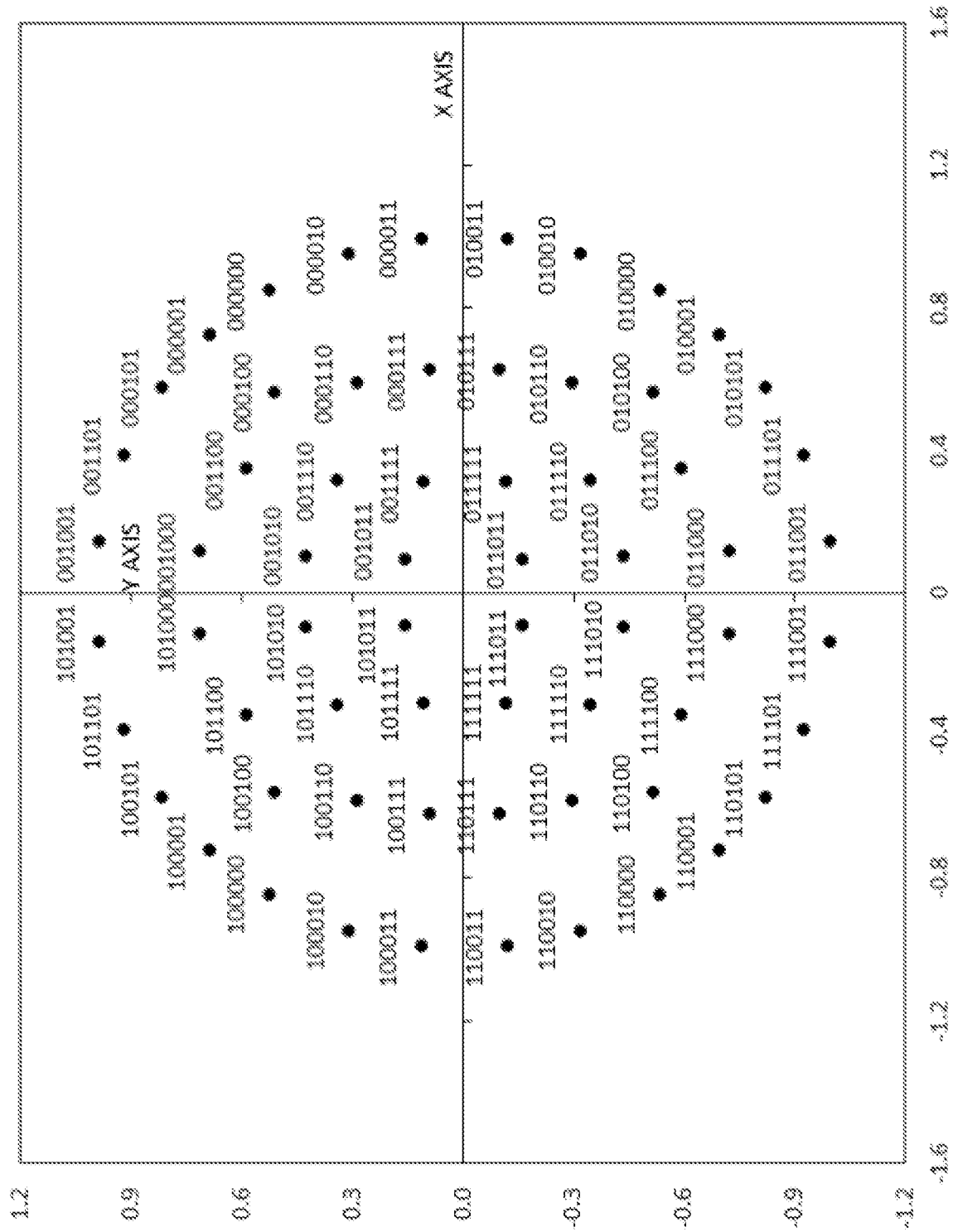


FIG.15A



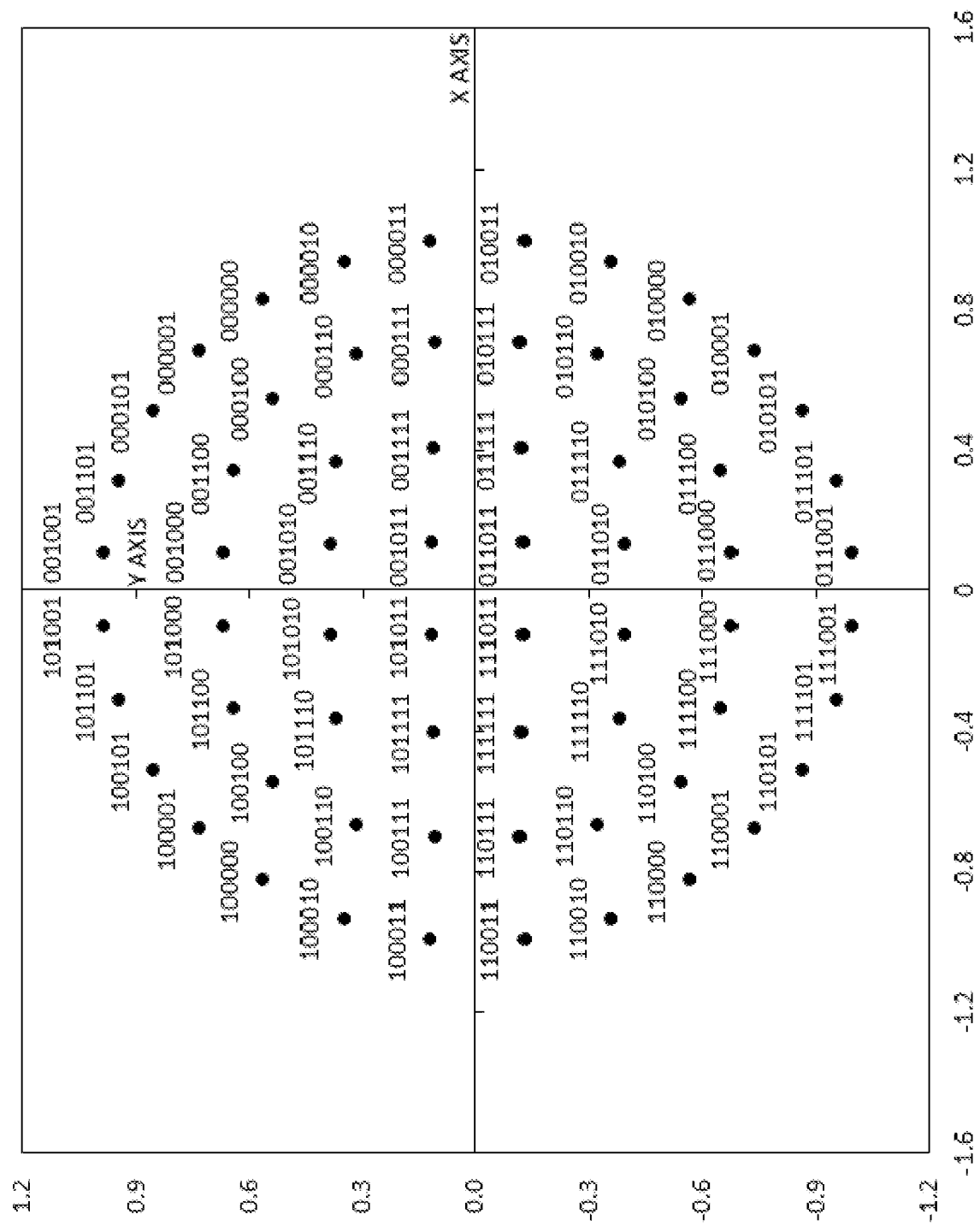


FIG. 15D

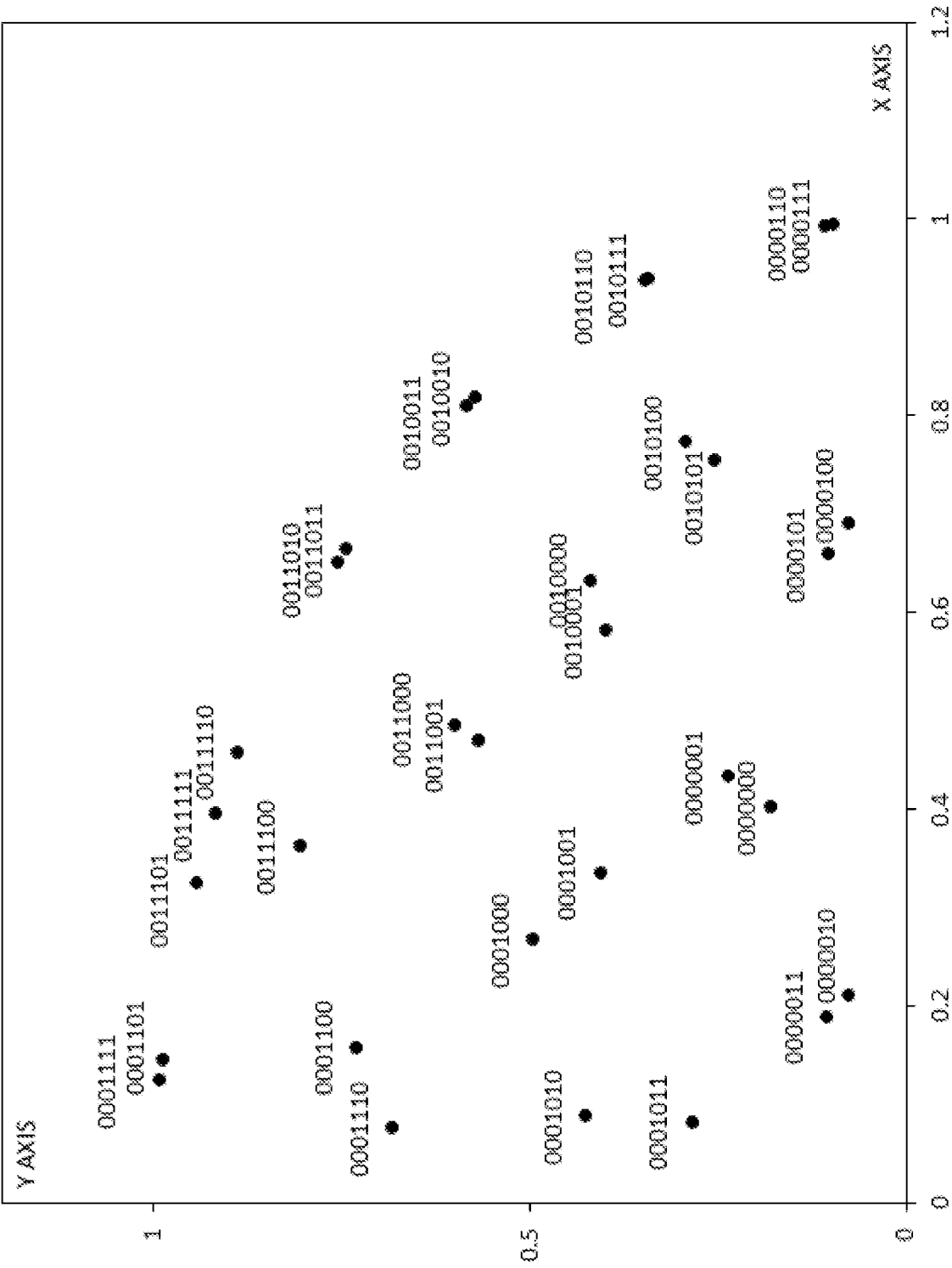


FIG.16A

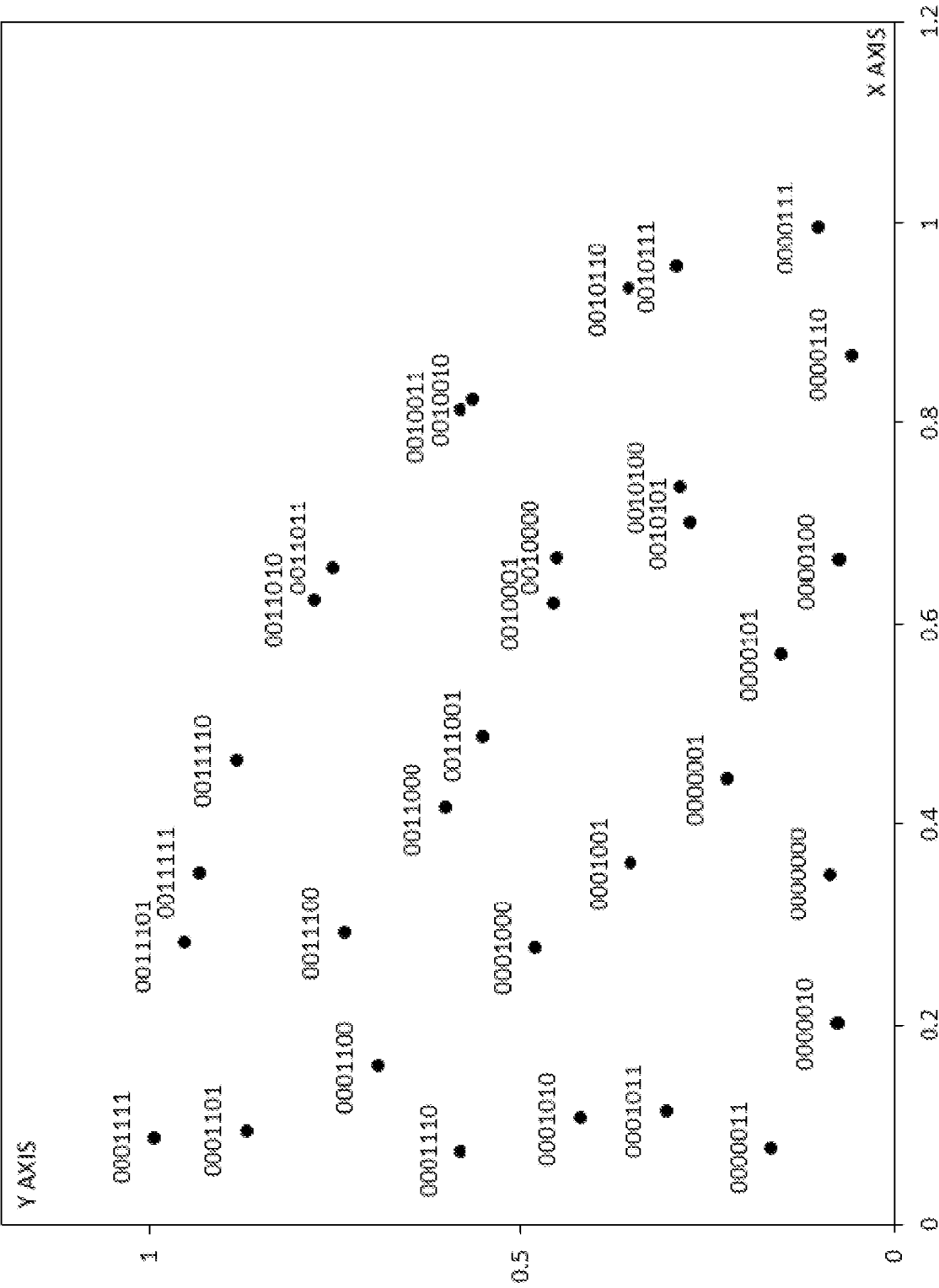


FIG.16B

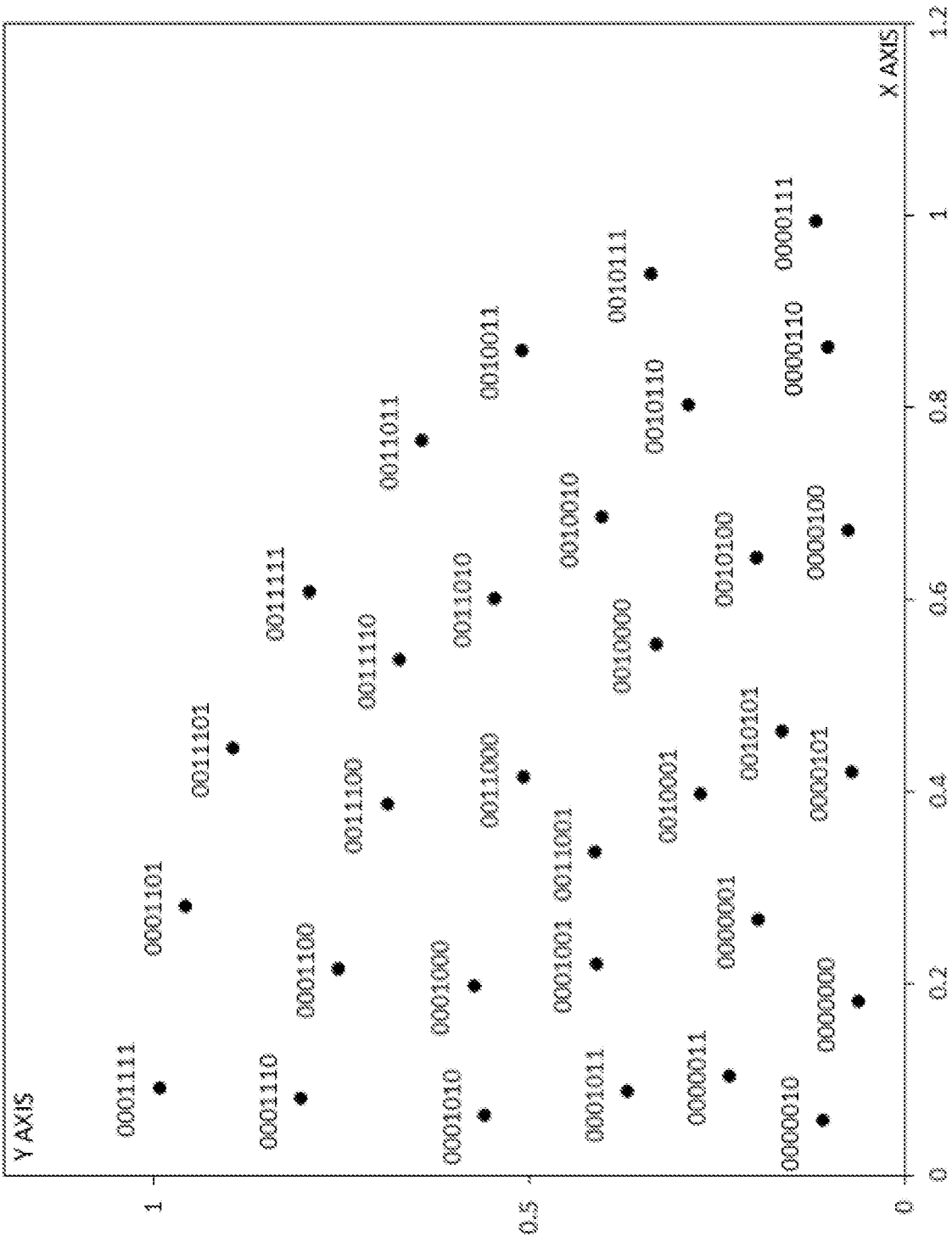


FIG.16C

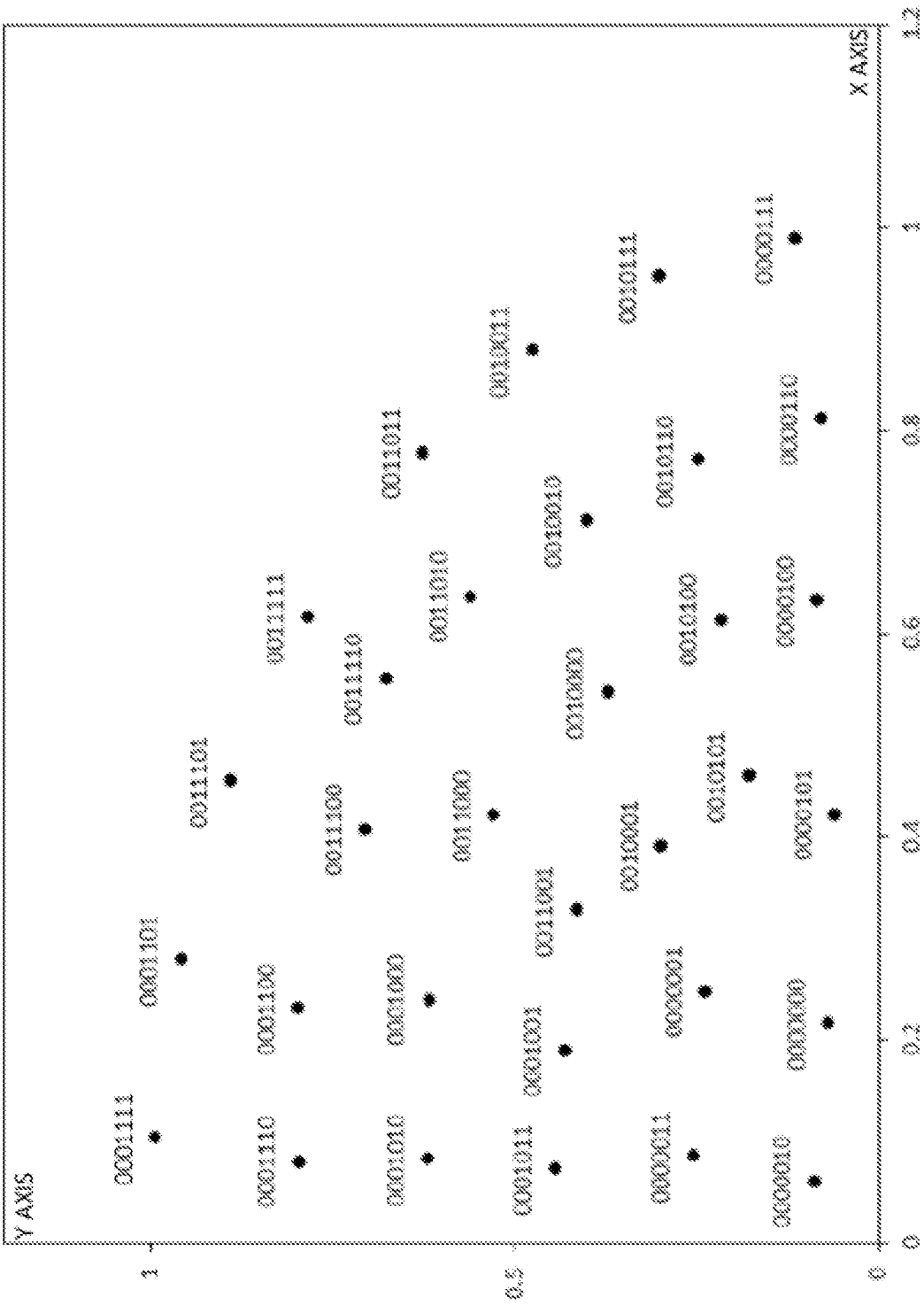


FIG.16D

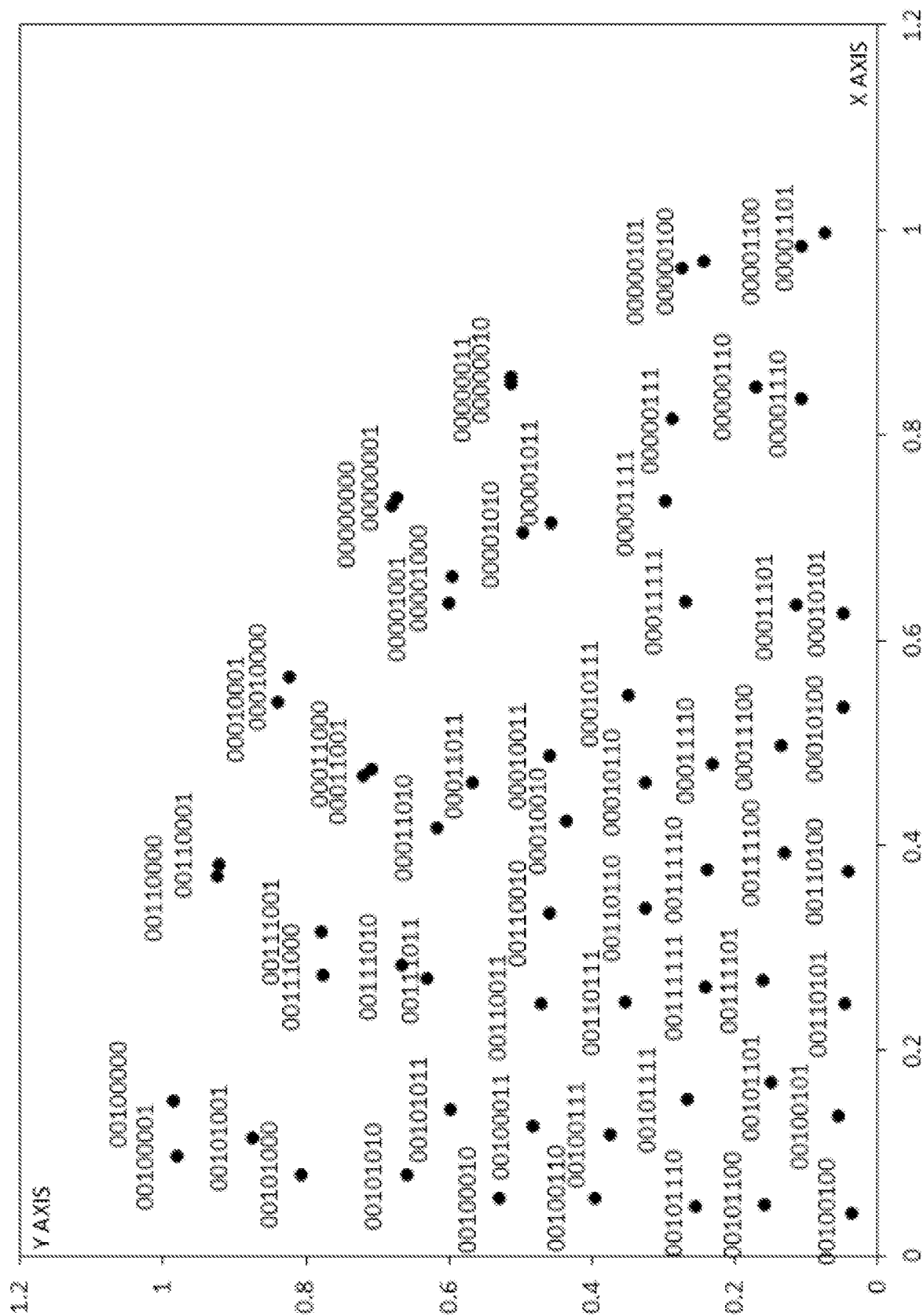


FIG.17A

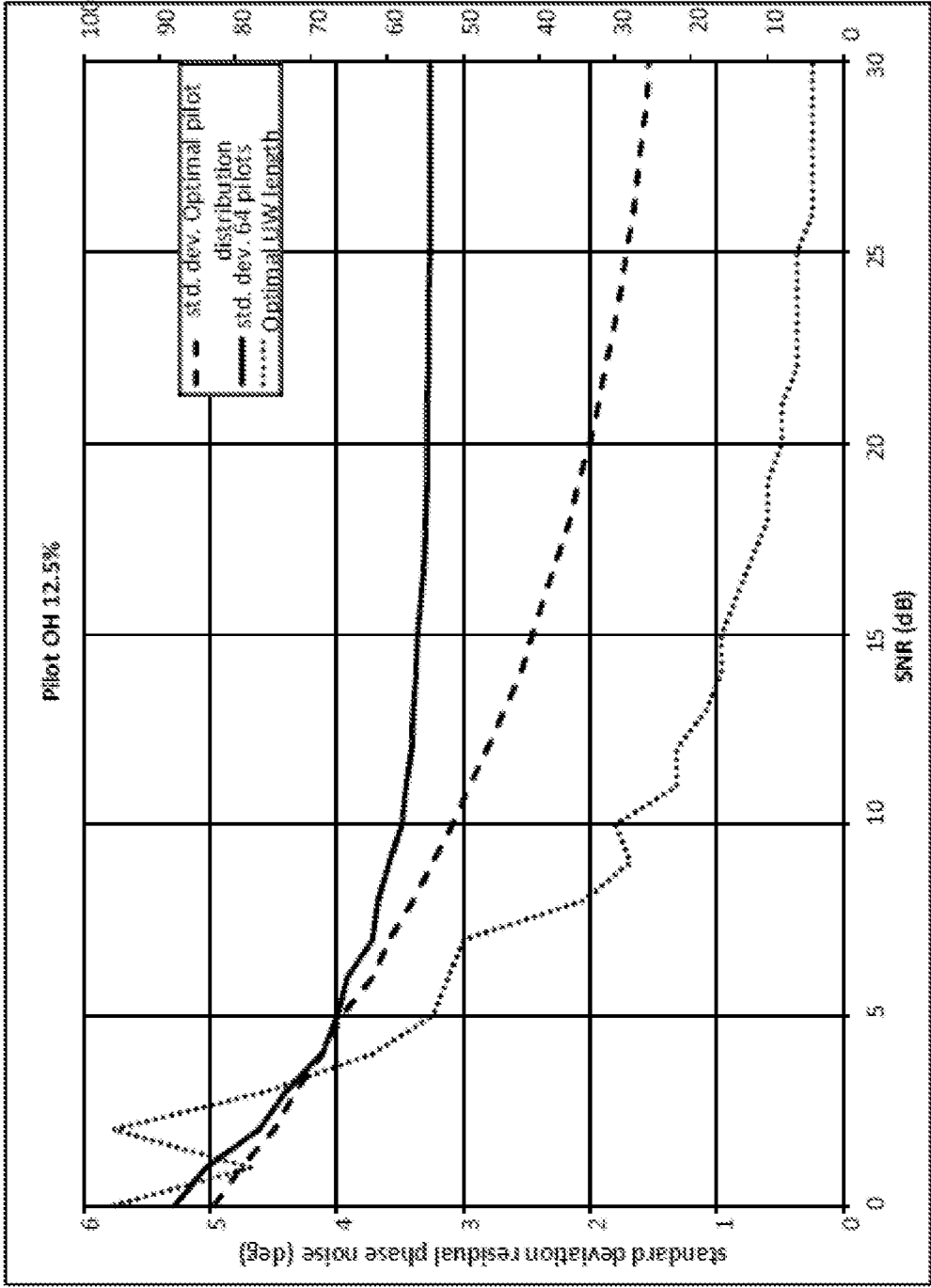


FIG.18

