

(51) International Patent Classification:
H04B 3/54 (2006.01) *H04L 27/26* (2006.01)

(21) International Application Number:

PCT/EP201 1/0041 18

(22) International Filing Date:

16 August 2011 (16.08.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

10 012 403.1 30 September 2010 (30.09.2010) EP

(71) Applicant (for all designated States except US): SONY CORPORATION [JP/JP]; 1-7-1 Konan, Minato-ku, Tokyo 108-0075 (JP).

(71) Applicant (for JP only): SONY DEUTSCHLAND GMBH [DE/DE]; Kemperplatz 1, 10785 Berlin (DE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): SCHWAGER, Andreas [DE/DE]; Rothaldenweg 49, 71336 Waiblingen (DE). SCHILL, Dietmar [DE/DE]; Rosenstrasse 26, 71634 Winnenden (DE). STADELMEIER, Lothar [DE/

DE]; Schlossbergstr. 27, 70569 Stuttgart (DE). SCHNEIDER, Daniel [DE/DE]; Nauheimerstrasse 67, 70372 Stuttgart (DE).

(74) Agent: JENSEN, Nils; MuUer, Hoffmann & Partner, Innere Wiener StraBe 17, 81667 Munchen (DE).

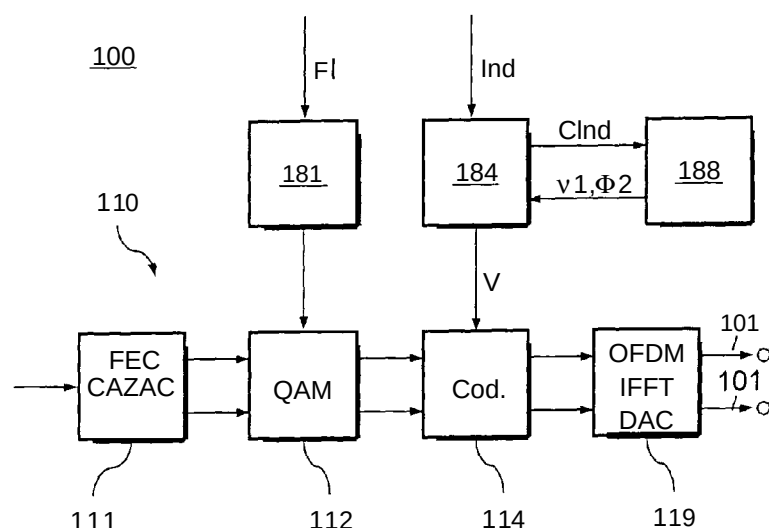
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,

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(54) Title: POWER LINE COMMUNICATION SYSTEM USING BEAMFORMING

Fig. 6A



(57) Abstract: A communication device (100) may store a codebook table containing a plurality of codebook entries, wherein each codebook entry includes predefined precoder values for each of at least two transmit paths of a transmission channel (300). On the basis of received feedback information, the communication device (100) selects that one from the codebook entries, whose precoder values approximate a perfect precoding matrix for beamforming transmit signals at best among the codebook entries. The communication device (100) may use the precoder values to construct a precoding matrix for beamforming its transmit signals.

Published:
— *with international search report (Art. 21(3))*

DESCRIPTION

POWER LINE COMMUNICATION SYSTEM USING BEAMFORMING

An embodiment of the present invention relates to a communications system using beamforming, wherein information describing a precoding matrix is fed back from a receiving communication device to a transmitting communication device. Further embodiments relate to communication devices and to methods for operating communication devices using beamforming.

Multiple-input multiple-output (MIMO) and multiple-input single-output communications systems (MISO) use beamforming for increasing bandwidth.

Embodiments described in EP 2019496 A1 refer to a powerline communications system combining Eigenbeamforming with an adaptive orthogonal frequency division multiplex method, wherein channel state information is fed back from a receiving communication device to a transmitting communication device.

Embodiments in EP 206 1160 A1 concern a precoding approach for powerline communications system without exchange of channel state information between the communication devices.

An object of the invention is to provide a wired communications system with enhanced data throughput, a communication device for such a communications system and a method of operating the communications system.

The object is achieved by the subject-matter of the independent claims. Further embodiments are defined in the dependent claims respectively. Details of the invention will become more apparent from the following description of embodiments in connection with the accompanying drawings, wherein features of the various embodiments may be combined unless they exclude each other.

Figure 1 is a schematic block diagram illustrating a wired MIMO communications system with two communication devices in accordance with an embodiment.

Figure 2A is a schematic block diagram illustrating a communication device with a decoder unit and a codebook control unit in accordance with an embodiment.

Figure 2B is a schematic block diagram illustrating a communication device with a decoder unit and a codebook control unit using a look-up table in accordance with another embodiment.

Figure 3A is a schematic diagram illustrating a codebook table with three precoder values per entry in accordance with an embodiment.

Figure 3B is a schematic diagram illustrating a codebook table with two precoder values per entry in accordance with another embodiment.

- 5 Figure 4A is a schematic block diagram of a codebook control unit according to an embodiment providing a search through all entries of a codebook table.

Figure 4B is a schematic block diagram of a codebook control unit according to another embodiment including a quantizer unit and providing a search through only a subset of all entries of a codebook table.

- 10 Figure 4C is a schematic block diagram showing the quantizer unit of Figure 4B in more detail.

Figure 5A is a schematic diagram showing a distribution of codebook entries in a two-dimensional coordinate system and values derived for each codebook entry on the basis of an equalizer matrix according to an embodiment.

- 15 Figure 5B is a section of the diagram of Figure 5A for illustrating details of an embodiment referring to a codebook search based on a look-up table.

Figure 6A is a schematic block diagram illustrating a communication device with a precoder unit configurable by entries in a codebook table in accordance with an embodiment.

- 20 Figure 6B is a schematic diagram of a sequence of sub-carriers for illustrating details of an embodiment referring to the interpolation of precoding matrices for sub-carriers between pilot sub-carriers assigned to codebook entries.

Figure 7 is a simplified flow chart illustrating a method of operating a communications system in accordance with further embodiments.

- 25 Figure 1A shows a communications system 199. The communications system 199 is a wired communications system, for example xDSL (generic Digital Subscriber Line) or DVB-C2 (Digital Video Broadcasting-Cable). According to an embodiment, the communications system 199 is based on an OFDM (Orthogonal Frequency Division Multiplexing) modulation scheme. The communications system 199 may
30 be a system using power distribution wires for data communication. For example, the communications system 199 is a power line communications (PLC), mains communications, power line telecommunications (PLT), broadband power line

(BPL) or power band or power line networking (PLN) using a modulated carrier superimposed to the 50 or 60 Hz alternating current of the power lines respectively.

- 5 The communications system 199 is, for example, a MIMO system with a first communication device 100 on the left hand side. The first communication device 100 includes a transmitter unit 110 employing one, two or more interface ports 101. A second communication device 100 on the right hand side includes a receiver unit 120 employing at least one, for example two, three or four, interface
10 ports 101. A transmission channel 300 connects the transmitter unit 110 of the first communication device 100 on the left hand side and the receiver unit 120 of the second communication device 100 on the right hand side.

- The first communication device 100 may be an exclusively transmitting device with the interface ports 101 configured exclusively as transmit ports. According to
15 other embodiments, the first communication device 100 is a bidirectional device including, in addition to the transmitter unit 110, a receiver unit 120 which may be of the type of the receiver unit 120 in the second communication device 100, wherein some or all of the interface ports 101 may be bidirectional ports. The second communication device 100 may be an exclusively receiving device.
20 According to other embodiments, the second communication device 100 is a bidirectional device including, in addition to the receiver unit 120, a transmitter unit 110 which may be of the same type as the transmitter unit 110 in the first communication device 100, and wherein some or all of the interface ports 101 may be bidirectional ports. The communication devices 100 may be stand-alone
25 devices or may be integrated in an electronic device for consumer applications, for example in a storage unit, a television set, an audio receiver, a video recorder, or in sensor devices like fire detectors.

- The transmission channel 300 may be a multi-wire connection. In accordance with an embodiment the transmission channel is a power cable containing two or
30 more electrical conductors used for transmission of AC (alternating current) electric power and installed as permanent wiring within buildings or buried in the ground. A plurality of m transmit signals t_x define a transmit vector t_m and a plurality of n receive signals r_y define a receive vector r_n . For example, each of the transmitter units 110 may supply two differential transmit signals t_x using the
35 live or phase wire (L, P), the neutral wire (N), and protective earth (PE), wherein the differential transmit signals t_x are modulated on a carrier superposing the AC frequency of the mains voltage. According to an embodiment, the receiver units 120 receive three differential receive signals between live wire and neutral wire,

between neutral wire and protective earth, and between live wire and protective earth. According to another embodiment, the receiver unit 120 may receive the three differential receive signals and a common mode signal resulting from a leakage current from the wiring as a fourth receive signal.

- 5 In a real transmission channel 300 the transmit signals t_x interfere with each other, for example through capacitive coupling between the wires. In a channel matrix $H_{n,m}$, which describes the receive vector r_n as a function of the transmit vector t_m , the entries of each line describe one of the receive signals r_y in dependence of all transmit signals t_x , wherein typically none of the entries $h_{x,j}$ of $H_{n,m}$ is equal 0 when crosstalk occurs.

$$(1) \quad r_n = H_{n,m} t_m$$

- For enhancing the signal-to-noise ratio (SNR) the principle of beamforming provides a decoupling of the receive signals by precoding the transmit vector with a precoding matrix $P_{m,m}$ such that after applying a suitable decoding scheme for the resulting equivalent channel matrix $H_{n,m} P_{m,m}$ on the receiving side a diagonal matrix results and each decoded signal depends on only one single transmit signal.

- 20 For example, the receiving communication device 100 may comprise a channel estimator unit for determining the channel matrix $H_{n,m}$ describing the channel state information (CSI) of the transmission channel 300 by comparing a received training symbol sequence with a nominal training symbol sequence. Then singular value decomposition of $H_{n,m}$ may be used to obtain a suitable precoding matrix $P_{m,m}$ and a suitable decoding matrix.

- 25 As shown in equation (2), singular value decomposition (SVD) decomposes the channel matrix $H_{n,m}$ in a first unitary matrix $U_{n,n}$, the Hermitian transpose $V_{m,m}^H$ of a second unitary matrix $V_{m,m}$ and a diagonal matrix $D_{n,m}$, wherein the diagonal entries of $D_{n,m}$ are the singular values of the channel matrix $H_{n,m}$.

$$(2) \quad H_{n,m} = U_{n,n} D_{n,m} V_{m,m}^H$$

- 30 According to an embodiment, the receiving communication device 100 transmits feedback information containing information describing the second unitary matrix $V_{m,m}$ to the transmitting communication device 100. In accordance with an embodiment, the feedback information is transmitted via the transmission channel 300. In accordance with other embodiments, the feedback information is transmitted via an alternative transmission path. For example, an operator may

configure the transmitting device on the basis of available channel state information during an installation phase of a communications system comprising the receiving and transmitting communication devices 100.

5 The feedback information may be a sequence of bits enclosed in a data section of a precoding initialisation message transmitted from the receiving communication device 100 to the transmitting communication device 100 during an installation period. The feedback information may also be included in a message sent by the receiving communication device 100 periodically or after the receiving communication device 100 has detected a significant change in the channel state information. According to an embodiment the feedback information is a binary
10 number between 0 and $2^n - 1$, where n is the number of bits used for coding the feedback information. The number of bits may be between 2 and 12. For example, the feedback information includes 5, 6, 7, or 8 bits.

The transmitting communication device 100 comprises a precoder control unit
15 configured to generate a precoding matrix on the basis of the feedback information. For example, the feedback information is an index identifying one of a plurality of entries of a table the transmitting communication device 10 stores in a memory unit and the precoder control unit uses precoder values assigned to the identified entry for obtaining the precoding matrix. Each codebook entry may
20 contain at least one precoder value for each interface port used for simultaneous transmission of transmit signals.

From the precoder values addressed by the index contained in the feedback information, the precoder control unit obtains a precoding matrix that at least approximates the second unitary matrix $V_{m,m}$ and uses the approximated second
25 unitary matrix $V_{m,m}$ as precoding matrix $P_{m,m}$. Then equation (3) describes the receive vector r_n received by the receiver unit 220:

$$(3) \quad r_n = H_{n,m} V_{m,m} t_m$$

In equation (3) the channel matrix $H_{n,m}$ can be replaced by its SVD description in equation (2):

$$30 \quad (4) \quad r_n = U_{n,n} D_{n,m} V_{m,m}^H V_{m,m} t_m$$

The product of a unitary matrix and its Hermitian transpose is the identity matrix. Decoding the receive vector using the Hermitian transpose $U_{n,n}^H$ of the first unitary matrix $U_{n,n}$ results in a decoded receive vector y_n :

$$(5) \quad y_n = U_{n,n}^H U_{n,n} D_{n,m} V_{m,m}^H V_{m,m} t_m$$

(6)
$$y_n = D_{n,m} t_m$$

With regard to the decoded receive vector y_n , the transmission channel 300 is decomposed into a set of parallel and independent paths.

Typically, the described precoding/ decoding scheme uses beamforming for decomposition of interfering signals in order to increase signal-to-noise ratio of payload data. The beamforming precoding/ decoding scheme may be applied to the payload data exclusively. According to other embodiments, the beamforming precoding/ decoding scheme may be applied also for the transmission of synchronization data and training symbols.

Figure 2A shows a receiving communication device 100 including a receiver unit 120 in more detail. The communication device 100 receives receive signals at one, two, three, four or more interface ports 101. According to an embodiment, each interface port 101 includes wire connectors, for example, connectors to a communications wiring or to an electric power wiring.

According to an embodiment, the communication device 100 may have three interface ports 101 each of them configured to receive differential signals between the live and neutral wires, or between the live wire and protective earth, or between the neutral wire and protective earth. According to another embodiment, the communication device 100 further comprises a fourth interface port configured to receive a common mode signal caused by a leakage current.

The receiver unit 120 recovers from the at least one receive signal at least a first transmit signal transmitted to the receiving communication device 100 via a transmission channel connecting the receiving communication device 100 with a transmitting communication device with which the receiving communication device 100 establishes a communication link, for example a point-to-point communication link. The receiver unit 120 may include an input signal processing unit 121 that may condition and sample analogue receive signals to obtain one or more, for example two, digital receive signals. The signal levels of the receive signals may be adjusted in response to information included in the received signals. According to an embodiment, the input signal processing unit 121 may transform the digital receive signals into the frequency domain, wherein for each digital receive signal a digital data stream is generated. Amplitude and phase information may be obtained from the receive signals for further adjusting the signal levels. In embodiments referring to multi-carrier transmission techniques, the input signal processing unit 121 may use OFDM to decompose, in the frequency domain, each data stream into orthogonally modulated components.

According to an embodiment, synchronization information included in the receive signals may be used for the demodulation.

The communication device 100 includes a channel estimation unit 150 that estimates the channel state information, for example on the basis of training symbols contained in the receive signals. The channel estimation unit 150 may compare selected symbols included in a receive signals burst with an equivalent nominal signal. Typically, a predefined set of training symbols is known at both the transmitter and the receiver side and the training symbols are selected for channel estimation. Based on the result of the comparison the channel estimation unit 150 may determine the channel matrix $H_{n,m}$. The channel estimation unit 150 may calculate the channel matrix $H_{n,m}$ or may select, from a plurality of predefined channel matrices, that one that models best the actual transmission channel.

The channel estimation unit 150 may further forward the channel state information or information derived from the channel state information to a codebook control unit 183. Based on the received channel state information, the codebook control unit 183 consults a table stored in a codebook memory unit 188 for generating a feedback information for the transmitter side. The table may be of the type of a look-up table and is denoted as codebook table in the following. Accordingly, an entry in the codebook table is denoted as codebook entry in the following. The feedback information may be a binary value representing an index identifying a matching entry in the codebook table, wherein precoder values identified by the matching entry represent or at least approximate the perfect precoding matrix. An index referring to an entry in the codebook table is denoted as codebook index in the following. According to an embodiment the feedback information represents a codebook index determining a codebook entry that, among all entries in the codebook table, approximates the second unitary matrix $V_{m'm}$ at best.

In the receiving communication device 100, the stored codebook table may be used for determining the codebook index to be transmitted to the transmitting communication device with which the receiving communication device establishes a communication link. In the transmitting communication device, the same codebook table is stored. The transmitting communication device determines the precoding matrix by using the received codebook index for accessing a corresponding entry in its own codebook table. The communication device 100 may use the same codebook table from the same codebook memory unit 188 both, as receiving device, for determining the codebook index and, as transmitting

device, for generating the precoding matrices on the basis of received codebook indices.

The receiving communication device 100 may include an output unit that outputs the codebook index identifying the matching entry. According to an embodiment, the output unit is a transmitter unit 110 configured to output the codebook index via at least one of the interface ports 101. These outbound transmit signals may be balanced to the receive signals with respect to frequency range, modulation method and transmit power, in other words, the outbound transmit signals may use the same frequency range, the same modulation techniques and almost the same transmit power as the transmit signals transmitted by the transmitting communication device with which the communication device 100 establishes a communication link.

The channel estimation unit 150 may further provide information required for determining or directly describing the first unitary matrix $U_{n,n}$ to a decoder control unit 189.

The decoder control unit 189 receives information for determining the decoding matrix, which is, for example, the Hermitian transpose $U_{n,n}^H$ of the first unitary matrix $U_{n,n}$, and configures a decoder unit 124 in the receive path of the receiver unit 120 accordingly.

The decoder unit 124 decodes the receive signals according to the beamforming scheme as discussed above to generate the decoded receive signals. The decoder unit 124 is defined by coefficients derived from the decoding matrix. The decoder unit 124 is programmable to realize different decode matrices. For example, during a learning phase, the decoding matrix may be selected to realize an equalizer or detection function for detecting the transmitted MIMO paths, for example a zero forcing receiver. During an operational phase, the decoding matrix may be approximately equal to the Hermitian transpose $U_{n,n}^H$ of the second unitary matrix $U_{n,n}$.

Demodulators 127 may demodulate each of the data streams output by the decoder unit 124. The demodulators 127 may be quadrature amplitude demodulators generating a demodulated data signal, which may be output to a demultiplexer unit 128 that combines the demodulated data signals to one, two or more data streams which are transmitted to a control unit 190 for further processing.

Figure 2B refers to details of an embodiment of a receiver unit 120 of a communication device 100. The illustrated embodiment refers to a transmitting communication device (not shown) driving two transmit signals, and a receiving communication device 100 receiving two or more, for example three or four, receive signals via interface ports 101. An input signal processing unit 121 samples the analogue receive signals and may output an equivalent number of digital receive signals, wherein the signal levels of the receive signals may be adjusted in response to information derived from the receive signals. The input signal processing unit 121 may further Fourier transform the digital receive signals into the frequency domain, wherein a digital data stream is generated for each digital receive signal, and may use OFDM to decompose, in the frequency domain, each data stream into orthogonally modulated components, wherein synchronization information included in the receive signals may be used for the demodulation.

According to an embodiment, the input signal processing unit 121 may output the resulting data streams to an equalizer unit 122 performing a channel equalizing using the Q and R matrices obtained by a QR decomposition of the channel matrix. The equalizer unit 122 may output the equalized data streams to a decoder unit 124. According to another embodiment, no channel equalization is performed and the input signal processing unit 121 may directly output the resulting data streams to the decoder unit 124. The decoder unit 124 decodes the data streams using a decoder matrix U^H . A demodulator unit 129 may perform a QAM demodulation that may or may not use tonemap information derived from the channel state information and recombines the two or more receive signals to a resulting receive signal. A forward error correction may be performed that uses included code redundancy for detecting and correcting data errors.

The channel estimation unit 150 may be configured to determine the parameters of a channel matrix H describing attenuation and mutual effects between the receive signals. The channel estimation unit 150 may perform a singular value decomposition to obtain the decoder matrix U^H for the decoder unit 124. According to another embodiment, a decoder control unit 189 may use information delivered from the channel estimation unit 150 to determine the decoder matrix U^H , for example by singular value decomposition of the channel matrix H. A pseudo inversion unit 182 may use information obtained by the channel estimation unit 150 to determine coefficients of the equalizer unit 122, for example by a QR decomposition of the channel matrix H.

Further, the information obtained by the channel estimation unit 150 may be used, directly or indirectly, for generating a codebook index that identifies, in a codebook table, a codebook entry with precoder values with which the perfect precoder matrix V can be approximated at best among all codebook entries.

- 5 The channel estimation unit 150 may supply the channel matrix H , or in the case of an embodiment including a pseudo-inversion unit 182 the pseudo-inversion unit 182 may supply the orthogonal matrix Q and/or the upper triangle matrix R or a derivative of at least one of them, for example R^{-1} to a codebook control unit 183. Based on the received information, the codebook control unit 183 generates
- 10 a binary value representing the codebook index, wherein the codebook index identifies a matching entry in the codebook table stored in a codebook memory unit 188. Precoder values identified by the matching entry at least approximate the perfect precoding matrix for the transmitter side at best among all codebook entries. According to an embodiment the codebook index identifies an entry in the
- 15 codebook table that represents or approximates the second unitary matrix V .

The codebook control unit 183 includes a codebook search unit 183a that may search all entries of the codebook table stored in the codebook memory unit 188 for the best matching entry. In accordance with an embodiment, the codebook

20 control unit 183 contains a look-up table memory unit 183b and the codebook search unit 183a selects a subset of codebook indices assigned to one of the entries of a look-up table stored in the look-up table memory unit 183b for the search for the best matching entry in the codebook table.

- 25 The tables of Figure 3A and 3B refer to embodiments of the codebook table for a MIMO scheme with two transmit ports, for example an in-home PLC system using two transmit ports. The number of available MIMO data streams depends on the number of receive ports. A communication devices with at least two receive ports allows support of two MIMO streams where different symbols are transmitted via
- 30 the two transmit ports. In this case, the precoding matrix is a 2x2 matrix with column vectors $\vec{v}_1$ and $\vec{v}_2$:

$$(7) \quad V = [v, \quad \vec{v}_2]$$

- 35 The perfect precoding matrix V decomposes the MIMO channel into two independent logical MIMO streams where the first path is stronger and provides better SNR than the second path. The columns of the perfect precoding matrix V

might be toggled to change the two logical MIMO paths, wherein then the second path would be stronger than the first one.

For embodiments where the receiving communication device comprises only one receive port or only a simplified decoder supporting not more than one receive stream, for example where spot beamforming is used, the precoding matrix V shrinks to a 2x1 precoding vector

$$(8) \quad V = [\vec{v}_1]$$

and the elements of the precoding vector $\vec{v}_1$ describe the precoding matrix V completely. Where V is a 2x2 matrix and the transmitting communication device uses two transmit ports with $\vec{v}_1$ and $\vec{v}_2$ being orthogonal the second column vector $\vec{v}_2$ can be derived from the elements v_1 and v_2 of the first column vector $\vec{v}_1$:

$$(9) \quad \vec{v}_1 = \begin{bmatrix} v_1 \\ v_2 \end{bmatrix}$$

As a consequence of the properties of the precoding matrix V , v_j is a real coefficient, whereas v_2 is a complex coefficient:

$$(10) \quad v_2 = |v_2| \cdot \exp(j \cdot \varphi_2)$$

The absolute value of V_2 depends on v_1 :

$$(11) \quad |v_2| = \sqrt{1 - v_1^2}$$

In other words, v_j and the phase angle φ_2 of v_2 suffice to determine V_2 . The parameters v_1 and φ_2 completely describe the 2x1 precoding vector V and the 2x2 precoding matrix V for the above described cases.

Figure 3A refers to a codebook table 310 with m entries identifying predefined precoding matrices on the basis of three real-valued parameters v_1 , $\text{Re}\{v_2\}$, and $|v_2|$. Based on a received codebook index and without further calculations a transmitting communication device has direct access to all values of that one of the predefined precoding matrices that fits best with the perfect precoding matrix.

Figure 3B refers to a codebook table 320 having a codebook length m and containing m entries 305 identifying predefined precoding matrices on the basis of only two real-valued parameters v_1 and φ_2 . A transmitting communication device may calculate the parameter v_2 from the precoder values of a codebook entry 305 identified by a received codebook index in order to generate that one of the predefined precoding matrices that fits best with the perfect precoding matrix. Since the codebook table 320 includes only two real-valued parameters per entry the codebook table 320 requires less memory space than the codebook table 310 of Figure 3A.

The codebook length m determines the minimum number of data bits assigned to a codebook index information transmitted from the receiving communication device to the transmitting communication device. For example, a codebook length m of 32, 64, 128, 256 entries require at least five, six, seven or eight data bits for the codebook index information. The codebook index information may directly give the binary value of the corresponding entry.

From the values v_1 and v_2 a precoder control unit in the transmitting communication device may construct the precoding matrix or the precoding vector V according to one of equations (12) or (13)

$$(12) \quad V = [\vec{v}_1 \quad \vec{v}_2] = \begin{bmatrix} v_1 & -v_2^* \\ v_2 & v_1 \end{bmatrix}$$

$$(13) \quad V = [\vec{v}_1 \quad \vec{v}_2] = \begin{bmatrix} v_1 & v_2^* \\ v_2 & -v_1 \end{bmatrix}$$

In accordance with an embodiment, the codebook entries predefine precoding matrices based on uniformly distributed precoding vectors pointing on equidistantly arranged coordinate points in a codespace with linearly scaled axes.

In accordance with other embodiments, the codebook entries predefine precoding matrices depending on properties of the expected channels. For example, the codebook table may be designed on the basis of statistically evaluated properties of real transmission channels. For example, the codebook table includes the first and at least one of the second, third and fourth columns of one of the codebook tables defined in tables 1 to 6. According to another embodiment, each

communication device may adaptively improve its codebook table by a self-training process.

According to other embodiments the codebook table may be designed to optimize both $\vec{v}_1$ and the orthogonal $\vec{v}_2$ simultaneously such that a codebook search algorithm searching a codebook table for a codebook entry that fits best with the respective perfect precoding matrix may check which one of the predefined precoding vector is closest to either the first column vector $\vec{v}_1$ or the second column vector $\vec{v}_2$. For example, the codebook table includes the first and at least one of the second, third and fourth column of one of the codebook tables defined in tables 7 to 12.

According to an embodiment, uniformly distributed codebook may be defined for the cases the orthogonal vectors are included or not included. The exclusion of the orthogonal vectors may allow maximizing the SNR always on the one and the same transmission path.

In accordance with an embodiment, the codebook table contains an entry (A) as follows:

$$(A) \quad \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

In this case, the precoding matrix is the identity matrix and no precoding is performed. A spatial multiplexing MIMO approach can be applied.

In accordance with another embodiment, the codebook table in addition or in the alternative, contains an entry (B) as follows:

$$(B) \quad \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

In this case, the logical MIMO paths are flipped. Apart from that no further precoding is performed and a spatial multiplexing MIMO approach can be applied.

In accordance with a further embodiment, the codebook table in addition or in the alternative contains an entry (C) as follows:

$$(C) \quad \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{\sqrt{2}} \\ \frac{1}{\sqrt{2}} \end{bmatrix}$$

In this case, a MISO approach is applied where only one symbol is transmitted and energy is uniformly distributed among the two transmit ports.

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According to an embodiment, the precoding scheme is applied to a communications system using a single-carrier approach. According to other embodiments, the precoding scheme is embedded in a multi-carrier approach, for example in a communications system using OFDM, wherein a transmitting communication device comprises a precoder unit configured to precode multi-carrier signals and the receiving communication device comprises a decoder unit configured to decode multi-carrier signals.

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Figure 4A refers to an embodiment of a codebook control unit 183 that is assigned to a codebook memory unit 188 storing a codebook table whose entries may have, for example, two independent precoder values respectively. By using one of the equations (12) or (13) the codebook table with two precoder values per entry allows constructing a precoding matrix that approximates the perfect precoding matrix V for a transmitting communication device that is adapted to send two transmit signals simultaneously.

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The codebook control unit 183 makes use of the fact that in the receiver unit the SNR after equalization depends on both the equalizer matrix and the applied precoding matrix, if a zero-forcing receiver is used. Therefore, from the equalizer matrix, a parameter w (or w₁ and w₂ for the different logical MIMO paths) reflecting the SNR can be derived for each precoding matrix predefined in the codebook table. Thereby the maximum value for the respective parameter w, w₁, w₂ represents that one of the predefined precoding matrices that, when applied to the channel, results in the lowest SNR.

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A parameter calculation unit 410 receives values defining the channel matrix H or a derivative of it, for example, the equalizer matrix or a derivative of the equalizer matrix. If zero-forcing detection is applied, the equalizer matrix is the pseudo-inverse matrix of the channel matrix H, wherein the pseudo-inverse matrix may be obtained by a QR decomposition of the channel matrix H into the orthogonal matrix Q and the upper triangular matrix R.

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According to an embodiment the parameter calculation unit 410 receives values defining the inverse matrix R^{-1} of the upper triangular matrix R as input. According to other embodiments, for example such embodiments providing no
 5 equalization or no QR decomposition for other purposes, the full equalizer matrix may be used as input.

From the equalizer matrix or the matrix R^{-1} the parameter calculation unit 410 calculates parameters PI , $P2$ and $PI2$ that describe the actual channel.

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From the parameters PI , $P2$ and $PI2$ a search index unit 490 calculates the parameter wl for predetermined codebook entries of a codebook table stored in the codebook memory unit 188 thereby recording that codebook index identifying that codebook entry which, when combined with the parameters PI , $P2$, $PI2$
 15 result in the minimum value for the parameter wl . The search index unit 490 outputs the recorded codebook index $CodeInd$. According to an embodiment, the search index unit 490 calculates the parameter wl for all codebook entries. According to other embodiments, the search index unit 490 calculates the parameter wl for a preselected subset of all codebook entries.

20

in Figure 5A black squares 502 represent the predefined precoding matrices defined by their precoder values v_j and φ_2 in an orthogonal coordinate system 500 with v_1 plotted against horizontal axis and φ_2 plotted against the vertical axis. Contour lines 551, 552 show lines connecting value pairs v_1 and φ_2
 25 resulting in the same value for $|wl|^2$, wherein dark contour lines 551 indicate high values and bright contour lines 552 indicate low values for $|wl|^2$. In multi-carrier systems, the contour lines 551, 552 vary for different channels. The illustrated codebook table contains 128 entries. The bright squares 504 refer to values $\varphi_2 \pm 1 \cdot \pi$.

30

The codebook control unit 183 of Figure 4A outputs the codebook index $CodeInd$ identifying the codebook entry closest to the perfect precoding matrix, which is denoted by a diamond 506 in Figure 5A. A six-pointed star 508 indicates the perfect orthogonal precoding matrix.

35

Figure 4B refers to an embodiment of a codebook control unit 183 where the search index unit 490 processes and checks only a subset of all codebook entries. To this purpose, the codebook control unit 183 comprises a look-up table memory unit 183b storing a look-up table, wherein each entry of the look-up table is

assigned to one of a plurality of possible combinations of quantized precoder values. Each look-up table entry contains a predefined number of codebook indices, wherein the predefined number of codebook indices is smaller than the total number of codebook entries. According to an embodiment the predefined number of codebook indices is between two and twelve, for example four. Each look-up table entry contains codebook indices identifying codebook entries with precoder values nearest to the combination of quantized precoder values the respective look-up table is assigned to.

The codebook search unit 183a includes a coarse quantizer unit 450 receiving at least a subset of the parameters PI, P2 and PI2, for example the parameters PI and P12. On the basis of these parameters the coarse quantizer unit 450 calculates a quantized version of the perfect precoding matrix with a coarse quantization to obtain a combination of quantized precoder values v_{1Q} and ϕ_{2Q} , wherein the combination of quantized precoder values v_{1Q}, ϕ_{2Q} represents the coarsely quantized perfect precoding matrix.

The combination of quantized precoder values identifies that one of the entries of the look-up table that contains codebook indices that identify entries of the codebook table representing those predefined precoder matrices closest to the quantized perfect precoder matrix. The coarse quantizer unit 450 selects, in the look-up table memory unit 183b, that one of the look-up entries that is addressed by the obtained combination of quantized precoder values. The look-up table memory unit 188 returns a predefined number of selected codebook indices identifying that codebook entries closest to the coarsely quantized perfect precoding matrix. The coarse quantization unit 450 outputs the selected codebook indices to the search index unit 490. The search index unit 490 performs the calculation of the parameter w_1 and the search for the codebook index identifying the codebook table entry with the minimum value for the parameter w_1 only for the codebook entries identified by the selected codebook indices.

Figure 4C shows details of an embodiment of the coarse quantizer unit 450. A first subunit 451 may derive angle information ϕ and an absolute value of a parameter P12 received from the parameter calculation unit 410. From the angle information ϕ a second subunit 452 derives a quantized angle ϕ_{2Q} . From the absolute value of P12 and another parameter PI output by the parameter calculation unit 410, a third subunit 453 derives a quantized precoding value v_{1Q} . With the quantized values ϕ_{2Q} and v_{1Q} defining a quantized perfect precoding matrix V_Q , the coarse quantization unit 450 identifies an entry in the

look-up table 183b. Each entry of the look-up table 183b contains a predefined number, for example four, of binary values (codebook indices) representing codebook entries defining predefined precoding matrices close to the quantized perfect precoding matrix V_Q . The look-up table 183b contains for each possible quantized precoding matrix V_Q a subset of codebook indices, wherein the codebook indices identify a codebook entry representing those predefined precoding matrices which are closest to the quantized precoding matrix V_Q .

In accordance with an embodiment where the receiving communication device applies singular value decomposition, the receiving communication device may calculate the precoder values of the perfect quantized precoding matrix directly. Then the precoder values of the perfect quantized precoding matrix may be used for accessing the look-up table 183b and the coarse quantization unit 450 may be omitted.

Figure 5B shows a section of Figure 5A in more detail. A black diamond marks the position of the perfect precoding matrix. Crosses mark the positions of possible quantized precoder values. A five-pointed star marks the position of the coarsely quantized perfect precoding matrix which maps on one of the positions for the possible quantized precoder values. Filled squares mark four codebook entries contained in the look-up table entry identified by the coarsely quantized perfect precoding matrix marked by the five-pointed star 524.

The precoder values contained in these four codebook entries are checked with regard to the parameter w_1 . The search over these four codebook entries provides the codebook entry marked by the filled square with the number one as identifying a codebook entry representing the best approximation for the (non-quantized) perfect precoder matrix available in the codebook table. The codebook control unit outputs the codebook index identifying this codebook entry as resulting codebook index $CodeInd$.

For comparison, the numbered circles 528 show the order of the codebook entries approximating the perfect precoder matrix at best (number 1), second best (number 2) and so on.

Figure 6A refers to an embodiment concerning the transmitting side. A communication device 100 includes a transmitter unit 110. A data source, for example a controlling unit of the communication device 100, outputs a primary data stream, which contains payload data, to an editing unit 111 of the

transmitter unit 110. The editing unit 111 may insert code redundancy according to an error detection scheme for facilitating error correction at the receiver side. The editing unit 111 may split up the primary data stream into at least two complementary data streams or multiplies, for example doubles, the data stream
 5 in two or more identical data streams. According to an embodiment, the editing unit 111 may insert in each of the output data streams training symbols and/or synchronization sequences. According to other embodiments, training symbols and synchronization sequences are inserted into the precoded data stream later.

A modulator unit 112 receives and modulates each data stream output by the
 10 editing unit 111, for example by using a plurality of sub-carriers and QAM (quadrature amplitude modulation), respectively. The modulator unit 112 may use constellation data describing frequency dependent channel characteristics for adapting the QAM scheme accordingly. A constellation control unit 181 may derive the constellation data ConDat from feedback information which may be
 15 received, for example, via a receiver unit as described with regard to Figures 2A and 2B.

A precoder unit 114 precodes the modulated data signals using a precoding matrix or precoding vector V provided by a precoder control unit 184. The precoder control unit 184 may configure parameters of the precoder unit 114. For
 20 example, the precoder control unit 184 may provide the precoding matrix or vector V on the basis of a codebook index information received, for example, via the receiver unit. According to an embodiment the precoder control unit 184 receives a binary value identifying an entry in a codebook table stored in a codebook memory unit 188. The codebook table returns precoder values from which the
 25 precoder control unit 184 derives a precoding matrix or vector which matches best the perfect precoding matrix or vector. For example, the codebook table returns the parameters v_1 and ϕ_2 . From v_1 and ϕ_2 , the precoder control unit 184 may calculate $\text{Re}\{v_2\}$, and $\text{Im}\{v_2\}$. Then the precoder control unit 184 may construct the precoding matrix or vector V on the basis of the equations (12) or (13).

A finalizing unit 119 of the transmitter unit 110 may modulate the precoded
 30 modulated data streams on a frequency carrier using, for example, OFDM. The finalizing unit 119 may combine the orthogonal signals and performs an inverse Fourier transformation for obtaining digital output signals describing the transmit signals in the time domain, converts the digital output signals in analogue
 35 transmit signals, and couples each analogue transmit signal to a corresponding interface port 101.

The precoder unit 114 and the precoder control unit 184 may be adapted to apply different precoding matrices to different sub-carriers. According to an embodiment the precoder control unit 184 receives one codebook index for each sub-carrier and applies for each sub-carrier the corresponding precoding matrix.

- 5 According to another embodiment each codebook entry is assigned to a plurality of sub-carriers and the precoder control unit 184 controls the precoder unit 114 to apply the same precoding matrix for a predefined number of neighbouring sub-carriers in the vicinity of a pilot sub-carrier for which the respective predefined precoding matrix has been selected such that overhead resulting from the feedback of the codebook indices is reduced. For example, the precoder control unit 184 may use the same codebook index for all sub-carriers included in a group of neighbouring sub-carriers.

- 15 According to a further embodiment codebook indices are transmitted for pilot sub-carriers representing a subset of all available sub-carriers and the precoder control unit 184 interpolates the values of precoding matrices for the sub-carriers between the pilot sub-carriers for obtaining better matching precoding matrices at low feedback overhead.