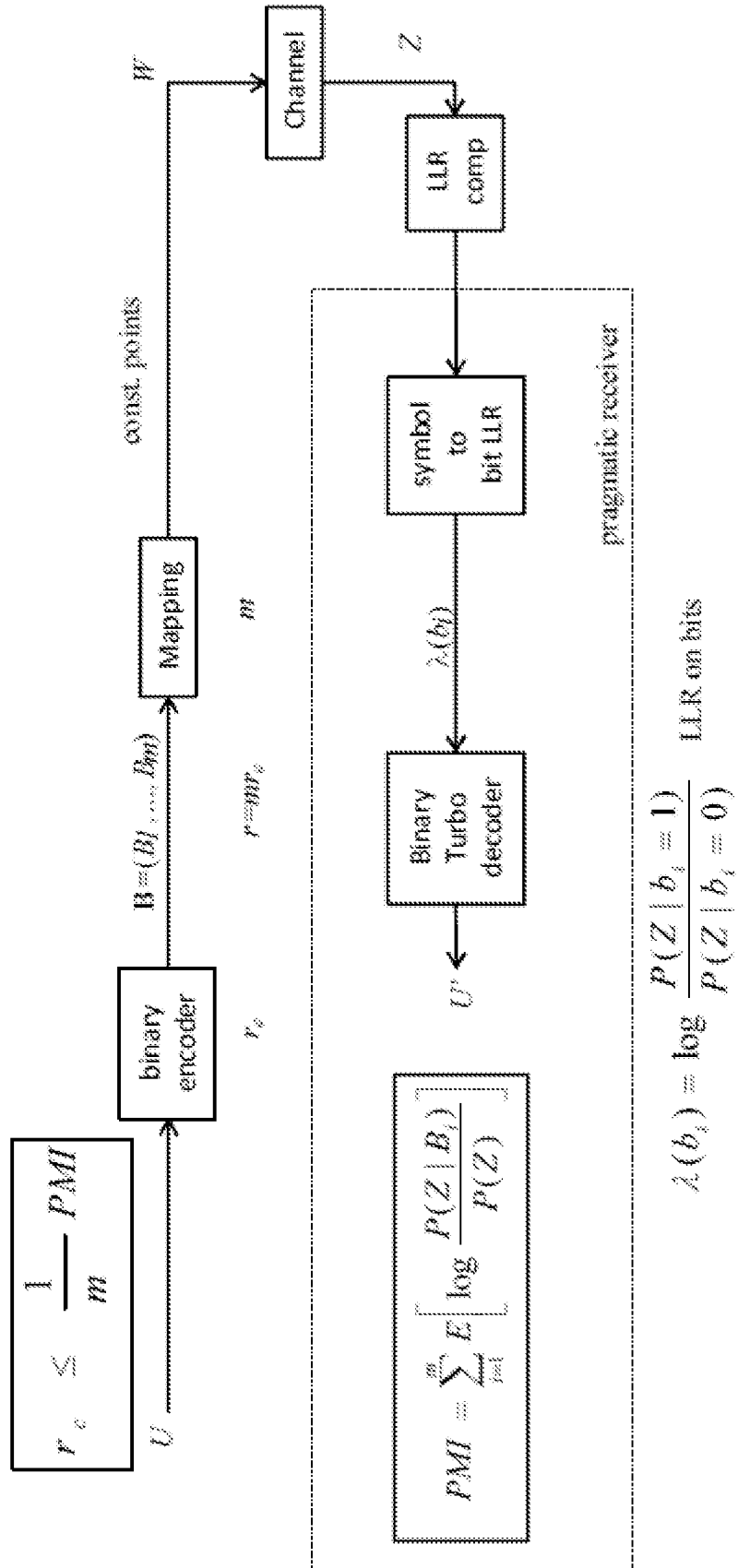


FIG.19

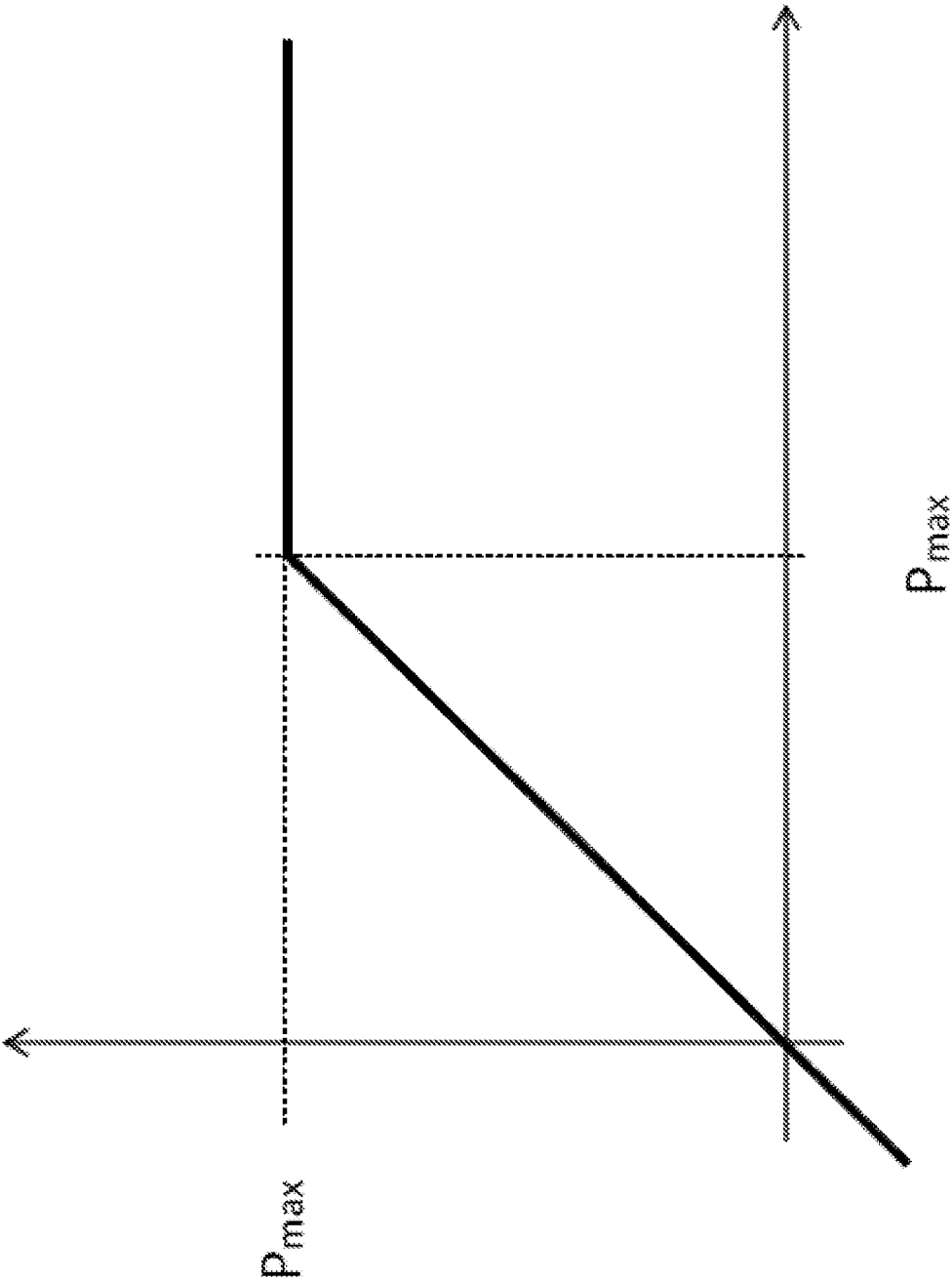


FIG.20

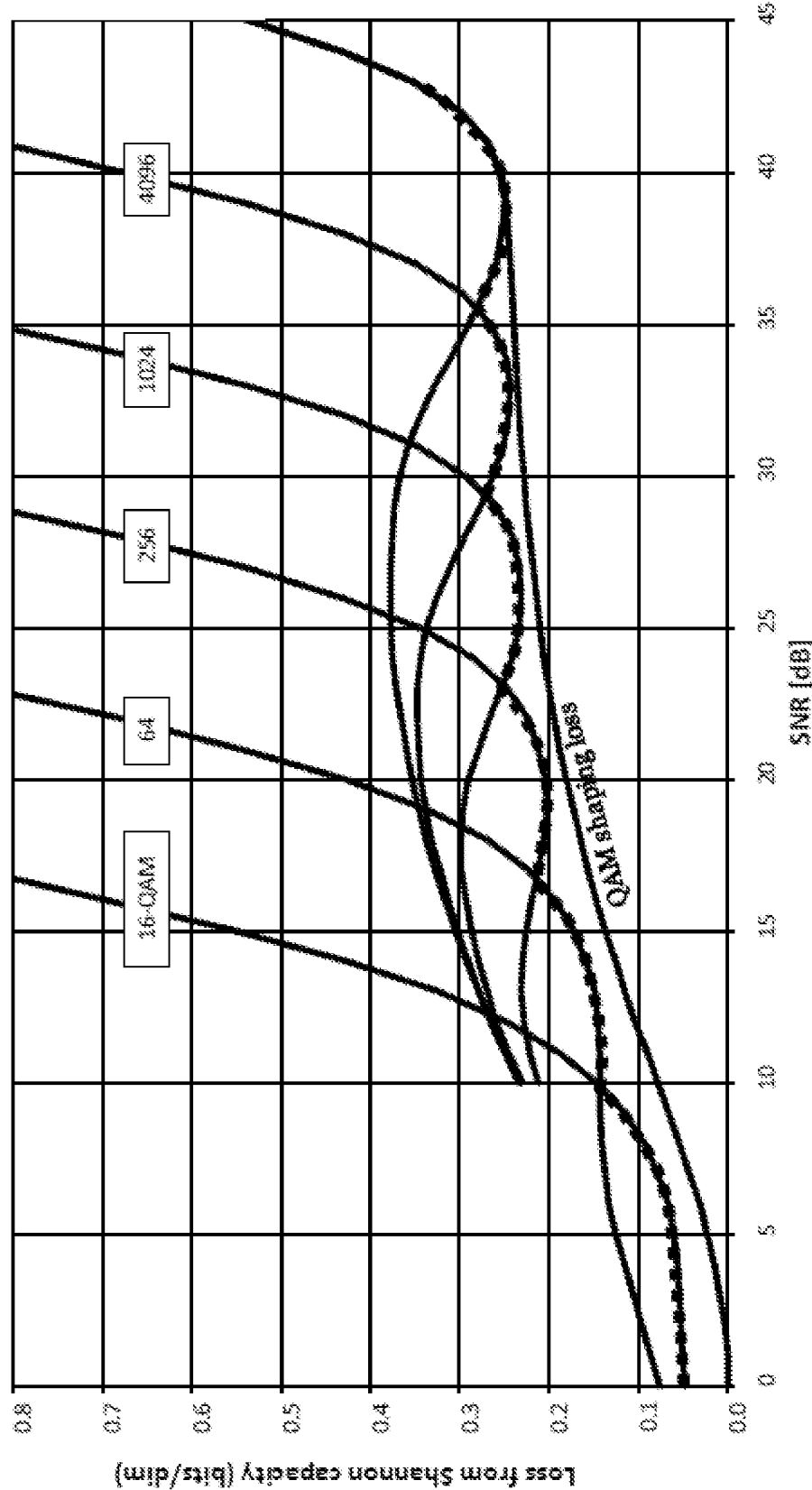


FIG.21

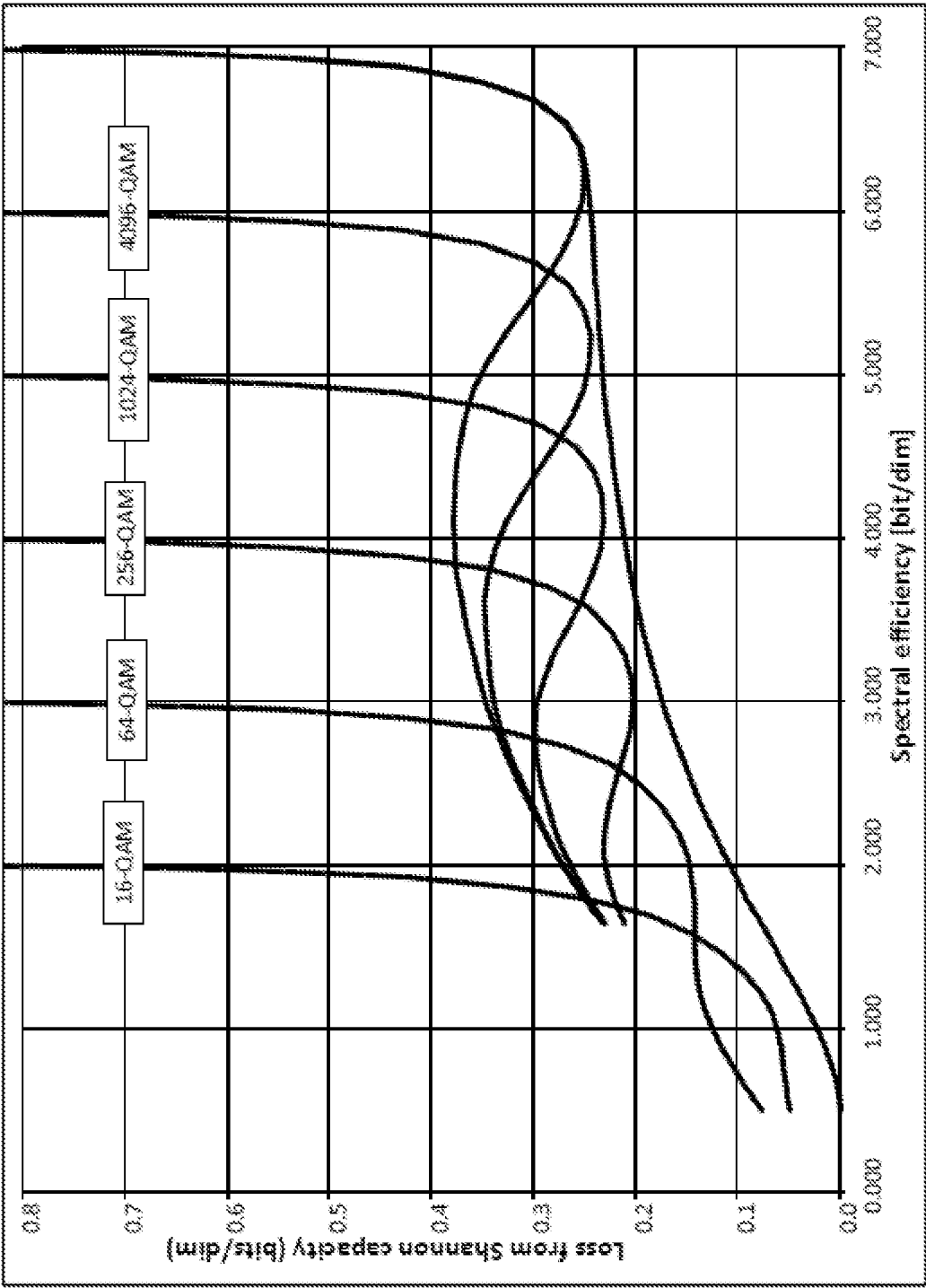


FIG.22

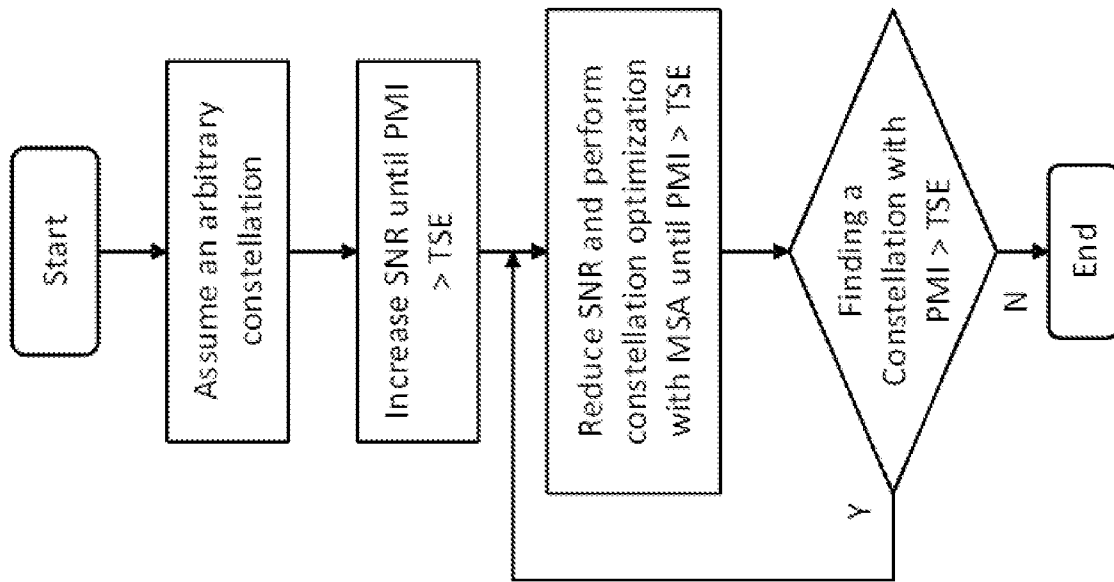


FIG.23

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2016/078101

A. CLASSIFICATION OF SUBJECT MATTER