- 20 Figure 6B refers to an embodiment providing interpolation of precoding matrices. Figure 6B shows pilot sub-carriers 602 for which the respective codebook index is known to the precoder control unit and further sub-carriers 604 for which no codebook index is transmitted. According to an embodiment the pilot sub-carriers are distributed uniformly. With N sub-carriers in total and K pilot sub-carriers, the number of sub-carriers between two successive pilot sub-carriers is $N/K-1$.

- 25 The precoder control unit calculates a subspace angle between the pilot sub-carriers. With $\vec{v}_1(c)$ representing the precoding vector of the c-th pilot sub-carrier, equation (14) gives the subspace angle for the first two pilot sub-carriers :

30 (14)
$$\Phi = \frac{K}{N} \arccos \left(\left| \vec{v}_1^H(0) * \vec{v}_1 \left(\frac{N}{K} \right) \right| \right)$$

- The calculation for the other pilot sub-carriers and sub-carriers is similar and can be derived from equation (14) simply by selecting the respective sub-carrier indices. With equation (14), $1 \leq m \leq N/K-1$, and $\vec{v}_1^{orth}$ being the orthogonal vector to $\vec{v}_1$ according to e.g. the calculation of the second column in equations
- 35

(12) and (13), a precoding vector for a sub-carrier m between the pilot sub-carriers may be calculated on the basis of equation (15):

$$(15) \quad \vec{v}_1(m) = \vec{v}_1(0) * \cos(m * \phi) - \vec{v}_1^{orth}(0) * \sin(m * \phi)$$

5

Typically the first entry v_1 of an interpolated precoding vector $\vec{v}_1$ is not real-valued. Accordingly the precoder control unit may derive such precoding matrices that are based on interpolated values for v_1 and ϕ_2 on the basis of equations (16) and (17) below. According to another embodiment, the interpolated precoding vectors $\vec{v}_1$ may be phase-rotated in the way that v_j becomes real-valued such that the precoder control unit can construct the precoding matrices on the basis of equations (12) and (13).

15 (16)

$$V = [\vec{v}_1 \quad \vec{v}_2] = \begin{bmatrix} v_1 & -v_2^* \\ v_2 & v_1^* \end{bmatrix}$$

(17)

$$V = [\vec{v}_1 \quad \vec{v}_2] = \begin{bmatrix} v_1 & v_2^* \\ v_2 & -v_1^* \end{bmatrix}$$

20

According to the described embodiment, a pilot sub-carrier is a sub-carrier used for interpolation. The codebook index of this sub-carrier is fed back from a receiving communication device to a transmitting communication device. On the basis of equations (14) and (15), the transmitting communication device interpolates the beamform vectors of sub-carriers for which no codebook index information is fed back, i.e the sub-carriers in between the pilot sub-carriers.

25

Elements of the above described embodiments, for example the precoder and decoder units, the precoder and decoder control units, the codebook control unit and sub-units of these units may be embodied in various forms by hardware only, for example by integrated circuits, field programmable gate arrays (FPGAs), application specific integrated circuits (ASICs) or digital signal processors (DSPs), by software only, which is implemented, for example, in a DSP or a computer program, or by a combination of hardware and software.

30

According to a method of operating a communications system like a PLC system, evaluation of the beamform vectors is part of a channel estimation procedure. Similar to the bit loading of the carriers, different beamform vectors could be used

at different times within an AC line cycle period. The codebook index may be transmitted from a receiving communication device to a transmitting communication device in a new type of message or may be integrated in an existing type of message. According to an embodiment, the codebook index is sent
5 in a message of the type CM_CHAN_EST.IND (Channel Estimation Indication message sent to or from a Connection Manager).

The new or adapted existing message may include further information, for example a dedicated information bit or flag for indicating that an operation mode
10 called Spot Beamforming will or shall be applied.

With Spot Beamforming the 2nd of two logical MIMO paths does not carry information. All physical transmitting paths are used to apply Spot-Beamforming. According to an embodiment Spot Beamforming may be applied if the receiving
15 communication device is connected to an outlet where additional MIMO paths are not available, for example, where only live and neutral wires are connected. Alternatively, Spot Beamforming may be applied where the SNR on most carriers on the 2nd transmission path is very low such that few or no information can be transported via the 2nd logical path. Alternatively, Spot Beamforming may be
20 applied where the receiver modem is a low cost implementation with only one logical reception path or only one decoder included. According to an embodiment the message of the type CM_CHAN_EST.IND includes an information bit indicating that Spot Beamforming shall or will be used.

According to another embodiment a receiving communication device performing a channel estimation of a transmission channel connecting the receiving communication device with a transmitting communication device with which the receiving communication device establishes a communication link, and which identifies the best fitting predefined precoding matrix transmits the corresponding
30 codebook indices to the transmitting communication device and uses temporarily or permanently the same precoding matrix for precoding data streams transmitted to the transmitting communication device. For example, in the case of a symmetric differential channel, the precoding matrices may be identical for each direction.

Usually all PLC channels are symmetric where they are identically terminated on both sides. Instead, in a common mode (CM), a CM path is used at the receiving side only. Due to regulatory constraints feeding via CM is not possible such that in the CM neither channel estimation nor a codebook table can be applied for the
35

transmit signals based on the received signals. Here different precoding matrices have to be applied for the two communication directions. Accordingly an embodiment provides that a message exchanged between a transmitting and a receiving communication device contains information about whether or not a codebook index exchange is performed between the devices. For example, the message of the type CM_CHAN_EST.IND may contain an information bit or flag indicating whether codebook indices will or shall be exchanged between the transmitting and receiving communication devices or whether both sides apply the beamforming vectors derived at their sides respectively.

According to an embodiment, interpolation of precoding matrices is performed on the basis of a predefined pilot sub-carrier raster or step size known to both the transmitting and the receiving communication device. In accordance with another embodiment, the pilot sub-carrier raster or step size is configurable in at least one of the transmitting and the receiving communication devices. In this case, for example the receiving communication device may send a message indicating the pilot sub-carrier step size, for example by sending a binary value indicating the number of sub-carriers between adjacent pilot sub-carriers. For example the message of the type CM_CHAN_EST.IND may contain an information bit or flag indicating whether or not interpolation is used. In addition the message of the type CM_CHAN_EST.IND may contain a data field indicating the number of sub-carriers between adjacent pilot sub-carriers.

According to an embodiment, the transmitting and the receiving communication devices use codebook tables of a predefined resolution or length. In accordance with another embodiment, at least one of the transmitting and the receiving communication devices stores codebooks of different length or resolution. In this case, for example the receiving communication device may send a message indicating the codebook resolution or length, for example by sending a binary value indicating the codebook length or resolution. For example the message of the type CM_CHAN_EST.IND may contain a data field indicating the codebook length or resolution. Depending on the information in this data field the corresponding codebook will be selected.

According to a further embodiment, the transmitting and receiving communication devices support both beamforming and an Alamouti scheme and both may be allowed to switch between a beamforming mode and an Alamouti mode. For example, the Alamouti mode may be applied, when the receiving communication device supports only one physical reception path or when the receiving

communication device is connected to only one reception path, for example a PLC device connected to an outlet, where only one reception path is available, e.g. without connection to protective earth. For coordinating a switch between the operation modes, for example the receiving communication device may send a message indicating that the Alamouti scheme will or shall be applied. For example the message of the type CM_CHAN_EST.IND may contain an information bit or flag indicating a change of the operation mode or the requested operation mode.

Figure 7 refers to a method of operating a communications system comprising a first and a second communication device connected by a wired transmission channel. Both communication devices store the same codebook table comprising a plurality of codebook entries, wherein each codebook entry includes at least one predefined precoder value for each of at least two transmit signals.

The first communication device identifies, in the codebook table, on the basis of channel state information describing the transmission channel, that one of the codebook entries, whose precoder values approximate a perfect precoding matrix for beamforming transmit signals at best among all or a subset of the codebook entries. The relevant codebook entry gives a codebook index (702).

The first and/or the second communication device may use the codebook index for constructing a precoding matrix for beamforming the respective transmit signals on the basis of the precoder values assigned to the codebook entry identified by the codebook index (704).

Table 1 (5 bit)

	v1	real (v2)	i mag (v2)	angle (v2)
5	+0.5429118123	+0.7325414029	+0.4106456589	+0.5109272538
	+0.8890378263	+0.1804094684	-0.4207899322	-1.1657621497
	+0.8520230127	-0.4242616312	-0.3066901598	-2.5156755927
	+0.9583699224	+0.2622585825	-0.1129049504	-0.4065284205
	+0.7845428042	-0.1379849364	-0.6045268776	-1.7952046406
10	+0.7208801863	+0.2438249187	-0.6487535480	-1.2112929532
	+0.7895094007	+0.5132647486	-0.3365029034	-0.5803107874
	+0.3678133423	-0.2445837675	+0.8971578043	+1.8369491567
	+0.4194919393	-0.7898742375	-0.4473535535	-2.6262754399
	+0.2789402854	-0.0495744116	-0.9590279948	-1.6224427089
15	+0.9493270518	+0.2248511744	+0.2195907514	+0.7735626971
	+0.8349743073	+0.2006290213	+0.5124118481	+1.1976054683
	+0.6437778772	-0.5296176025	-0.5523180606	-2.3352162299
	+0.7515049899	+0.5231669119	+0.4019162007	+0.6550710142
	+0.3154816246	+0.6055763516	+0.7305810201	+0.8786819854
20	+0.9339951934	-0.1163966601	+0.3377940144	+1.9026334400
	+0.6058703520	-0.6968905692	+0.3837507669	+2.6382417583
	+0.9974148629	-0.0662278106	+0.0278831213	+2.7430993563
	+0.3545051951	-0.8948992442	+0.2710745457	+2.8474676471
	+0.6921350912	-0.7194854156	-0.0573563622	-3.0620422954
25	+0.5307601623	-0.0547795048	-0.8457498779	-1.6354763166
	+0.0383121179	-0.9477381321	+0.3167406110	+2.8190561069
	+0.5156760692	+0.6028865201	-0.6087742074	-0.7902573132
	+0.9526501184	-0.0948727896	-0.2888890891	-1.8881053686
	+0.5971425452	+0.2532717747	+0.7611006431	+1.2495524869
30	+0.8469389995	+0.5256289112	+0.0800535994	+0.1511391618
	+0.6289801775	+0.7730414887	-0.0824062679	-0.1061990035
	+0.5914770000	-0.3603891509	+0.7213006436	+2.0341542272
	+0.9177609510	-0.3969777000	+0.0111149657	+3.1136009993
	+0.7726056604	-0.1260646301	+0.6222444877	+1.7706873855
35	+0.8190726488	-0.4597451218	+0.3431536377	+2.5003996982
	+0.3091478225	+0.9343053665	-0.1774855095	-0.1877283626

Table 2 (6 bit)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.5370545358	-0.1855474350	-0.8228879480	-1.7925706697
	+0.8384124707	-0.5446977253	-0.0192072 159	-3.1063451024
	+0.8726365170	+0.4878962574	+0.0215116531	+0.0440620922
	+0.9959431368	+0.0562311975	+0.0702518373	+0.8957974147
	+0.7124662060	-0.6820405895	+0.1649622365	+2.9042843163
10	+0.8001176514	-0.5483103928	-0.2432436167	-2.7240536962
	+0.8070029620	+0.3346201991	-0.4865958711	-0.9683896224
	+0.2687047193	-0.8360541367	-0.4783421937	-2.6219084317
	+0.9440520070	-0.1127762428	-0.3099150323	-1.919794 9218
	+0.8799164606	-0.1312542481	+0.4566391844	+1.8506864428
15	+0.9282229308	-0.3569673078	+0.1047689456	+2.8561122523
	+0.9183604277	+0.2674778994	-0.2916671017	-0.8286322600
	+0.8824289340	-0.3105185571	-0.3534082654	-2.291684 0746
	+0.3732044063	-0.4735026723	+0.7978180811	+2.1064205205
	+0.9686776061	-0.1346593940	+0.2086397447	+2.143942 1792
20	+0.8308013261	-0.0839352753	-0.5502036225	-1.7221822663
	+0.5653353832	+0.3581176545	+0.7430663834	+1.12 16961899
	+0.5214077647	-0.6653388823	+0.5342828040	+2.4650107889
	+0.3265207182	+0.9156699443	-0.2343774170	-0.2505827623
	+0.9868755405	-0.1581712059	-0.0325351671	-2.9387263226
25	+0.5173607870	+0.8517732567	+0.082584 1102	+0.0966534058
	+0.1869679277	-0.2939958967	+0.9373416702	+1.8747272584
	+0.755594 8274	-0.2232 625836	+0.6158167549	+1.9186049508
	+0.0600016333	-0.487111134 67	-0.8712762707	-2.0805824428
	+0.8487683522	+0.2738351930	+0.4523345790	+1.0264288991
30	+0.6649767787	+0.4177867256	-0.6190800722	-0.9771491177
	+0.9367940037	+0.0350272498	+0.3481236653	+1.4705165620
	+0.2945556475	-0.8789475759	+0.375084 1630	+2.7382471375
	+0.9824201600	+0.0606530887	-0.1765554 645	-1.2398919992
	+0.5403210814	+0.6950135216	+0.4743514877	+0.5988888616
35	+0.8030958367	+0.0480358982	+0.5939104559	+1.4900912952
	+0.7171617233	+0.1056318437	-0.6888548296	-1.4186374529
	+0.7172625048	+0.6951466795	+0.0480165931	+0.0689645026
	+0.2899682464	+0.4920228933	-0.8208726385	-1.0308254386
	+0.7252078766	+0.3248 125960	+0.6070999202	+1.0795242146
40	+0.7344223090	+0.5850292197	-0.3440416896	-0.5316057733
	+0.5836664489	-0.7730405125	+0.2484790582	+2.8305923204
	+0.9401761036	+0.2553869953	+0.2254914 118	+0.7233093752
	+0.8866466031	+0.1075855428	-0.4497589934	-1.3360012009
	+0.1412279570	+0.8632288323	+0.4846551839	+0.5115873860
45	+0.5958421040	+0.7641504586	-0.2470754210	-0.3127238440
	+0.6396444809	-0.5569270499	-0.5297992065	-2.3811522112
	+0.6531713929	+0.0203413973	+0.7569368263	+1.5439294839
	+0.5135078730	-0.7875 611786	-0.3406714755	-2.7333317927
	+0.7843161996	-0.3784 187351	-0.4915764029	-2.2268535887
50	+0.3611153600	+0.4452488515	+0.8193589915	+1.0730257666
	+0.8294727167	-0.5076319558	+0.2329910077	+2.7112992043
	+0.2973638436	-0.2072267913	-0.9320041853	-1.7895825975
	+0.9589399172	+0.2801736008	-0.0440112331	-0.1558123060
	+0.5015828956	+0.6652934310	-0.5529911839	-0.6934773017
55	+0.8485421665	+0.4866646919	-0.2076864689	-0.4033559970
	+0.4473921579	-0.0404210742	+0.8934239720	+1.6160083759
	+0.7029118578	-0.2195961595	-0.6765297088	-1.8846591974
	+0.8305397871	+0.4858567340	+0.2722992764	+0.5108321886
	+0.5821292785	-0.3527594192	+0.7325887628	+2.0195545723

5 +0.4238950361 -0.9056675283 +0.0089065525 +3.1317587299
+0.9245914011 -0.3594312596 -0.1262533592 -2.8037969329
+0.6591708476 -0.7365179258 -0.1517733131 -2.9383686453
+0.8724454181 -0.3288260032 +0.3615417710 +2.3088410186
+0.7213952222 -0.5080642040 +0.4705950468 +2.3944620132
+0.6907592035 +0.5969629956 +0.4080280684 +0.5995704991
+0.4988766087 +0.2143087516 -0.8397582321 -1.3209268257
+0.3432442229 +0.8496337693 +0.4003821443 +0.4403767466
+0.4443477116 -0.5684575522 -0.6923952069 -2.2582125646

10

table 3 (7 bit)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.6317736337	+0.7238481520	+0.2773191817	+0.365868 6672
	+0.6106276958	-0.3125280924	-0.7276400268	-1.9764801068
	+0.6950914471	-0.6157145944	-0.3711380046	-2.5991344475
	+0.6100571752	-0.0333070436	-0.7916570494	-1.6128440951
	+0.5995506391	+0.7258933546	-0.3370724979	-0.4347275404
10	+0.5981134001	+0.1640861692	+0.7844336107	+1.364591 6468
	+0.6301042649	-0.7648413642	-0.1341130231	-2.9680098305
	+0.3013116427	+0.5158354554	+0.8019507946	+0.9991980235
	+0.7538002344	-0.6253031951	-0.2019433603	-2.8292135728
	+0.5882469008	+0.2375951112	-0.7729903925	-1.2725906082
15	+0.7126897012	+0.6899172353	+0.1268368958	+0.1818134420
	+0.8497712596	+0.0281703101	-0.5263983662	-1.5173321332
	+0.9093227347	+0.3992401893	-0.1172153375	-0.2855712936
	+0.4829533864	+0.72624845 16	-0.4892026299	-0.5927888406
	+0.9383003240	-0.0318738915	+0.3443494692	+1.6630959506
20	+0.7749910322	-0.6270158022	+0.0789942015	+3.0162685341
	+0.1993472259	-0.9154479748	-0.3495936054	-2.7768016639
	+0.3652433356	+0.9289266539	+0.0607665825	+0.0653228388
	+0.1080676645	-0.8526190750	+0.5112358486	+2.601462 6201
	+0.3483369396	+0.6361832923	-0.6884273347	-0.8248187874
25	+0.9980685734	+0.0474729116	+0.0400680104	+0.701011 1648
	+0.491368 1458	-0.8671896177	-0.0808672510	-3.0486094595
	+0.5601156584	-0.5087949528	-0.6537569466	-2.2321418603
	+0.9635567540	-0.1774140601	-0.2002064761	-2.2959096382
	+0.3259274700	+0.8407719365	+0.4322890642	+0.4749092301
30	+0.3574216567	-0.2358272879	-0.9036787314	-1.8260667927
	+0.4961731867	+0.7641439340	+0.412184 6878	+0.494674 1313
	+0.3516886085	+0.2254711463	-0.9085581351	-1.3275466936
	+0.2463405697	+0.9423449983	-0.2264999511	-0.2358832468
	+0.5919203439	-0.7517513017	-0.2906893305	-2.7726190352
35	+0.0490053971	+0.9648624124	+0.2581453005	+0.2614233805
	+0.4663774743	-0.81650438 60	-0.3403125609	-2.746694 6780
	+0.823982 1537	+0.5107919419	+0.2452447805	+0.4476228350
	+0.4863184928	+0.0914 979337	-0.8689778200	-1.4658891309
	+0.9335120204	+0.1960111899	+0.3002247844	+0.9923981548
40	+0.8006009055	+0.03840954 62	+0.5979656318	+1.5066507488
	+0.717914 8968	-0.2762553914	-0.6389688252	-1.9788723165
	+0.3715729080	+0.8699346223	-0.3242642858	-0.3567927295
	+0.5633144111	-0.6413080554	+0.5209614 691	+2.4593712771
	+0.948844 1314	-0.3013187162	+0.0943495919	+2.8381410036
45	+0.8448396019	+0.4592951402	-0.2743975604	-0.5385290393
	+0.8511158488	+0.25775314 81	+0.4573457406	+1.0575831198
	+0.7953101618	-0.5571693454	+0.2388389983	+2.7366218170
	+0.8806153808	-0.4713095859	+0.0488244326	+3.0383677323
	+0.9673344247	+0.2209276586	+0.1243184 637	+0.5125498685
50	+0.7594503312	-0.4188442250	-0.4977998 690	-2.2702710188
	+0.8791381839	-0.4171842780	+0.2303765000	+2.6370484666
	+0.9021693959	-0.3294772655	-0.2784512750	-2.4399324066
	+0.6046827111	+0.7963828109	+0.0115428480	+0.0144930800
	+0.586492 6108	+0.6299381353	+0.5091211675	+0.6797259419
55	+0.9458872731	+0.1263919973	-0.2988684 152	-1.170704 1964
	+0.4556689198	-0.8745251554	+0.1660469456	+2.9539552377
	+0.8007902108	-0.4397364589	+0.4066532737	+2.3952620154
	+0.4043567632	-0.3405656790	+0.8488289736	+1.9523524818

	+0.9103782182	-0.0320116191	-0.4125369753	-1.6482381120
	+0.8313017730	-0.5100030850	-0.2209846501	-2.7327123712
	+0.4532876467	+0.2896524476	+0.8429897798	+1.2398331747
	+0.8591974203	-0.1469751593	+0.4900796829	+1.8621618669
5	+0.6964405573	-0.7174431073	-0.0156824091	-3.1197373846
	+0.9382208559	-0.1944106762	+0.2862623176	+2.1673810552
	+0.9915754066	-0.1278243236	-0.0209560307	-2.9790942229
	+0.6039404631	-0.2354148749	+0.7614694700	+1.8706342311
	+0.8818169744	-0.3060645715	+0.3587802972	+2.2770697659
10	+0.6879346876	+0.0032447053	+0.7257653460	+1.5663256205
	+0.8067555856	+0.3810920657	-0.4515686686	-0.8698371459
	+0.9069527033	+0.3492839388	+0.2354517446	+0.5931300182
	+0.7564516125	-0.1579564765	+0.6346894591	+1.8147131228
	+0.9656793568	+0.2578122352	-0.0315631309	-0.1218205999
15	+0.5034726798	+0.8457730539	-0.1765876607	-0.2058315523
	+0.7395360689	+0.2213624141	+0.6356768711	+1.2356982921
	+0.7974907213	+0.6023978161	+0.0335472892	+0.0556321293
	+0.8836466089	+0.0790075989	+0.4614395626	+1.4012208517
	+0.5784950444	-0.6602681825	-0.4789461460	-2.5140346224
20	+0.9597323722	-0.2680045189	-0.0841864099	-2.8372297746
	+0.2936947163	-0.5722512380	-0.7656839650	-2.2126137966
	+0.5715766722	-0.7534498454	+0.3249822123	+2.7343763831
	+0.9826165920	-0.1012532525	+0.1556033802	+2.1476731115
	+0.8840517465	+0.4657226280	+0.0394327685	+0.0844686042
25	+0.5023809145	-0.4875592891	+0.7140723747	+2.1698762440
	+0.8857454044	+0.1482734448	-0.4398523208	-1.2456611888
	+0.4862609003	-0.0525511146	+0.8722320318	+1.6309725930
	+0.5581448706	+0.4362820549	+0.7057848624	+1.0171368548
	+0.4337857134	-0.6231426179	-0.6507866260	-2.3344980966
30	+0.8419321901	-0.2912144414	-0.4542514022	-2.1408799235
	+0.4143404761	-0.7609704892	+0.4992453150	+2.5609663464
	+0.1786270657	+0.8816225713	+0.4368455256	+0.4600425368
	+0.1903259722	+0.5717110973	-0.7980742106	-0.9491724752
	+0.3623847908	-0.9300985091	-0.0599502032	-3.0772259364
35	+0.1686825679	+0.0046949336	+0.9856592458	+1.5660331207
	+0.4806440138	+0.4291749302	-0.7647157716	-1.0593786040
	+0.6071617024	-0.7879417707	+0.1024813800	+3.0122565588
	+0.7765762773	-0.0097799293	-0.6299473299	-1.5863200748
	+0.6966222961	+0.7041715907	-0.1373307958	-0.1926069940
40	+0.7938554882	+0.4243614384	+0.4355580712	+0.7984179867
	+0.8843614249	+0.3091437239	-0.3497642464	-0.8469684917
	+0.7588531775	-0.3345675980	+0.5587543086	+2.1103139290
	+0.4891892313	-0.2469811946	-0.8364772474	-1.8579020580
	+0.3335960145	+0.0422838380	+0.9417673684	+1.5259280707
45	+0.8127848898	+0.5647287164	-0.1430461458	-0.2480827281
	+0.9758267505	+0.0698350086	+0.2070874804	+1.2455476616
	+0.9039912908	-0.1779259166	-0.3887700020	-2.0000050792
	+0.7426457039	+0.5835403107	-0.3285697251	-0.5128167339
	+0.5783084262	+0.5445184765	-0.6075022575	-0.8400162246
50	+0.4245649628	+0.6204512033	+0.6593822083	+0.8158075930
	+0.5063894189	+0.8471300283	+0.1610604593	+0.1878824320
	+0.7223864418	+0.1256255213	-0.6799823947	-1.3881080420
	+0.1063876553	-0.3325702638	-0.9370585288	-1.9118374796
	+0.2482791229	-0.1299972578	-0.9599261378	-1.7054016678
55	+0.8273551724	-0.4313368871	-0.3597664638	-2.4464179946
	+0.6272136116	-0.4256506250	+0.6522458362	+2.1489917600
	+0.7075658348	+0.5016891015	-0.4976531270	-0.7813595544
	+0.8225995601	-0.5639907295	-0.0724183737	-3.0138879536

	+0.6931110677	-0.5435049170	+0.4734970465	+2.4249235650
	+0.6909784146	+0.3349971755	-0.6405667202	-1.0889420340
	+0.9578692419	-0.0729725637	-0.2777796254	-1.8276912708
	+0.8037830442	+0.2303065730	-0.5485359608	-1.1732900381
5	+0.2864657220	-0.9141766823	+0.2867374822	+2.8376545002
	+0.9085490897	-0.4029687721	-0.1102484483	-2.8745372681
	+0.6971682910	-0.6701070089	+0.2547802398	+2.7782636484
	+0.9883017639	+0.0556017256	-0.1420143358	-1.1976199362
	+0.3367231338	-0.8349070774	-0.4353707652	-2.6609246906
10	+0.8230805551	-0.1608203598	-0.5446789988	-1.8578962076
	+0.6841667907	+0.4086352535	+0.6040968731	+0.9760580949
	+0.6666039422	-0.5034436914	-0.5497123191	-2.3122894149
	+0.9426889166	+0.2656139735	-0.2019574797	-0.6500872460
	+0.7105932712	+0.5762010980	+0.4037938802	+0.6112535396
15	+0.7098063460	-0.1180267778	-0.6944383564	-1.7391476558
	+0.2794117654	-0.5983260544	+0.7509560560	+2.2435538974

table 4 (8 bit)

	vl	real (v2)	imag (v2)	angle (v2)
5	+0.8909402196	+0.1356014147	-0.4334025627	-1.2675686224
	+0.7801305003	+0.6194043211	+0.0879470833	+0.1410437709
	+0.4605040367	+0.5304757763	-0.7117102521	-0.9302755722
	+0.8690485029	-0.0927698858	+0.4859510756	+1.7594303962
	+0.2074053916	+0.9586694037	+0.1947716047	+0.2004405101
10	+0.6311597071	-0.4454653253	+0.6349787934	+2.1825575309
	+0.7297945686	+0.0011364906	+0.6836655586	+1.5691339796
	+0.9287951424	+0.3106438808	+0.2020889972	+0.5767609083
	+0.7315091601	-0.1623082680	+0.6622313605	+1.8111513275
	+0.8654404094	-0.3451943029	+0.3631167733	+2.3308967820
15	+0.9774419950	+0.1461541109	+0.1524667908	+0.8065344596
	+0.3226018604	+0.8665657160	-0.3807780187	-0.4140128292
	+0.8812253145	+0.3074054292	-0.3590875203	-0.8627866424
	+0.9015159785	+0.4281232371	+0.0630827576	+0.1462945119
	+0.4098284032	-0.0399730297	+0.9112863638	+1.6146326264
20	+0.8038391632	-0.3492961158	+0.4814922878	+2.1983960637
	+0.7316461051	+0.4716434094	-0.4921854033	-0.8067078443
	+0.9596128553	-0.1086028338	+0.2595160734	+1.9671333351
	+0.8995554706	+0.1153958006	+0.4212882203	+1.3034421193
	+0.7776075410	-0.6264177047	+0.0541051895	+3.0554340997
25	+0.9307610248	-0.1810749674	-0.3176409464	-2.0889114937
	+0.9468196717	+0.3123429563	+0.0772941582	+0.2425919904
	+0.4754862767	-0.1478982763	-0.8672017646	-1.7397176424
	+0.3866161872	+0.5777035564	-0.7188786578	-0.8938534078
	+0.8892302607	+0.4250732565	-0.1690629175	-0.3785449666
30	+0.6782698102	+0.6115729126	+0.4073433897	+0.5875815068
	+0.4982285619	+0.7707089859	+0.3972102203	+0.4758780472
	+0.7054902896	+0.5001980206	+0.5020810606	+0.7872769194
	+0.8402284199	-0.0115762343	-0.5421090233	-1.5921471523
	+0.1148849877	-0.8740435200	+0.4720692373	+2.6463834473
35	+0.4883522981	+0.8670709229	-0.0984888200	-0.1131031978
	+0.9940100953	+0.1091764577	+0.0049428307	+0.0452428827
	+0.7286123567	+0.3389312963	+0.5951887180	+1.0531416509
	+0.8103117225	+0.2603711415	+0.5249778862	+1.1103811847
	+0.5505836355	-0.8342431861	+0.0299327035	+3.1057279693
40	+0.9846785462	-0.0534523151	+0.1659849710	+1.8823405762
	+0.6863876900	+0.2458879152	+0.6844056343	+1.2258851979
	+0.8448369767	-0.5310310980	-0.0652415190	-3.0193470721
	+0.4806513866	-0.5653700618	-0.6703215182	-2.2714644630
	+0.7533281147	+0.3595538621	-0.5506521332	-0.9923430187
45	+0.5178028700	-0.6896499372	+0.5062244087	+2.5083903075
	+0.2373453639	-0.9396475447	+0.2464339059	+2.8851069325
	+0.2981040126	+0.8213564811	+0.4863203971	+0.5345861217
	+0.8059242581	+0.4071354651	-0.4297985614	-0.8124702608
	+0.9368367352	-0.3410049241	-0.0777982866	-2.9172875642
50	+0.1149624948	+0.2795281336	+0.9532301125	+1.2855500119
	+0.5949849162	-0.1443170541	-0.7906741031	-1.7513330398
	+0.6403778011	+0.4236255484	+0.6406697017	+0.9865718834
	+0.6472939793	+0.0446749795	-0.7609301220	-1.5121526316
	+0.8995729683	-0.3203467244	-0.2968946796	-2.3941711540
55	+0.6627071719	+0.4742966270	-0.5795359470	-0.8849315818
	+0.4558207444	+0.5016768332	+0.7352195618	+0.9720146946
	+0.4205305938	+0.8887105603	+0.1826131422	+0.2026601626
	+0.4798584641	+0.7775112873	-0.4064628551	-0.4817005473

	+0.9360459504	+0.0525696065	+0.3479287501	+1.4208375803
	+0.8251112025	-0.2680913030	-0.4973113277	-2.0652181315
	+0.5515889147	+0.8340590132	+0.0097586707	+0.0116996823
	+0.3058928880	+0.9439481007	-0.1240625818	-0.1306804423
5	+0.8946280497	+0.3262277443	+0.3053131367	+0.7522934706
	+0.9340332030	+0.3289498700	-0.1391903686	-0.4002903421
	+0.7524316836	+0.5412005260	+0.3754311551	+0.6064856874
	+0.5851969478	+0.0870559763	+0.8062045580	+1.4632306237
	+0.6761653310	+0.7161466115	-0.1730158258	-0.2370504350
10	+0.5816676839	+0.7475973224	+0.3205634868	+0.4050778177
	+0.9752210079	-0.0541428352	-0.2145053359	-1.8180399344
	+0.8580800640	+0.1554302505	+0.4894282796	+1.2632945543
	+0.7353975447	+0.6378811647	-0.2286877149	-0.3442372074
	+0.1873656604	+0.7288848248	+0.6584990671	+0.7347089024
15	+0.9386809708	+0.0807696623	-0.3351929247	-1.3343393869
	+0.6583323272	-0.2976231761	-0.6913891755	-1.9772920464
	+0.6764170439	-0.5580123900	+0.4807100533	+2.4304781437
	+0.7410750058	+0.1755312700	+0.6480714537	+1.3062908112
	+0.5802587125	+0.7075977729	-0.4032433735	-0.5179753423
20	+0.5672093369	+0.0753541314	-0.8201190907	-1.4791716517
	+0.4955494428	+0.2210143013	-0.8399901359	-1.3135123985
	+0.9603351648	-0.0155127920	+0.2784164589	+1.6264567169
	+0.9216021925	+0.3081750070	-0.2359609369	-0.6534558957
	+0.5956405604	-0.5837600243	-0.5517576976	-2.3843700591
25	+0.3704547391	+0.4644041272	+0.8044203459	+1.0472238214
	+0.9253321609	-0.0718061621	+0.3722959403	+1.7613305517
	+0.6097709750	+0.2155968216	-0.7626908735	-1.2953049640
	+0.9624681500	-0.1849716214	-0.1985964742	-2.3206880785
	+0.9709008409	+0.2280597798	+0.0730773154	+0.3100934316
30	+0.5294461920	-0.7905767065	+0.3076933554	+2.7704301618
	+0.3207949781	+0.9304283725	+0.1771824642	+0.1881779576
	+0.7381240731	-0.6042783887	+0.3000341341	+2.6807358009
	+0.2271441370	+0.6327359364	-0.7403045156	-0.8635818121
	+0.9915469382	+0.0183887185	-0.1284387964	-1.4285916478
35	+0.6109111657	-0.7554291721	+0.2368845997	+2.8377276445
	+0.7913617971	-0.0160446652	+0.6111375253	+1.5970440694
	+0.6374012229	+0.7081779359	+0.3036506087	+0.4050656818
	+0.8332225173	-0.4128949153	-0.3677744223	-2.4139274501
	+0.3156563240	-0.0723344860	+0.9461124707	+1.6471023074
40	+0.4928357614	+0.0141598710	+0.8700071323	+1.5545221834
	+0.6984400519	+0.1978362216	-0.6877807233	-1.2907132033
	+0.9479443905	-0.0823699072	-0.3075981647	-1.8324417038
	+0.7906530084	+0.0991243619	-0.6041872071	-1.4081826622
	+0.3802001800	+0.7427936364	-0.5510947622	-0.6383109567
45	+0.1164006758	+0.5092872213	-0.8526883422	-1.0323848209
	+0.8116286667	+0.5834614172	-0.0288388975	-0.0493870649
	+0.7079819218	-0.5313628285	-0.4652044097	-2.4224835298
	+0.2627849958	-0.2611965631	-0.9288274336	-1.8449277079
	+0.3931902665	+0.8013707543	+0.4507841263	+0.5124018564
50	+0.8615282146	+0.0824415986	-0.5009715742	-1.4076947411
	+0.3612391203	-0.4561968066	-0.8132593507	-2.0820065995
	+0.8003832600	+0.1339630685	+0.5843291310	+1.3454312439
	+0.9217603851	+0.1901158112	-0.3379552793	-1.0583709781
	+0.2169470497	+0.1670554082	-0.9617829631	-1.3988186596
55	+0.8668555861	-0.4244155172	+0.2615967537	+2.5892236719
	+0.5634180396	-0.5652763583	+0.6025136940	+2.3243182787
	+0.5288598655	+0.8076380311	-0.2608218804	-0.3123712220
	+0.2317999262	-0.6654747865	+0.7095154000	+2.3241756709

	+0.8992308481	+0.0257846608	+0.4367139030	+1.5118223366
	+0.7732069641	-0.5531334100	-0.3101522552	-2.6305573651
	+0.7834536828	-0.6113872082	-0.1113822629	-2.9613893456
	+0.9927060102	-0.0988966945	-0.0689508607	-2.5327477768
5	+0.4951890175	-0.1843407461	+0.8490031368	+1.7846037667
	+0.8167377077	+0.5501117523	-0.1741165608	-0.3065350650
	+0.6177171903	-0.7754722992	-0.1306452676	-2.9746880789
	+0.4571962645	-0.5868652507	+0.6682520132	+2.2914411944
	+0.8956906825	+0.4101220332	+0.1718665738	+0.3968304065
10	+0.7927741800	-0.4655833611	+0.3933716225	+2.4400665621
	+0.9062407378	-0.3654484958	-0.2125444004	-2.6148133545
	+0.9330041409	+0.1830178778	+0.3098511407	+1.0372699017
	+0.7546614369	+0.6471683361	-0.1079780548	-0.1653240708
	+0.1176061059	-0.4891759210	-0.8642197187	-2.0858647167
15	+0.5557191368	+0.6615153115	+0.5035610526	+0.6506455872
	+0.4275528798	-0.7684138411	+0.4761708766	+2.5868279301
	+0.8550357868	-0.2325675486	+0.4634934073	+2.0358597287
	+0.7060699277	-0.6733204161	-0.2193282348	-2.8266904643
	+0.7060699277	-0.6733204161	-0.2193282348	-2.8266904643
20	+0.5812699293	-0.4111884754	-0.7021746983	-2.1005549665
	+0.7789809438	+0.4196100371	+0.4659571932	+0.8376865814
	+0.3934366478	+0.9174505067	-0.0590946024	-0.0643229029
	+0.7417670367	+0.1149192162	-0.6607384029	-1.3985934815
	+0.9043258345	-0.0198723454	-0.4263799654	-1.6173697512
25	+0.9695164792	+0.0725749753	+0.2340313430	+1.2700921928
	+0.4523402355	+0.6928895450	-0.5615090291	-0.6810427707
	+0.9679255239	-0.2491108213	+0.0326186889	+3.0113929175
	+0.5956962848	+0.7936494797	+0.1235574348	+0.1544428415
	+0.3251367104	+0.6236293190	+0.7108956267	+0.8506964869
30	+0.1991749513	-0.1648291161	+0.9660024334	+1.7397988461
	+0.4152658272	-0.2036273226	+0.8866172829	+1.7965490557
	+0.8773083574	+0.2444193289	+0.4130245000	+1.0364434237
	+0.7920705916	+0.5017041416	-0.3477314081	-0.6060804252
	+0.6086573001	+0.7642700556	-0.2131374512	-0.2719671768
35	+0.7386184591	-0.3082744937	+0.5995078052	+2.0457492951
	+0.3258283513	-0.4934177505	+0.8064581880	+2.1198711767
	+0.8788411106	+0.4744503645	-0.0503503121	-0.1057277320
	+0.8146974340	+0.4710709457	+0.3381719313	+0.6226247710
	+0.5256800318	+0.3727306276	-0.7646779606	-1.1172513347
40	+0.4358836078	+0.6665961775	+0.6046941513	+0.7367443096
	+0.6960877347	+0.6594562912	+0.2838648720	+0.4064802206
	+0.9461686453	-0.2116078394	+0.2449224714	+2.2833500711
	+0.7552097716	-0.2270958904	-0.6148867029	-1.9245864870
	+0.4463752228	-0.8877580386	+0.1124047389	+3.0156464314
45	+0.9027022869	-0.4300809784	-0.0126068705	-3.1122882615
	+0.7814907956	+0.2347244070	-0.5780800889	-1.1850927820
	+0.9305740111	-0.3634694122	+0.0438405781	+3.0215555631
	+0.6688158100	+0.6534908603	-0.3544504306	-0.4969859977
	+0.6844852730	-0.4247085537	-0.5925390750	-2.1926825492
50	+0.9520396599	+0.2151839654	+0.2175232103	+0.7908041798
	+0.6693877566	-0.6578000634	+0.3452812011	+2.6582217267
	+0.5356360076	-0.4515275314	+0.7135943916	+2.1349499550
	+0.9485608119	-0.2817750530	-0.1443440527	-2.6681796968
	+0.6073554103	+0.2305992137	+0.7602258929	+1.2762874215
55	+0.7035382882	-0.7096901400	-0.0370645673	-3.0894136515
	+0.7322529246	-0.4510057443	+0.5102935165	+2.2945978849
	+0.5495738073	+0.5283843078	+0.6471310946	+0.8860734322
	+0.9218335521	-0.3599130665	+0.1438244996	+2.7614233933