H04L 27/34(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H04L; H04W; H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNPAT, CNKI, WPI, EPODOC, GOOGLE, 3GPP, IEEE: QAM, 16QAM, 32QAM, 64QAM, PSK, QPSK, BPSK, Quadrature Amplitude Modulation, constellation, bit?, symbol?, map+, 1.484+, 0.355+, 0.356+, 1.469+, 0.279+, 1.492+, 0.360+, 1.223+, 0.871+, 0.825+, 0.564+, 0.894+, 0.445+, 0.847+, 0.528+, 0.089+, 0.995+, 0.208+, 0.385+, 0.270+, 0.962+, 1.310+, 0.338+, 0.358+, 0.139+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2011016835 A1 (THOMSON LICENSING) 10 February 2011 (2011-02-10) description, page 6, line 19 to line 25, page 10, line 5 to page 21, line 27, page 24, line 10 to page 32, line 21, claims 1-16, figures 1-9	1-72
A	US 2016080192 A1 (SONY CORPORATION) 17 March 2016 (2016-03-17) the whole document	1-72
A	CN 101340412 A (UNIVERSITY QINGHUA) 07 January 2009 (2009-01-07) the whole document	1-72
A	IEEE Computer Society. "Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications Amendment 3: Enhancements for Very High Throughput in the 60 GHz Band" <i>IEEE Standard for Information technology—Telecommunications and information exchange between systems Local and metropolitan area networks—Specific requirements</i> , 28 December 2012 (2012-12-28), the whole document	1-72

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

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 "E" earlier application or patent but published on or after the international filing date
 "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
 "O" document referring to an oral disclosure, use, exhibition or other means
 "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

05 December 2016

Date of mailing of the international search report

26 December 2016

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STATE INTELLECTUAL PROPERTY OFFICE OF THE
P.R.CHINA
6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing
100088
China

Facsimile No. (86-10)62019451

Authorized officer

LI, Wen

Telephone No. (86-10)62413858

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No. PCT/CN2016/078101

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2011016835	A1	10 February 2011	CN	102474496	A	23 May 2012
				JP	2016076956	A	12 May 2016
				EP	2462730	A1	13 June 2012
				KR	20120041251	A	30 April 2012
				JP	2013502095	A	17 January 2013
				EP	2282471	A1	09 February 2011
				US	2012134423	A1	31 May 2012
US	2016080192	A1	17 March 2016	WO	2014177565	A1	06 November 2014
CN	101340412	A	07 January 2009	None			