	+0.3490444356	-0.1082254095	-0.9308357764	-1.6865435576
	+0.5945485686	+0.5784212783	-0.5585166285	-0.7678927073
	+0.9787220976	-0.2003300221	-0.0443952467	-2.9235066692
	+0.9612651871	-0.2352714316	+0.1435847954	+2.5936382356
5	+0.3381755714	-0.9338643602	+0.1163384706	+3.0176536983
	+0.3630873657	-0.7398855734	-0.5663363868	-2.4882843413
	+0.9687787025	+0.2462445849	-0.0288345284	-0.1165662656
	+0.5663350150	-0.1001861435	+0.8180631928	+1.6926569979
	+0.5895722345	+0.4376336624	-0.6788824330	-0.9981995078
10	+0.1061409494	+0.9902987221	-0.0896802094	-0.0903124020
	+0.5709274552	-0.3075047730	+0.7612375815	+1.9547064524
	+0.0134484414	-0.9282986139	+0.3715922805	+2.7608329327
	+0.7805584700	-0.5974916329	+0.1836633426	+2.8433693119
	+0.9648512791	+0.2238704553	-0.1376373074	-0.5512365151
15	+0.8056755281	-0.5218284718	+0.2803247927	+2.6486319561
	+0.2182255609	-0.8938911070	-0.3915817837	-2.7287086667
	+0.6507956275	-0.1345125299	+0.7472425514	+1.7489007636
	+0.6452815829	-0.7611654299	+0.0651065820	+3.0562649534
	+0.8532036572	+0.4398994857	-0.2802355470	-0.5672136813
20	+0.7269174758	+0.6727951951	+0.1376139848	+0.2017577588
	+0.7525284906	+0.5712896462	-0.3276110666	-0.5206752448
	+0.6445484879	+0.7644539234	+0.0129400823	+0.0169256069
	+0.8482006122	+0.0311743711	+0.5287569197	+1.5119066477
	+0.6921252172	+0.5747346477	-0.4366265779	-0.6496809944
25	+0.6520696908	+0.3250047675	-0.6849649768	-1.1277692684
	+0.8555949206	-0.4920858045	+0.1606514640	+2.8260313765
	+0.9663805264	+0.0670960014	-0.2482071813	-1.3067838707
	+0.3883235217	+0.2082069141	+0.8976941146	+1.3428906933
	+0.5180521836	+0.8328068359	+0.1950761626	+0.2300910318
30	+0.5180521836	+0.8328068359	+0.1950761626	+0.2300910318
	+0.6683211647	+0.0397918655	+0.7428078003	+1.5172779504
	+0.2190452190	+0.9163320932	-0.3351935067	-0.3506798792
	+0.8346727904	-0.5101333935	-0.2075698768	-2.7551579094
	+0.6236515055	+0.6005436988	+0.5004059008	+0.6946919084
35	+0.8410396127	+0.2132239237	-0.4971799756	-1.1656551338
	+0.9942903297	+0.0429995210	+0.0976615664	+1.1560455727
	+0.5906075122	-0.6785309394	+0.4367820175	+2.5696468713
	+0.5433023434	+0.3773487881	+0.7499536358	+1.1046216623
	+0.8787738843	-0.2751710440	-0.3899196799	-2.1853456500
40	+0.9074450492	-0.2213743477	+0.3571230611	+2.1257071991
	+0.6480092808	-0.3041765550	+0.6982553941	+1.9816307700
	+0.8527760237	+0.5197099036	+0.0517172068	+0.0991851463
	+0.8210865764	+0.3195864084	-0.4729496396	-0.9765451115
	+0.4856271799	+0.2664331417	+0.8325740947	+1.2610831065
45	+0.9294597487	+0.3665236678	-0.0420116232	-0.1141238029
	+0.4083318883	+0.1033660175	-0.9069622569	-1.4573164872
	+0.9898594603	-0.1198000878	+0.0763294684	+2.5743108022
	+0.8999701394	-0.1312308514	-0.4157309368	-1.8765601381
	+0.8597907217	+0.4526755816	+0.2363149014	+0.4811239888
50	+0.4074379353	+0.8643081508	-0.2948995581	-0.3288112979
	+0.9999984653	+0.0017232240	+0.0003160976	+0.1814170108
	+0.5192784403	+0.6668787443	-0.5344367519	-0.6755941332
	+0.4961596819	-0.7200088432	-0.4851936064	-2.5486185012
	+0.8431750809	-0.1368515322	-0.5199302271	-1.8281700256
55	+0.6723319595	+0.7192858844	+0.1749215615	+0.2385569885
	+0.2752683297	+0.3289984756	+0.9033201812	+1.2215185471
	+0.7110560511	+0.3277009825	-0.6221023696	-1.0859676666
	+0.7662378147	-0.3996182393	-0.5031747948	-2.2419867854

	+0.7791921091	+0.5756259475	+0.2480210187	+0.4068336286
	+0.3299436157	+0.2753821256	-0.9029406932	-1.274773693 9
	+0.7227870273	+0.0104541399	-0.6909917685	-1.5556682994
	+0.4994238044	+0.0229922216	-0.8660526666	-1.5442542665
5	+0.8206507575	+0.5395971841	+0.1880617270	+0.3353579013
	+0.4884941360	-0.3400141399	+0.8035943403	+1.9710706733
	+0.8029403439	-0.1689656988	+0.5716094793	+1.8582082320
	+0.8928255090	-0.4338620721	-0.1209392944	-2.8697429339
	+0.7187494042	+0.6952452918	-0.0057687162	-0.0082971922
10	+0.5802650788	-0.7493339240	-0.3190471888	-2.7390662801
	+0.2666612715	-0.5942457064	-0.7587910165	-2.2351768914
	+0.3644949458	-0.9116198615	-0.1899806900	-2.9361343065
	+0.7777698533	-0.0542668701	-0.6262021736	-1.6572406622
	+0.6620950236	-0.6532002296	-0.3673685340	-2.6292690134
15	+0.7029570106	-0.1397463344	-0.6973681977	-1.7685678528
	+0.8647308416	-0.4997123702	+0.0502804013	+3.0413114797
	+0.33372 07472	-0.8095004033	+0.4830523366	+2.6035817985
	+0.4824127577	-0.3421419889	-0.8063602115	-1.9720774404
	+0.7003340113	-0.6907202499	+0.1801049943	+2.88652 26345
20	+0.4140401953	-0.4139039733	+0.8107121669	+2.0428432577
	+0.3008515857	+0.6234909280	-0.7216282880	-0.8582272392
	+0.8356293323	+0.3440875579	+0.4281674572	+0.8938468164
	+0.4705737366	-0.8526101726	-0.2271921037	-2.8811770884
	+0.9073901234	-0.3195771135	+0.2729718529	+2.4346850721
25	+0.9839051142	+0.1215947464	-0.1309406121	-0.8223894292
	+0.9496500986	+0.1945428796	-0.2455967391	-0.9008767880
	+0.4299713008	+0.3795396729	-0.8191912580	-1.1369289250
	+0.5364948439	+0.5315738888	-0.6554406787	-0.8893733824

Table 5 (9 bit)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.8849664064	+0.0504737955	+0.4629112826	+1.4621897997
	+0.3552782612	-0.6239635574	-0.6960221520	-2.3016581866
	+0.4319731382	-0.3206448151	+0.842962 6981	+1.9342739620
	+0.9491159414	-0.2821692218	-0.1398551394	-2.6814368869
	+0.7068243617	-0.5717230493	+0.4165718144	+2.5119123536
10	+0.8713805998	+0.2777505940	-0.4044137211	-0.9689857271
	+0.8633308251	-0.0117204695	+0.5045022468	+1.5940238974
	+0.6738477447	-0.1521654937	-0.7230317279	-1.7782240664
	+0.6016132073	+0.7306407976	-0.3228398578	-0.4160628741
	+0.9121437820	-0.4036894584	-0.0709122144	-2.9677063726
15	+0.9998105035	-0.0188831027	-0.0047313257	-2.8960882207
	+0.6409182920	-0.2926755834	+0.7096229604	+1.9619790515
	+0.7993138716	+0.3100551666	+0.5147456929	+1.0286533873
	+0.3898517790	-0.7336624228	+0.5565564 120	+2.4926101420
	+0.8406028447	+0.4836659474	-0.2438321325	-0.4669488160
20	+0.7686250597	-0.5793714767	-0.2711903568	-2.703808 1494
	+0.1425407156	-0.9266561965	+0.3478367979	+2.7824996620
	+0.2361615775	+0.7817213331	+0.5771823513	+0.6360020004
	+0.9500860769	-0.1083901388	+0.2925543098	+1.9256122610
	+0.9016965912	+0.2870561879	+0.3233295569	+0.8447553140
25	+0.4383816424	-0.8775854135	-0.1940757005	-2.9239482176
	+0.8540775190	-0.1328247506	-0.5029007628	-1.8290170211
	+0.4464161273	+0.5061145823	+0.7379435418	+0.9696339509
	+0.9505375607	-0.2061470074	-0.2323397450	-2.2965309988
	+0.8879331370	-0.4007371713	+0.2257973952	+2.6284779681
30	+0.7812450693	+0.0264721912	+0.6236628 615	+1.5283754745
	+0.3661960311	-0.8512254721	-0.3759197552	-2.7257278155
	+0.8086878210	-0.0549259730	+0.5856681191	+1.6643062601
	+0.1848329633	+0.0745368211	+0.9799393032	+1.4948798158
	+0.8635353156	-0.3359974909	-0.3760484 608	-2.3000059647
35	+0.6469437390	+0.3560910157	-0.6742870213	-1.0849221992
	+0.6558964432	+0.0422053729	-0.7536700620	-1.5148549548
	+0.8331170113	-0.5528303428	-0.0171655936	-3.1105522442
	+0.5862071865	+0.3747165985	-0.7182956253	-1.0899597540
	+0.7390056711	-0.2461900018	-0.6271053349	-1.9448911988
40	+0.3419774748	+0.8911801406	+0.2980761039	+0.3227763160
	+0.7565871548	-0.5252225164	-0.3895089029	-2.5034844842
	+0.5164225300	+0.8518176975	+0.0878315476	+0.1027476286
	+0.3163508572	+0.2872775576	+0.9040983022	+1.2631353911
	+0.9372217378	-0.3217342472	+0.1345454883	+2.7455057205
45	+0.3648325536	+0.0504898990	-0.9297031666	-1.5165420749
	+0.8201265147	+0.4702531118	-0.3259670394	-0.6061297758
	+0.8838773709	-0.2432113909	-0.3995109668	-2.1176414224
	+0.6533284925	+0.1394 684129	-0.7441172238	-1.3855179197
	+0.9362264337	+0.3199249088	+0.1453551426	+0.42 64583964
50	+0.8663611739	-0.3616373518	+0.3444368478	+2.3805504329
	+0.7217373631	-0.1980606169	+0.6632248267	+1.8609982408
	+0.4374232543	-0.2301016920	-0.8693181857	-1.8295543773
	+0.3897980336	+0.8266625386	+0.4058158946	+0.4563482144
	+0.9483924062	+0.2492319898	+0.1960491243	+0.666524 6693
55	+0.7473335402	+0.5656915363	-0.3485479385	-0.5522062252
	+0.9686971138	-0.0885914329	-0.2318996759	-1.9357114787
	+0.3845920865	-0.1824836402	+0.9048694094	+1.7697956803
	+0.4589814549	+0.1652988720	+0.8729331630	+1.3836518791

	+0.4834999459	-0.8702058678	+0.0947077076	+3.0331856479
	+0.5092966432	+0.7082970032	+0.4888070012	+0.6040614701
	+0.9435226084	+0.1316451396	+0.3040306641	+1.1621695503
	+0.8070464402	-0.3337424703	+0.4871262741	+2.1714692664
5	+0.9963142387	-0.0747704349	-0.0420395021	-2.6293949018
	+0.4214726120	-0.9063625695	+0.0294572574	+3.1091035668
	+0.6370567030	-0.6824501149	+0.3583581978	+2.6580630786
	+0.9445883503	+0.1688956825	+0.2814730838	+1.0303459176
	+0.4218807483	+0.1350123837	-0.8965424086	-1.4213271627
10	+0.7072232341	+0.1733574497	-0.6854068075	-1.3230653435
	+0.7715745679	+0.5771651250	-0.2674941207	-0.4339923859
	+0.6273365540	-0.5546928763	-0.5465936892	-2.3635486534
	+0.3407947045	+0.9232397870	-0.1774465135	-0.1898842529
	+0.6991846829	+0.6567633036	+0.2824937915	+0.4062080134
15	+0.5560474738	-0.7557670134	-0.3458719826	-2.7124004681
	+0.7995824138	-0.5752018645	-0.1726579816	-2.8499804805
	+0.4150684407	+0.8889481708	+0.1936216391	+0.2144602763
	+0.7297987345	-0.6413853340	-0.2366826155	-2.7880769242
	+0.6964218502	+0.3675147082	-0.6163842517	-1.0331440102
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	+0.4901073099	+0.5962108419	+0.6358674836	+0.8175738415
	+0.1898681028	-0.8493742189	-0.4924566374	-2.6161678113
	+0.4655285660	+0.7944802294	+0.3899798960	+0.4563102596
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	+0.9144360966	-0.2627655738	-0.3078325493	-2.2773761217
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	+0.7023265985	+0.5552651350	-0.4454413305	-0.6760893377
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	+0.8598621685	-0.4324796817	+0.2712902064	+2.5813482467
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	+0.8236010763	+0.1680943979	-0.5416876780	-1.2699023129
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	+0.8056694671	-0.5214540015	-0.2810381365	-2.6472719455
15	+0.9953678744	+0.0956672653	+0.0095167771	+0.0991516789
	+0.6382169307	-0.6218090942	+0.4539081402	+2.5110280091
	+0.9109376991	+0.1387452798	+0.3885128771	+1.2277936598
	+0.7647517616	+0.4128412386	+0.4946886444	+0.8753418410
	+0.6618467953	+0.7424393700	+0.1036465219	+0.1387062328
20	+0.6143075316	-0.7661489463	-0.1887910186	-2.8999904196
	+0.3682440182	+0.3522814239	-0.8604034759	-1.1821807661
	+0.7862836275	+0.1791476656	+0.5913240828	+1.2766259650
	+0.5687250842	+0.4199874572	+0.7072215454	+1.0349070358
	+0.8641905160	+0.4901565565	-0.1136719060	-0.2278810841
25	+0.2050151699	+0.3302055226	-0.9213756525	-1.2266728171
	+0.7449089200	-0.6249810156	+0.2334725488	+2.7840785305
	+0.5642791749	-0.3013184254	+0.768632 6947	+1.9444034342
	+0.7462315110	+0.5082016663	-0.4299646478	-0.7021971315
	+0.7119103973	-0.6067052290	-0.3536839710	-2.6137979183
30	+0.4879852222	-0.6079360208	+0.6263259675	+2.3412960439
	+0.6078378218	+0.2406252438	-0.75672 49662	-1.2629246139
	+0.9595847340	-0.0203260332	+0.2806848601	+1.6430859911
	+0.9636278584	-0.2269166148	+0.1411743621	+2.5850511520
	+0.8461835746	-0.5120368723	+0.1476197798	+2.8609048770
35	+0.6188378974	-0.7401788832	+0.2630111740	+2.8001733260
	+0.7748328501	+0.3360159945	-0.5354692389	-1.0103891560
	+0.3229609960	-0.9305241601	-0.1726875285	-2.9580992510
	+0.7799362105	+0.5073243552	-0.3664989853	-0.6256120607
	+0.8639970625	+0.3697869204	-0.3417114418	-0.7459589716
40	+0.419952602 4	-0.4552525830	+0.7851018389	+2.0962786251
	+0.3463350312	-0.9253324155	+0.1543112663	+2.9763501883
	+0.5625112310	-0.7818302239	+0.2689286446	+2.8102969770
	+0.5148309175	+0.5462457142	-0.6607304641	-0.8799677611
	+0.3883864185	+0.5769582449	-0.7185229110	-0.8942420359
45	+0.8808940481	+0.4335727654	-0.1898429169	-0.4127101384
	+0.6294830076	+0.7447146886	-0.2217006444	-0.2893442365
	+0.9138113784	-0.1221299935	+0.3873409730	+1.8762332991
	+0.8314306171	+0.2676298959	-0.48692 64500	-1.0682364230
	+0.6932321125	+0.1898150862	+0.6952693515	+1.3042816773
50	+0.5245828566	-0.6816966663	+0.5100024330	+2.4992849933
	+0.9443271737	+0.3283465309	-0.0208505312	-0.0634164535
	+0.3759103545	-0.9184434650	-0.1230975509	-3.0083582121
	+0.6594005196	-0.7165368586	+0.2275211746	+2.8341328603
	+0.5722672547	-0.6667883951	+0.4773923181	+2.5202368851
55	+0.5722672547	-0.6667883951	+0.4773923181	+2.5202368851
	+0.7885372125	+0.4035609147	-0.4640556569	-0.8550107035
	+0.8164074511	+0.5502665898	-0.1751729260	-0.3081981629
	+0.6019697700	+0.0120550307	+0.7984278754	+1.5556990148

	+0.8081071943	+0.3421904255	-0.4794460087	-0.9509212314
	+0.9490948094	-0.2081285199	+0.2364351116	+2.292607 5731
	+0.2771860541	+0.9540680792	-0.1136749386	-0.1185885590
	+0.3697521799	+0.7629268053	+0.5303074723	+0.6074271908
5	+0.3184235993	-0.2865169619	+0.9036118868	+1.8778479674
	+0.2225189201	-0.9351452178	+0.2756605737	+2.8549332122
	+0.7535640219	-0.3652 692888	-0.5465524783	-2.1599393037
	+0.8949668207	+0.2848090172	-0.3433922152	-0.8783846957
	+0.9429744954	-0.3287740553	-0.0520261634	-2.9846510903
10	+0.9429744954	-0.3287740553	-0.0520261634	-2.9846510903
	+0.6847441258	+0.6101678271	+0.3985231548	+0.5785772992
	+0.5394017107	+0.2812335608	+0.7936960871	+1.2302656550
	+0.5667342991	+0.7003879833	-0.4338996510	-0.5546440701
	+0.6827660568	+0.7126827720	-0.1609775704	-0.2221475901
15	+0.6292886184	-0.6608712856	-0.4089559618	-2.5874545536
	+0.2708595318	+0.9344096168	+0.2313304606	+0.2426889605
	+0.5060294114	-0.4987823012	+0.7036692766	+2.1874243008
	+0.3475086364	+0.6174044250	+0.7057262384	+0.8520514294
	+0.4592071326	-0.1701534792	+0.8718810715	+1.7635306109
20	+0.6786814641	+0.6925383993	-0.2445036519	-0.3393931936
	+0.9238860946	+0.1800634782	-0.3376560795	-1.0808845728
	+0.6316261035	-0.7614510286	+0.1457422261	+2.9524792013
	+0.6719371939	-0.5691212449	+0.4739213185	+2.4472136778
	+0.7761913368	-0.6255597570	-0.0787527724	-3.0163597880
25	+0.8347962368	-0.4981178582	+0.2345076593	+2.7015869490
	+0.3861225369	+0.1596626811	+0.9085247463	+1.3968342963
	+0.3861225369	+0.1596626811	+0.9085247463	+1.3968342963
	+0.8976951783	-0.4404074674	-0.0135878425	-3.1107495491
	+0.4284740781	-0.5668237919	-0.7036481744	-2.2489122697
30	+0.7889124032	-0.0445126586	-0.6128913797	-1.6432963534
	+0.4919371423	-0.8700431351	-0.0319811044	-3.1048511278
	+0.4318662034	-0.0402660792	-0.9010384149	-1.6154551404
	+0.4250807268	-0.8812695929	+0.2065678588	+2.9113512331
	+0.1997052456	+0.4880154736	+0.8496815359	+1.0494498946
35	+0.810652 6329	-0.5798513147	-0.0813311850	-3.0022396227
	+0.8096433747	-0.4708318834	+0.3504210943	+2.5017756101
	+0.3665841731	-0.4038241011	+0.8381778686	+2.0197685342
	+0.4980295326	+0.8385011004	+0.2210938474	+0.2578095753
	+0.9800385959	-0.1961346043	+0.0324894984	+2.9774343147
40	+0.8607562972	-0.5047960334	-0.0654183570	-3.0127172738
	+0.334693 8777	-0.1420538026	-0.9315582244	-1.7221211012
	+0.6630990230	-0.4907434728	+0.5652172410	+2.2857840521
	+0.6871093381	+0.4935878209	+0.5331527179	+0.8239135717
	+0.4261516796	-0.6059355672	+0.6717416426	+2.3047354995
45	+0.4334953469	+0.8841909632	-0.1740348376	-0.1943451217
	+0.7530077947	-0.1979313894	+0.6275367927	+1.8763301116
	+0.9717736165	-0.2275445060	-0.0622859222	-2.8744068616
	+0.4064214006	+0.8550388689	-0.3220716965	-0.3602382830
	+0.9377130042	+0.0794209524	+0.3382109314	+1.3401486157
50	+0.6116756333	+0.2480904874	+0.7512017237	+1.2518159909
	+0.9666062111	+0.2428982172	+0.0816877516	+0.3244221726
	+0.2856876759	+0.3150048880	-0.9050715289	-1.2358649378
	+0.5626705062	+0.7832346347	-0.2644719426	-0.3256451438
	+0.8581031798	+0.0508353297	-0.5109546967	-1.4716317842
55	+0.9018288504	-0.3818930599	-0.2021445410	-2.6547632459
	+0.9913553065	+0.1051303825	-0.0785000566	-0.6413808757
	+0.9169547471	-0.0110347736	-0.3988385960	-1.5984565366
	+0.8164068896	-0.4178791592	-0.3985684368	-2.3798422084

	+0.2996336795	-0.0621909188	+0.9520251823	+1.63602 85103
	+0.6719578127	-0.7111959184	-0.2065745956	-2.8589101529
	+0.9368962907	+0.3321053194	-0.1092309358	-0.3177593275
	+0.4903418475	-0.0602531468	+0.8694448982	+1.6399864122
5	+0.7100339744	+0.4771409700	-0.5178689506	-0.8263075621
	+0.9990694591	+0.0103284302	+0.0418752850	+1.3289755319
	+0.2720055025	+0.1076532923	+0.9562550785	+1.4586903315
	+0.9734130753	-0.1736572908	-0.1493657600	-2.4312538238
	+0.5755623309	+0.6058018240	-0.5493015140	-0.7365234759
10	+0.5755623309	+0.6058018240	-0.5493015140	-0.7365234759
	+0.3255184951	-0.3845170454	-0.8638196288	-1.9895978295
	+0.2651856466	-0.3483345181	-0.8990771026	-1.9404246620
	+0.7636704683	-0.0008396035	-0.6456056930	-1.5720968157
	+0.6812799589	+0.0204948383	+0.7317360038	+1.5427951331
15	+0.7990330817	-0.5999026440	+0.0407793093	+3.0737205211
	+0.3261992517	+0.9399174894	+0.1007430458	+0.1067752225
	+0.9832441998	-0.0712415654	-0.1677959564	-1.9723049064
	+0.4297972907	+0.9026084391	+0.0239226799	+0.0264977367
	+0.9289208832	+0.3174619355	-0.1905883319	-0.5406769499
20	+0.7307150281	-0.6803820964	-0.0559977725	-3.0594743204
	+0.9984000770	+0.0306935157	-0.0474888858	-0.9970050405
	+0.5661566251	+0.8034508461	+0.1842102431	+0.2253785817
	+0.2635728406	-0.0057851351	-0.9646221488	-1.5767935619
	+0.9751439032	+0.1565353042	+0.1568153901	+0.7862920048
25	+0.8685040243	+0.1906379344	-0.4575564859	-1.1760249495
	+0.4788317910	-0.8280330257	-0.2916872028	-2.8029012835
	+0.9051739796	+0.0637662861	+0.4202308026	+1.4202040241
	+0.809590932 8	+0.5869164010	-0.0095739136	-0.0163107805
	+0.4798822804	-0.8536478258	+0.2024805829	+2.9087020456
30	+0.1712227886	+0.6917372202	+0.7015571073	+0.7924460099
	+0.7879490842	+0.4668356728	+0.4014980638	+0.7102948772
	+0.3936401015	+0.3368470814	+0.8553253850	+1.1956259898
	+0.6700561595	+0.2427004658	-0.7015135259	-1.2377189704
	+0.0793615654	+0.3446316910	-0.9353773246	-1.2177880611
35	+0.080596972 5	+0.9383519093	+0.3361544622	+0.3439959482
	+0.2640995845	-0.607 3662464	-0.7492380478	-2.2519946383
	+0.3571197816	-0.5477290738	+0.7566097563	+2.1973998385
	+0.7501597874	+0.6414176465	+0.1607597468	+0.2455733384
	+0.1784603957	-0.9711457415	-0.1582018833	-2.9801088156
40	+0.7021626537	-0.5702559454	-0.4263516911	-2.4995974293
	+0.5340530963	-0.7592586557	+0.3719053429	+2.6861165644
	+0.8225029234	-0.4010922786	+0.4032541694	+2.3535067360
	+0.8461379349	-0.2299413138	-0.4808093045	-2.0168833201
	+0.5017401529	+0.8329852804	-0.2332216579	-0.2729928723
45	+0.5943046737	+0.5651067324	+0.5722380063	+0.7916681888
	+0.9473553072	+0.3147740592	+0.0586106961	+0.1840910881
	+0.6993727012	-0.6441793022	+0.3096947715	+2.6934562731
	+0.9166971997	+0.2877547580	+0.2772425711	+0.7667945813
	+0.6446893456	-0.7640270423	-0.0252651213	-3.1085363392
50	+0.8137816377	+0.4824239017	+0.3240781160	+0.5915276659
	+0.7604215448	-0.3767167000	+0.5290024595	+2.1896146397
	+0.4558473822	-0.7963403451	+0.3975490145	+2.6785692519
	+0.8750095781	+0.4642568257	+0.1371999926	+0.2873472293
	+0.5809499246	+0.8006971733	-0.1462231919	-0.1806293980
55	+0.9070554339	-0.1004121049	-0.4088616502	-1.8116195889
	+0.8393170556	+0.3098539256	+0.4466961214	+0.9643400555
	+0.6882416959	+0.7037564484	+0.1762107530	+0.2453419121
	+0.4915445562	+0.0658992868	-0.8683554763	-1.4950517570

	+0.9867888967	+0.0765712824	-0.1427743393	-1.0785245196
	+0.7320490385	-0.0846020325	-0.6759783291	-1.6953038824
	+0.7149315721	-0.5039136762	+0.4847100723	+2.3756166305
	+0.6632505282	+0.7480559432	-0.0226062550	-0.0302108114
5	+0.9847727916	+0.1662526394	-0.0508193747	-0.2966555959
	+0.7712704734	+0.1470121638	-0.6192974088	-1.3377250089
	+0.9936567857	+0.0450411858	+0.1030411755	+1.1587062889
	+0.6895461600	-0.1399765208	+0.7105861432	+1.7652934902
	+0.2980137337	-0.7840820267	-0.5444292331	-2.5346670933
10	+0.2733372980	+0.8419752935	+0.4651497895	+0.5047227529
	+0.5637235164	+0.4912854582	-0.6639686706	-0.9337759800
	+0.5347974188	+0.6266516311	+0.5668328273	+0.7353189286
	+0.7970242831	+0.4485339093	-0.4044374170	-0.7337466375
	+0.5555858823	-0.1070022121	+0.8245452407	+1.6998463110
15	+0.4098100012	+0.6583255601	+0.6313978301	+0.7645225101
	+0.6975111109	-0.1074686450	-0.7084692940	-1.7213399689
	+0.5987192688	+0.0452370521	-0.7996804651	-1.5142876423
	+0.417932 8398	-0.0343757292	+0.9078273242	+1.6086441783
	+0.3089109054	+0.5976444166	-0.7398616112	-0.8913302673
20	+0.5549754362	-0.0463942763	-0.8305719934	-1.6265965640
	+0.9416702410	+0.2152156636	+0.2587264488	+0.8769476522
	+0.7591629503	-0.2881727231	+0.5836335294	+2.0294364993
	+0.9232056091	-0.3610988540	-0.1315257426	-2.7922908249
	+0.7927982297	-0.5464433539	+0.2699456020	+2.6827527524
25	+0.7696262199	+0.2361105730	-0.5932345902	-1.1920106104
	+0.7925308406	+0.0781941631	-0.6047979328	-1.4422198494
	+0.5207237320	+0.6423084542	-0.5623936740	-0.7191594916
	+0.6818097515	+0.3937244782	+0.6165358855	+1.0024715858
	+0.6721990172	-0.6698251203	-0.3154089241	-2.7015091883
30	+0.9363784095	-0.0489933237	+0.3475559357	+1.7108388777
	+0.4505625999	+0.6491339146	-0.6128772345	-0.7566767769
	+0.1181537846	-0.9869963490	-0.1089857344	-3.0316165680
	+0.3756260559	+0.9236355488	-0.0761737427	-0.0822854250
	+0.6079293169	-0.7108112879	-0.3537926774	-2.6797620446
35	+0.5703857491	+0.6800994400	+0.4605701347	+0.5952663523
	+0.6624637059	+0.6594642052	-0.3553150720	-0.4941987322
	+0.6286905605	+0.4126333624	+0.6591524007	+1.0114739177
	+0.9724380814	-0.0121277579	-0.2328456472	-1.6228342713
	+0.6318561358	-0.0581361152	-0.7729023326	-1.6458728841
40	+0.6233100444	-0.4196446173	+0.6598355733	+2.1372550164
	+0.6757077954	-0.7345157897	+0.0624942383	+3.0567148436
	+0.3355492081	+0.1476957914	+0.9303723352	+1.4133609569
	+0.8851478283	-0.4437083261	+0.1401293811	+2.8356913165
	+0.8298651703	+0.3953553624	-0.3937231726	-0.7833296907
45	+0.8789038463	+0.3870626603	+0.2787660774	+0.6241607963
	+0.6992934105	-0.2059372550	-0.6845279929	-1.8630287476
	+0.1626653083	+0.8925335111	+0.4206232626	+0.4403996733
	+0.8177322494	+0.3909691657	+0.4224418064	+0.8240710484
	+0.2233969336	+0.9050284949	-0.3619630277	-0.3804603020
50	+0.4995050187	+0.0456535693	+0.8651072118	+1.5180730815
	+0.9590688063	+0.0658584881	+0.2754082139	+1.33607 37069
	+0.9345324994	+0.2313465901	-0.2704214541	-0.8631156705

Table 6 (10 bit)

	vl	real (v2)	imag (v2)	angle (v2)
5	+0.7393308570	+0.2441256533	+0.6275289230	+1.1997851326
	+0.6094372697	-0.1435708610	+0.7797266329	+1.7528864997
	+0.3615414294	+0.8078477257	+0.4654780843	+0.5227321356
	+0.5288322589	-0.5309347582	+0.6621515872	+2.2466537366
	+0.6247313201	+0.7694918778	+0.1326387111	+0.1706944443
10	+0.5660637671	-0.5800939600	-0.5857156385	-2.3513724035
	+0.5350787109	-0.0516961557	+0.8432189992	+1.6320277881
	+0.8264081922	+0.0018685678	-0.5630683868	-1.5674777939
	+0.9736340403	+0.0891629024	-0.2099684083	-1.1692229048
	+0.4369312608	+0.0212501001	-0.8992438527	-1.5471696478
15	+0.8418419196	-0.1220764501	-0.5257371233	-1.7989536988
	+0.4088056652	+0.3769367680	-0.8311417455	-1.1450216559
	+0.4468074033	-0.8926326570	+0.0597501798	+3.0747553266
	+0.3911724160	+0.4196628446	+0.8190648557	+1.0973031293
	+0.4314083251	+0.2392811872	+0.8698456015	+1.3023514039
20	+0.7543255713	+0.6363715050	+0.1613203030	+0.2482702450
	+0.8635196786	-0.4727758019	-0.1755471610	-2.7860595237
	+0.5388496835	+0.5731689120	-0.6173478897	-0.8224902187
	+0.8742168972	-0.4849848436	+0.0231196466	+3.0939578511
	+0.1628877703	-0.9140415900	+0.3714775176	+2.7555708969
25	+0.6670096852	-0.6050938494	-0.4346947357	-2.5186292489
	+0.6277656724	+0.7583847970	-0.1753931590	-0.2272761315
	+0.3160036615	-0.9272926942	+0.2006737281	+2.9284709170
	+0.9450220966	+0.3254987286	-0.0313658206	-0.0960657313
	+0.1973791308	+0.3673681711	-0.9088905905	-1.1866796242
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	+0.8488486285	-0.4531671879	+0.2722048964	+2.6006790925
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	+0.9118754266	-0.1749363931	-0.3713225885	-2.0110717396
	+0.3846239446	-0.4103585721	-0.8268435545	-2.0314757882
	+0.2439239120	-0.6644929376	-0.7063641136	-2.3256601887
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40	+0.6036504671	-0.5145559731	-0.6089649120	-2.2723618967
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45	+0.5615438925	-0.5167420267	+0.6462554716	+2.2452896865
	+0.9355657590	-0.0262971298	+0.3521720766	+1.6453292572
	+0.7617474321	+0.4302849278	+0.4843508342	+0.8444414104
	+0.3198779688	+0.7464796969	+0.5834776321	+0.6634444996
	+0.3424415523	+0.3679770288	-0.8644805895	-1.1683646111
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	+0.7916859405	+0.6035739774	+0.0945083350	+0.1553200281
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5	+0.7633073857	-0.5451730197	+0.3466240232	+2.5752607737
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20	+0.8709583257	+0.4354121931	+0.2277011573	+0.4818428303
	+0.6216977173	-0.2231890501	-0.7507853196	-1.8597504475
	+0.9111585013	+0.1054232493	-0.3983417175	-1.3120726995
	+0.9607516127	-0.2772133415	+0.0104451875	+3.1039312318
	+0.8020279501	+0.5542234957	+0.2226824737	+0.3820501049
25	+0.9497034153	+0.2419921438	+0.1987541829	+0.6876093736
	+0.9128044711	+0.4034953582	+0.0630832267	+0.1550864402
	+0.3599573238	+0.8389374920	+0.4081845289	+0.4528293397
	+0.3599573238	+0.8389374920	+0.4081845289	+0.4528293397
	+0.3354880150	+0.9366780053	+0.1004096916	+0.1067898546
30	+0.6459396529	-0.6611157019	-0.3816909660	-2.6179988269
	+0.9115860869	-0.2854508896	+0.2958523209	+2.3383031019
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35	+0.3675990672	-0.9038494423	-0.2189226154	-2.9039577884
	+0.3674230285	-0.9246022071	+0.1005538498	+3.0332647586
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	+0.7708270340	-0.5853809842	-0.2513061619	-2.7360824755
40	+0.7846850141	-0.3720483469	+0.4958320847	+2.2145223555
	+0.8132044244	+0.2241693267	+0.5370723202	+1.1753879067
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45	+0.7443186176	+0.2753769737	-0.6084055538	-1.1457651274
	+0.9283705291	+0.3396324160	+0.1509237649	+0.4181653796
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	+0.7762094401	+0.3574567140	-0.5193492107	-0.9679807736
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	+0,5553555283	-0.6898175829	+0,4644695248	+2,5489964837
15	+0,7926157230	+0.5194931720	+0,3191976814	+0,5509699582
	+0,6892949003	-0.5677265130	+0,4500657139	+2,4712875405
	+0,8755678418	+0.0461527900	-0,4808855106	-1,4751147962
	+0,1130402153	+0.0541058783	-0,9921161543	-1,5163144661
	+0,6167416943	+0.4708992954	+0,6307801013	+0,9295166386
20	+0,6547959070	-0.0684302620	+0,7527015474	+1,6614599674
	+0,8515994636	+0.4600516687	+0,2512584641	+0,4998846370
	+0,8515994636	+0.4600516687	+0,2512584641	+0,4998846370
	+0,6342026463	-0.5733735442	-0,5186808096	-2,4062351089
	+0,6612038548	-0.6763320632	+0,3246296394	+2,6940843961
25	+0,4270388736	-0.4784287732	+0,7672963635	+2,1283345539
	+0,6137577196	-0.7857645046	+0,076652 4947	+3,0443488560
	+0,9426285288	-0.2980045768	-0,1504816566	-2,6739815385
	+0,7971677817	-0.1167101395	-0,5923700457	-1,7653271307
	+0,5767480736	-0.8024841835	+0,1529077984	+2,9533066130
30	+0,8075063668	+0.2590235070	-0,5299436673	-1,1161685319
	+0,7884331419	-0.3780114258	-0,4852633746	-2,2325893703
	+0,4550620723	-0.8368621287	+0,3042700904	+2,7928674660
	+0,8669320338	+0,1717292909	+0,4679080032	+1,2190444493
	+0,0905872122	+0.9527570981	+0,2899101050	+0,2953837313
35	+0,6412346731	+0.4836189744	-0,5957606748	-0,8889213349
	+0,3993740815	+0.8811852466	+0,2530077158	+0,2796006938
	+0,8935385349	-0.4488346659	-0,0116760149	-3,1155844527
	+0,4250730069	+0,0073589858	-0,9051291533	-1,5626661901
	+0,6371002577	-0,0024258996	+0,7707771252	+1,5739436589
40	+0,1157778930	+0,8550004066	-0,5055391026	-0,5339782636
	+0,5701625455	+0,5088815716	-0,6449451277	-0,9027798001
	+0,9999686957	+0,0011550747	-0,0078277284	-1,4242916549
	+0,6675762309	+0,7115661683	-0,2191245402	-0,2987314172
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45	+0,7830114149	+0,5356572148	-0,3161715869	-0,5332194195
	+0,1779180238	+0,7558745828	-0,6300784014	-0,6948810743
	+0,8906875093	+0,3556846382	-0,2831328290	-0,6723106762
	+0,5835911266	-0,3020744522	-0,7537721289	-1,9519493988
	+0,6785411390	-0,2964293936	-0,6720948871	-1,9861849735
50	+0,4296848724	+0,4271544982	-0,7955563746	-1,0780465093
	+0,5085565241	+0,7071194220	-0,4912762815	-0,6071986063
	+0,6328892722	-0,3779558142	-0,6757222592	-2,0807790568
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	+0,9685455150	-0,1511446371	-0,1976736807	-2,2235868077
55	+0,9407988275	-0,1814336589	+0,28632 04388	+2,1356084274
	+0,9407988275	-0,1814336589	+0,28632 04388	+2,1356084274
	+0,7314147231	+0,0096046492	-0,6818652752	-1,5567114123
	+0,5316458783	-0,2572010330	-0,8069698190	-1,8793418008

	+0.7070445506	-0.1034952447	-0.6995546711	-1.7176753720
	+0.8211679085	+0.3274551168	+0.4673932097	+0.9596686035
	+0.8294154330	+0.0765402514	+0.5533639214	+1.4333503242
	+0.9284220114	-0.3393276250	+0.1512922064	+2.7221878874
5	+0.1821796354	-0.4438543360	-0.8773846983	-2.0391395541
	+0.2252076980	-0.932 41632 78	+0.2826327732	+2.8472771790
	+0.6613616249	+0.1091273473	-0.7420862640	-1.4247880072
	+0.8646491165	+0.4607364123	-0.2002594909	-0.4100165561
	+0.8267621976	-0.5572252135	-0.0772290754	-3.0038741815
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	+0.46335 05985	-0.0690 41932 9	-0.8834814284	-1.6487854005
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	+0.6257845539	-0.7758494756	-0.0803198813	-3.0384350519
15	+0.4784836114	-0.3044640165	-0.8236231518	-1.9248808736
	+0.8762667241	+0.2782656868	-0.3933507796	-0.9551053316
	+0.5351519362	-0.8331118535	-0.1397749792	-2.9753662146
	+0.4217096629	+0.2525890885	-0.8708385112	-1.2884902651
	+0.8285752351	+0.3808848662	+0.4103532606	+0.8226243533
20	+0.2913611714	-0.8874860792	-0.3570393915	-2.7591014629
	+0.5897633172	-0.7120407752	+0.3810212122	+2.6502519584
	+0.8924645471	+0.3802854426	+0.2426726486	+0.5679875010
	+0.5089686101	-0.3795539292	-0.7725864151	-2.0274412086
	+0.9296010491	+0.0828827997	+0.3591271794	+1.3439781881
25	+0.6133960783	+0.6433186377	+0.4581335848	+0.6188279033
	+0.3181014078	+0.6152403247	+0.7213118862	+0.8645942523
	+0.9484551656	-0.2176682743	-0.2303330659	-2.3279324778
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	+0.8530729264	-0.0708783793	+0.5169553536	+1.7070541059
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	+0.5527000515	+0.7259848436	+0.4092293488	+0.5132918817
	+0.2055163750	+0.9343392008	+0.2911585090	+0.302082693 4
40	+0.2475297505	-0.9454919433	-0.2115986952	-2.9214231006
	+0.9428770756	+0.2948943273	+0.1549843733	+0.4838851319
	+0.8356535545	-0.1434402283	+0.5301962258	+1.8350130561
	+0.7468359774	-0.0853032423	-0.6595145030	-1.6994246853
	+0.7620395133	-0.4245753183	+0.4889085592	+2.2858843329
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	+0.3422318035	-0.0897540570	-0.9353189841	-1.6664642976
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	+0.5342159407	+0.4633731808	+0.7070350939	+0.9906517673
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55	+0.7321464462	+0.0398481319	+0.6799806671	+1.5122614120
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25	+0.9391775798	+0.2253552033	-0.2591534409	-0.8550431018
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	+0.9922938898	+0.1037048415	+0.0678096014	+0.5790917616
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	+0.9381260784	+0.2794835820	+0.2044709963	+0.6316226179
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	+0.1734719027	+0.8814886934	+0.4391869560	+0.4622331917
	+0.7534139288	+0.5425138188	+0.3715457016	+0.6004920649
15	+0.8742137497	+0.1309495060	+0.4675495125	+1.2977169347
	+0.5730222542	-0.6414045409	-0.5101428340	-2.4696918612
	+0.9123615011	-0.2347786919	+0.3353736083	+2.1815566425
	+0.9025296068	+0.2249496534	-0.3672028898	-1.0211612943
	+0.4011290696	+0.1185466290	-0.9083183177	-1.4410176604
20	+0.6727790789	+0.7352084337	-0.0826853675	-0.1119946025
	+0.3247147616	-0.8145541115	+0.4806890086	+2.6084655855
	+0.9575441652	+0.1988096154	+0.2087675945	+0.8098254331
	+0.9567389184	-0.1095353040	-0.2695415723	-1.9567873907
	+0.8189452746	-0.4083300141	+0.4032309968	+2.3624773823
25	+0.6242386188	-0.6641166796	+0.4114306536	+2.5869468897
	+0.7501001530	+0.5117259673	-0.4189108435	-0.6859939565
	+0.6871126620	+0.2400557564	-0.6857473468	-1.2340641069
	+0.8436294416	-0.2189149056	+0.4902709754	+1.9907510023
	+0.4654942695	+0.7063576188	+0.5332672870	+0.6466639360
30	+0.3975852187	-0.7197988387	+0.5690479995	+2.4726310992
	+0.8772927878	+0.3538490866	+0.3242656139	+0.7417997486
	+0.7784888763	+0.5926196138	+0.2067778104	+0.3357138238
	+0.7765763827	+0.5723143784	+0.2634110364	+0.4313498810
	+0.9759665797	-0.0635981877	-0.2084334564	-1.8669479883
35	+0.8506453682	+0.1523903967	+0.5031695784	+1.2767169148
	+0.6713823687	+0.4815576501	-0.5633364400	-0.8635040928
	+0.7617609936	-0.5747171775	+0.2990323636	+2.6618276372
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	+0.2874106019	+0.9366890500	-0.2000219225	-0.2103816198
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	+0.7727218323	-0.0010474468	-0.6347439427	-1.5724465133
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	+0.8277233786	+0.5130357757	+0.2273066240	+0.4170692716
	+0.7359059148	+0.6591957912	-0.1546072233	-0.2303751881
5	+0.7394970319	-0.6696628937	+0.0685255321	+3.0396191905
	+0.5124547566	-0.8094851322	+0.2865727536	+2.8013423286
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15	+0.6955252611	+0.6208104939	+0.3617166596	+0.5275661662
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	+0.3054086835	+0.8985698804	-0.3151153854	-0.3372853373
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25	+0.9921945683	+0.1194712909	-0.0357288300	-0.2905922327
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	+0,9908375239	-0,0673214333	+0,1170846949	+2,0926160604
	+0,7165070085	+0,6791137578	+0,1594434404	+0,2306050162
10	+0,4826112405	-0,7498222794	-0,4526068270	-2,5985165162
	+0,5841713697	+0,0318481529	-0,8110052441	-1,5315465230
	+0,8018895079	-0,0488129484	-0,5954750315	-1,6525865785
	+0,8018895079	-0,0488129484	-0,5954750315	-1,6525865785
	+0,8021735642	+0,1615384628	+0,5748242321	+1,2968398406
15	+0,8021735642	+0,1615384628	+0,5748242321	+1,2968398406
	+0,6262497710	-0,7580205648	-0,1822527029	-2,9056388638
	+0,9347441165	-0,3536207586	-0,0347245709	-3,0437092613
	+0,6410388454	+0,7639636989	+0,0736794775	+0,0961463269
	+0,7945721908	-0,1865779785	-0,5777920833	-1,8831416490
20	+0,8403844380	+0,4075624315	-0,3572770085	-0,7197462718
	+0,7048263332	+0,3274952338	-0,6292588593	-1,0909260565
	+0,7327061257	-0,5007092804	-0,4609034062	-2,3975657842
	+0,7327061257	-0,5007092804	-0,4609034062	-2,3975657842
	+0,2988883430	-0,9438373021	-0,1408435497	-2,9934613308
25	+0,9667582390	+0,1118013957	+0,2299542458	+1,1182578366
	+0,9798016222	-0,1909769505	-0,0593008057	-2,8405191246
	+0,9685405297	+0,1587514250	+0,1916434906	+0,8789952977
	+0,5509430417	+0,7867163548	-0,2784585103	-0,3401896969
	+0,8150086037	-0,3515376058	+0,4606324866	+2,2226685787
30	+0,9566268340	-0,1398324730	+0,2555620864	+2,0714538565
	+0,9961807532	+0,0556917569	+0,0672483101	+0,8791242675
	+0,8195027812	+0,5167826402	-0,2476911270	-0,4469465050
	+0,9574306516	-0,1888860499	-0,2182856101	-2,2841152394
	+0,4930663004	-0,8424450393	-0,2171911122	-2,8892766199
35	+0,7206518486	+0,1061805868	-0,6851179432	-1,4170381208
	+0,4627598029	-0,8297052418	-0,3121579352	-2,7817462467
	+0,9834049919	+0,0800529659	-0,1628070775	-1,1138071467
	+0,5712301482	-0,6849369898	-0,4522802647	-2,5579940599
	+0,6182156552	+0,5934626999	+0,5153750357	+0,7150912508
40	+0,7033904439	-0,7055832800	-0,0859890597	-3,0203212063
	+0,9593672897	+0,0715142948	+0,2729470812	+1,3145484181
	+0,9720574601	-0,0108860455	+0,2344904864	+1,6171872707
	+0,9643191006	+0,2576724107	-0,0607750029	-0,2316282231
	+0,6930219609	-0,7196264011	+0,0431092171	+3,0817591616
45	+0,5111975817	+0,7528569321	+0,4145883166	+0,5033702924
	+0,9675875218	-0,2123494137	+0,1366825307	+2,5696816105
	+0,3489144964	-0,3339543191	+0,8756330207	+1,9351540375
	+0,6868260782	-0,0181151757	+0,7265960217	+1,5957227277
	+0,9599472339	+0,2424561305	-0,1404148597	-0,5249363777
50	+0,3696728730	+0,2044621496	+0,9063868911	+1,3489305362
	+0,6321248438	-0,2724594348	+0,7253854411	+1,9300985544
	+0,7190962082	-0,0289411496	+0,6943076070	+1,6124556790
	+0,8449164565	+0,0446528772	-0,5330312393	-1,4872198715
	+0,3028697552	-0,3030091508	+0,9035791974	+1,8943546804
55	+0,8297252773	+0,1975922216	-0,5220280435	-1,2089529802
	+0,6983379578	+0,7032933244	-0,1330511050	-0,1869732452
	+0,8092584968	-0,4743720828	-0,3465137984	-2,5107094246
	+0,9171475470	+0,3396404197	+0,2085300036	+0,5506303683

	+0.4935106354	+0.0366701993	- 0.8689663683	- 1.5286215590
	+0.6584343860	+0.5297406533	- 0.5346391302	- 0.7900003199
	+0.6827352532	+0.7302437423	+0.0248324565	+0.0339926106
	+0.4153740987	- 0.6042285540	+0.6799795678	+2.2972762050
5	+0.4541253844	+0.5023065536	- 0.7358384751	- 0.9718224012
	+0.4541253844	+0.5023065536	- 0.7358384751	- 0.9718224012
	+0.6333656477	+0.2898198620	- 0.7175321623	- 1.1869220783
	+0.4092727459	+0.5961122516	- 0.6907575573	- 0.8588128994
	+0.9013562930	+0.2853514427	+0.3257781256	+0.8514526818
10	+0.7907156207	+0.5925058391	+0.1539663530	+0.2542334180
	+0.2429152873	+0.8568729870	- 0.4547096297	- 0.4878749858
	+0.5609711237	- 0.7919895568	- 0.2409646039	- 2.8462392932
	+0.3964591901	+0.8312552784	+0.3896598166	+0.4383453425
	+0.2059357720	- 0.8818005961	- 0.4242854776	- 2.6931318852
15	+0.9344309132	+0.1447386849	- 0.3254067939	- 1.1522809197
	+0.7065911798	- 0.1113367005	+0.6988083026	+1.7287920673
	+0.4183545373	+0.7546261860	+0.5054886750	+0.5902053391
	+0.7322370412	- 0.6792049076	- 0.0500959982	- 3.0679691401
	+0.7322370412	- 0.6792049076	- 0.0500959982	- 3.0679691401
20	+0.5178187833	+0.8378021988	- 0.1730641018	- 0.2037040127
	+0.2849485710	+0.0584623399	- 0.9567583115	- 1.5097676009
	+0.5355117470	+0.4374623974	- 0.7223945042	- 1.0262893180
	+0.7830544823	- 0.4529462775	+0.4262221808	+2.3865821482
	+0.5687189294	+0.1631148215	- 0.8061962133	- 1.3711647955
25	+0.4025643053	- 0.9006663677	- 0.1635300409	- 2.9619836515
	+0.7170789071	+0.6941540282	+0.0628333194	+0.0902718241
	+0.9365352054	+0.2944298932	- 0.1902967343	- 0.5737858044
	+0.9365352054	+0.2944298932	- 0.1902967343	- 0.5737858044
	+0.3466042817	- 0.9120030448	+0.2193534094	+2.9055576717
30	+0.9007461075	+0.0396469760	+0.4325327353	+1.4793893850
	+0.9291854739	+0.2144444837	- 0.3010447118	- 0.9518401652
	+0.8390962957	- 0.4993324611	+0.2158344270	+2.7336006767
	+0.3483413836	+0.0242581305	+0.9370537997	+1.5449144471
	+0.8913970568	- 0.4264856648	- 0.1533664400	- 2.7963866686
35	+0.8552233305	+0.0154949938	+0.5180279531	+1.5408937413
	+0.8552233305	+0.0154949938	+0.5180279531	+1.5408937413
	+0.8674466043	- 0.2880176239	- 0.4056873637	- 2.1881687786
	+0.9336320069	+0.3559658963	+0.0402437130	+0.1125769604
	+0.5897831091	+0.7047881291	+0.3942455799	+0.5100175046
40	+0.8213111575	+0.4887349747	+0.2942551733	+0.5419439341
	+0.6944845540	+0.2242368739	+0.6836731885	+1.2538639026
	+0.0941176083	- 0.1249273038	+0.9876917761	+1.6966123196

Table 7 (5 bit, Codebook optimized including orthogonal precoding vectors)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.8868707849	+0.4618952503	+0.0106296123	+0.0230089754
	+0.9337412276	+0.3154378798	- 0.1691929785	- 0.4923223792
	+0.7728530345	- 0.2933029007	+0.5627358132	+2.0512667191
	+0.5908364455	- 0.7742251893	+0.2269089044	+2.8564977180
	+0.7320805228	- 0.6659323432	+0.1434999035	+2.9293508553
10	+0.4591559629	+0.5473755421	- 0.6996826550	- 0.9069293985
	+0.9149189768	- 0.0166002174	+0.4032960434	+1.6119344737
	+0.6774622269	- 0.0651096162	+0.7326702321	+1.6594296933
	+0.8156779110	- 0.0154336120	+0.5783003970	+1.5974778742
	+0.318484 6599	- 0.56168324 83	- 0.7635963921	- 2.2050020425
15	+0.341848 1620	+0.9180995345	- 0.2005818509	- 0.2150953002
	+0.5428840615	+0.7413848505	- 0.3944938520	- 0.4889997522
	+0.7102884428	- 0.2509334044	- 0.6576646216	- 1.9352990092
	+0.1857306992	- 0.4508656337	+0.8730545732	+2.0474960045
	+0.9718577907	- 0.1058940388	+0.2104254910	+2.0370307348
20	+0.5027996612	- 0.7542386322	- 0.4222754863	- 2.6312033994
	+0.1499672138	+0.9347809800	+0.3220160775	+0.3317513924
	+0.8503001398	- 0.0440620252	- 0.5244503887	- 1.6546151027
	+0.9971360769	+0.0490047775	+0.0576036098	+0.8658820513
	+0.5231794805	- 0.6413996163	+0.5611503929	+2.4228282412
25	+0.8458055052	- 0.2911356100	- 0.4470493305	- 2.1480415080
	+0.5340994093	+0.8422806899	+0.0728083816	+0.0862276017
	+0.7493379790	+0.4905209459	+0.4448390663	+0.736598 1182
	+0.5901007419	+0.6878083454	+0.4227301674	+0.5510890174
	+0.6744282076	- 0.7201708760	- 0.1627897483	- 2.9192854755
30	+0.8495796058	+0.2453837005	+0.4669061287	+1.0869162737
	+0.9161147911	+0.1375686797	- 0.3765747574	- 1.2205428942
	+0.7177634833	+0.5388733824	- 0.4409433748	- 0.6857817215
	+0.9246319214	- 0.3322668698	- 0.1861572915	- 2.6309030913
	+0.3266361514	+0.3301758751	+0.8856030240	+1.2139329484
35	+0.9622781839	+0.2688055703	+0.0420031197	+0.1550049105
	+0.5945174836	- 0.3599055575	+0.7190389081	+2.0348734207

Table 8 (6 bit, Codebook optimized including orthogonal precoding vectors)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.9273716336	+0.3246533257	-0.1859625535	-0.5201819671
	+0.6179634900	-0.6443196655	-0.4505255750	-2.5313858069
	+0.9252378169	-0.3500544499	+0.1462766701	+2.7457780643
	+0.2063172598	+0.9402642101	+0.2708069488	+0.2804222500
	+0.4684326185	-0.5812423405	+0.6653782559	+2.2888054902
10	+0.5214576025	+0.7581839443	-0.3914576291	-0.4766099730
	+0.6727514533	+0.6667293262	-0.3207452067	-0.4483913547
	+0.0742827590	+0.8689268141	-0.4893345108	-0.5128816723
	+0.6779939200	-0.7349396641	+0.0137089248	+3.1229416870
	+0.6113759150	+0.4314359867	+0.6633871267	+0.9941728023
15	+0.3450834000	-0.0841670317	+0.9347905422	+1.6605925785
	+0.6026979262	+0.1399536811	+0.7856005199	+1.3944972033
	+0.3737211492	+0.8311273697	+0.4117763933	+0.4599955185
	+0.9650410057	+0.1846633653	-0.1859981152	-0.7889991421
	+0.9956020883	+0.0843760640	-0.0407082489	-0.4495190692
20	+0.9004705376	+0.4304486232	-0.0621835487	-0.1434696414
	+0.5054592423	-0.7433613861	-0.4380922322	-2.6090486293
	+0.7517315124	+0.0868697303	-0.6537227113	-1.4386856415
	+0.5323653437	-0.3010565622	+0.7911713387	+1.9343976939
	+0.2316418927	+0.8436596581	-0.4843350234	-0.5211487402
25	+0.6616827242	+0.2893385702	-0.6917074268	-1.1746175548
	+0.8850043139	+0.2329979062	+0.4030872611	+1.0466853431
	+0.6296491548	+0.7593331481	-0.1641801209	-0.2129383253
	+0.9534294514	+0.1085939700	+0.2813887542	+1.2024851898
	+0.9739837398	+0.1956563039	+0.1143428413	+0.5288748765
30	+0.8572963866	+0.4511211468	-0.2480576876	-0.5027428912
	+0.3403052379	+0.9400800591	+0.0210196913	+0.0223557443
	+0.5760894271	-0.5287103478	+0.6233669386	+2.2742169561
	+0.3725668939	-0.6946545967	-0.6153445383	-2.4166627526
	+0.6080400422	-0.7619680701	+0.2229169514	+2.8569807984
35	+0.8826936550	+0.0604817553	+0.4660406298	+1.4417397777
	+0.8111948305	+0.3547420313	+0.4648881997	+0.9189830414
	+0.7071821496	+0.1016276439	+0.6996893806	+1.4265581951
	+0.9304472102	-0.0705123005	+0.3595775360	+1.7644368019
	+0.9917439857	-0.0699540844	-0.1074722892	-2.1478064033
40	+0.9921886010	+0.0446975435	+0.1164641993	+1.2043435946
	+0.6290480912	+0.0352540893	-0.7765665768	-1.5254300934
	+0.5882358033	-0.2193089063	-0.7783843802	-1.8454260033
	+0.5157814306	+0.8165623666	+0.2592207889	+0.3073915108
	+0.6173770002	-0.7567730727	-0.2148025976	-2.8650265240
45	+0.7676416388	+0.2850329794	-0.5740056751	-1.1098979044
	+0.8618752221	-0.1827643104	-0.4730415504	-1.9394890231
	+0.5237351622	+0.4154501763	-0.7437087003	-1.0613595583
	+0.5709884897	+0.6656282721	+0.4805321510	+0.6252881577
	+0.3754662004	+0.2783704025	+0.8840447112	+1.2657421999
50	+0.6994420939	+0.5165257330	+0.4939452646	+0.7630554035
	+0.8736972401	-0.4849372867	+0.0385870528	+3.0621887330
	+0.6981853355	-0.2960745485	-0.6518259730	-1.9971568015
	+0.8118307021	-0.4117126696	+0.4140333186	+2.3533841309
	+0.8697009071	+0.0253589194	-0.4929272334	-1.5193960771
55	+0.6794415446	+0.6767880977	+0.2834026434	+0.3965619712
	+0.2983577584	+0.5711668848	+0.7646901579	+0.9292655465
	+0.7029961458	-0.4987729573	+0.5069733287	+2.3480411520
	+0.6238415094	+0.7762419139	+0.0909409817	+0.1166238335

	+0.8869315223	-0.3097210131	-0.3426738519	-2.3057268072
	+0.3892763374	-0.3901733698	+0.8344031847	+2.0081959696
	+0.8391062875	+0.5437102311	+0.0167279082	+0.0307565174
	+0.9148854685	+0.3907245050	+0.1015821868	+0.2543532324
5	+0.9611228936	+0.2737193167	-0.0363389456	-0.1319880604
	+0.4095133351	+0.6036188796	-0.6840636495	-0.8477895983
	+0.2359262874	+0.3414584320	-0.9098048836	-1.2117543262
	+0.6328652830	-0.6531553408	+0.4157759426	+2.5747200024
	+0.9782279749	+0.0196684539	-0.2065990829	-1.4758813123
10	+0.8540098170	-0.1010801186	+0.5103430631	+1.7663287711

Table 9 (7 bit, Codebook optimized including orthogonal precoding vectors)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.5809413615	+0.7842335412	+0.2179102735	+0.2710269001
	+0.5982471968	-0.3537775777	-0.7189865903	-2.0280639860
	+0.7143483868	-0.5665504922	-0.4107638276	-2.5142674304
	+0.6365481899	-0.0078575688	-0.7711969013	-1.5809847714
	+0.6509687276	+0.6897368486	-0.3170217586	-0.4308309356
10	+0.6227345860	+0.2471720964	+0.7423662103	+1.2493892760
	+0.6566562329	-0.7289006393	-0.1936658201	-2.8818969151
	+0.2061480264	+0.6813508854	+0.7023275319	+0.8005570612
	+0.7868204647	-0.5594789679	-0.2605702225	-2.7057289337
	+0.5531449600	+0.3329374898	-0.7636643773	-1.1596677979
15	+0.7157159233	+0.6968533676	+0.0463260318	+0.0663812062
	+0.8352186103	+0.0610630506	-0.5465173162	-1.4595265934
	+0.8839929771	+0.4064879097	-0.2309198904	-0.5166223292
	+0.4629649762	+0.7323743464	-0.4992907445	-0.5983672522
	+0.9506709131	-0.0190534640	+0.3096155365	+1.6322579270
20	+0.7503467683	-0.6500984036	+0.1197989688	+2.9593588836
	+0.1857539411	-0.9167585642	-0.3536229749	-2.7734465948
	+0.3778026764	+0.9170825056	-0.1273766688	-0.1380104082
	+0.1087997835	-0.9091855279	+0.4019257183	+2.7253509473
	+0.3905706117	+0.6147848521	-0.6851964556	-0.8395088408
25	+0.9939201075	+0.0475772273	+0.0992936418	+1.1239618523
	+0.4651189867	-0.8600664556	-0.2096426008	-2.9025033995
	+0.5590499980	-0.5083217426	-0.6550359575	-2.2307440356
	+0.9016737689	-0.2118567860	-0.3769630178	-2.0828130813
	+0.3834674462	+0.8663998125	+0.3198500939	+0.3536509617
30	+0.3738207711	-0.1372512833	-0.9172895488	-1.7193214623
	+0.4524734468	+0.7583810682	+0.4691758043	+0.5540231867
	+0.1693542866	+0.3394164544	-0.9252651491	-1.2192061924
	+0.2550778487	+0.9446996628	-0.2061015242	-0.2148004803
	+0.5754827100	-0.7720097366	-0.2698529545	-2.8053223006
35	+0.0956355383	+0.6541083746	+0.7503306458	+0.8538042215
	+0.4985175102	-0.7675902784	-0.4028466911	-2.6582868094
	+0.7654203843	+0.5664976833	+0.3053064201	+0.4943096935
	+0.4100234369	+0.1483201216	-0.8999343991	-1.4074525865
	+0.9337335058	+0.1883323430	+0.3044218597	+1.0167721607
40	+0.8366983882	+0.0645341179	+0.5438484668	+1.4526866675
	+0.6759278812	-0.4399231176	-0.5912606448	-2.2104737953
	+0.3590571853	+0.8499338137	-0.3856040067	-0.4259158866
	+0.5612676019	-0.7515987818	+0.3465226548	+2.7095897903
	+0.8828791982	-0.4440800915	+0.1526996850	+2.8104016185
45	+0.8339650528	+0.4324104263	-0.3428170269	-0.6703381514
	+0.8945743463	+0.2583236952	+0.3646993383	+0.9545085239
	+0.8154968517	-0.5505683914	+0.1784357902	+2.8281806192
	+0.8475368679	-0.5274330414	-0.0591239745	-3.0299610864
	+0.9692591498	+0.1587047653	+0.1880146217	+0.8697324634
50	+0.7494407615	-0.4682466851	-0.4680636568	-2.3563899684
	+0.8370401396	-0.4767693403	+0.2684302533	+2.6288089361
	+0.9123943947	-0.3031393768	-0.2750327014	-2.4047692434
	+0.5851759702	+0.8091231899	-0.0537470683	-0.0663288674
	+0.5669537650	+0.5644863006	+0.5999322001	+0.8158296251
55	+0.9224035591	+0.1852012620	-0.3389279669	-1.0706961917
	+0.4066331880	-0.9124568120	+0.0455194098	+3.0917473300
	+0.7948800956	-0.4613917725	+0.3940599776	+2.4347416050
	+0.3107547247	-0.1328348192	+0.9411622665	+1.7110093209

	+0.8712977785	-0.0042248210	-0.4907365201	-1.5794052573
	+0.8519131775	-0.4691990734	-0.2325858282	-2.6813843752
	+0.3271327866	+0.5825021449	+0.7440936709	+0.9066101868
	+0.8631913123	-0.0789571715	+0.4986647406	+1.7278298607
5	+0.6751059455	-0.7342014203	+0.0719738619	+3.0438747438
	+0.9380013059	-0.1148331833	+0.3270579307	+1.9084593230
	+0.9620467986	-0.2052635743	+0.1798132986	+2.4221899266
	+0.6485038729	-0.4135972361	+0.6390462058	+2.1452078663
	+0.8866408108	-0.2202717681	+0.4066305703	+2.0672448292
10	+0.7304265220	-0.1708300651	+0.6612822278	+1.8236009500
	+0.7611630150	+0.4895688060	-0.4253859997	-0.7153642796
	+0.9473881949	+0.3162272586	+0.0495573304	+0.1554499349
	+0.8008722385	-0.1164918456	+0.5873953588	+1.7665753230
	+0.9636712677	+0.2653323059	-0.0306015568	-0.1148256156
15	+0.4964581654	+0.8619537141	-0.1027865981	-0.1186879261
	+0.7775183433	+0.1588605612	+0.6084640892	+1.3154126782
	+0.7951658039	+0.6019977122	+0.0728704246	+0.120461602 3
	+0.8882139897	+0.0592169171	+0.4555977010	+1.4415445995
	+0.5761447276	-0.6652624389	-0.4748506504	-2.5216784843
20	+0.9545998766	-0.2937391118	-0.0495621816	-2.9744384688
	+0.2869061670	-0.8256773618	-0.4857383509	-2.6098273906
	+0.6034204817	-0.7695725531	+0.2089062179	+2.8765228787
	+0.9633044350	-0.1171814798	+0.2414809853	+2.0225839513
	+0.8631347261	+0.5049736409	-0.0002579582	-0.0005108349
25	+0.5140001302	-0.4645909229	+0.7210819236	+2.1431519580
	+0.8869471101	+0.1342286953	-0.4419360601	-1.2759221643
	+0.4015765917	+0.1965971263	+0.8944751595	+1.3544458762
	+0.4937606763	+0.5653251051	+0.6607631346	+0.8630809694
	+0.4843651270	-0.6536501396	-0.5814911166	-2.4145498364
30	+0.8355630411	-0.2584140085	-0.4848263654	-2.0604966005
	+0.3592440164	-0.8780081182	+0.3162996698	+2.7958185505
	+0.1770727972	+0.9639796082	+0.1984654619	+0.2030442937
	+0.1399657571	+0.8355391334	-0.5313040028	-0.5663860818
	+0.3868868738	-0.8539017481	-0.3480953196	-2.7545066131
35	+0.1631231844	-0.2840416359	+0.9448339408	+1.8628273222
	+0.5080211710	+0.5926423830	-0.6250515944	-0.8120071166
	+0.5899490625	-0.8051930190	+0.0602022079	+3.0669640849
	+0.7217439533	+0.0121827775	-0.692 0529212	-1.5531943213
	+0.6779443238	+0.7154516447	+0.1688799512	+0.2318035858
40	+0.7083356157	+0.2855664424	+0.6455326966	+1.1543028212
	+0.8908306057	+0.3118523458	-0.3304072432	-0.8142801578
	+0.7416354420	-0.3107668917	+0.5944752394	+2.0524844074
	+0.4927629027	-0.3238753861	-0.8076443871	-1.9521751280
	+0.3186457883	+0.3182328525	+0.8928564908	+1.2284126829
45	+0.8777648402	+0.4608223077	-0.1310407802	-0.2770498440
	+0.9750457783	+0.0314749736	+0.2197613622	+1.4285403404
	+0.8610863734	-0.1396102449	-0.4889163907	-1.8489444130
	+0.7605973054	+0.5692419020	-0.3121784683	-0.5016223600
	+0.5942645533	+0.4807183991	-0.6447941232	-0.9301571410
50	+0.3111132673	+0.8139837377	+0.4905497014	+0.5423679164
	+0.4230580889	+0.9029197821	+0.0758796443	+0.0838410767
	+0.7632372295	+0.1119663536	-0.6363430421	-1.3966263019
	+0.0123673211	-0.4121337901	-0.9110394000	-1.9956256821
	+0.2949875380	-0.3437096493	-0.8915413784	-1.9387605185
55	+0.8158573706	-0.4684659483	-0.3389932243	-2.5151869474
	+0.5842996463	-0.5064202142	+0.6341391724	+2.2446798220
	+0.6971483119	+0.4813261481	-0.5313279311	-0.8347350566
	+0.7794212145	-0.6246057866	-0.0486845119	-3.0638055447

	+0.7146874724	-0.5738247818	+0.3999336652	+2.5329089987
	+0.7662506124	+0.2427423618	-0.5949253271	-1.1833939935
	+0.9137884804	+0.0424074221	-0.4039705727	-1.4662029000
	+0.8277062855	+0.2106509496	-0.5201235261	-1.1859855282
5	+0.2336360902	-0.8229244580	+0.5178894803	+2.5798870537
	+0.8742883592	-0.4666085500	-0.1337771508	-2.8623809617
	+0.6890979318	-0.6885331786	+0.2259781017	+2.8244672088
	+0.9762128412	-0.0454664999	-0.2119935992	-1.7820668978
	+0.3798958471	-0.7138237752	-0.5883321879	-2.4522699501
10	+0.7974915588	-0.0532898687	-0.6009720489	-1.6592378004
	+0.6398055637	+0.4262592733	+0.6394934500	+0.9828691763
	+0.6344166582	-0.5611857107	-0.5315882823	-2.3832725451
	+0.9352794198	+0.2794876928	-0.2171152607	-0.6604542251
	+0.6937562102	+0.6614605787	+0.2849073949	+0.4067094919
15	+0.7113962414	-0.1323414489	-0.6902181747	-1.7602357356
	+0.2776387724	-0.5234697161	+0.8055409167	+2.1470564486

Table 10 (8 bit, Codebook optimized including orthogonal precoding vectors)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.7756558849	+0.0384581078	+0.6299832713	+1.5098257536
	+0.4492053963	+0.4964587818	+0.7427941774	+0.9816178040
	+0.9106430412	-0.4067173725	-0.0728713279	-2.9643043165
	+0.9352287003	-0.3381002663	-0.1050499312	-2.840342 6063
	+0.7846709884	+0.5309793126	+0.3199256314	+0.5422703483
10	+0.8616463760	-0.2535146826	+0.4396542146	+2.0938493940
	+0.6639633467	+0.6475250576	+0.3739839222	+0.5237553067
	+0.5096342401	-0.7057483792	+0.4921302333	+2.5326697351
	+0.8139488988	+0.0720712075	+0.5764485503	+1.4464154743
	+0.6813272081	+0.2665718761	+0.6817130411	+1.1980444769
15	+0.3068846118	-0.3956683378	+0.8656029121	+1.9995400960
	+0.3839944983	+0.75680074 88	+0.5289620514	+0.6100175171
	+0.7460863961	-0.3611503374	-0.5593974 646	-2.1440763870
	+0.5165598777	+0.5745252139	+0.6348910705	+0.8352699914
	+0.6991627464	-0.7144811947	-0.0262312092	-3.1048954902
20	+0.9002856832	-0.3980943445	-0.1760868581	-2.7251400289
	+0.7818659303	+0.4538919874	-0.4273964562	-0.7553426772
	+0.9359660733	+0.2331461599	-0.2638377868	-0.8470756061
	+0.6814674670	+0.6660532506	-0.3032740655	-0.4272775548
	+0.7955544817	-0.5712239331	+0.2019809023	+2.8017203525
25	+0.5829728208	-0.5311824670	+0.6148071868	+2.2833519806
	+0.8221511037	+0.5459798734	-0.1611630865	-0.2870301903
	+0.7760981159	-0.5578898079	+0.2939909467	+2.6566029076
	+0.7064386309	-0.3254879633	+0.6284918826	+2.0486511603
	+0.6473224756	+0.7614782521	+0.0335333298	+0.0440087135
30	+0.4758508799	+0.0881505349	-0.8750973793	-1.4704027192
	+0.5387392250	-0.7689905795	-0.3441126795	-2.7208311631
	+0.7631886297	+0.2781381835	-0.5832514 606	-1.1258190706
	+0.7887253209	+0.0574465554	-0.6120557665	-1.4772121228
	+0.2147964630	-0.3194 174832	-0.9229490511	-1.9039778513
35	+0.7753180742	+0.6194824555	-0.1229771163	-0.1959681329
	+0.1530113531	+0.4644 150637	+0.8722993605	+1.0815633495
	+0.5314878670	+0.6721350232	+0.5155144594	+0.6542803533
	+0.9478056397	-0.1060908231	-0.3006812374	-1.9099944007
	+0.8094131198	+0.5862410428	-0.0342321671	-0.0583264166
40	+0.8233921300	-0.1279332041	+0.5528639033	+1.798194 8215
	+0.9754783086	+0.21340564 88	-0.0538525634	-0.2471876510
	+0.7151362935	+0.67109898 82	-0.1954641393	-0.2834190754
	+0.7957470917	+0.3367 138166	-0.5033988198	-0.9812624123
	+0.3626290543	-0.8493989126	+0.3834340312	+2.7175600721
45	+0.4787796819	+0.2896833537	+0.8287662944	+1.2345352547
	+0.6728287078	-0.4881373859	+0.5558987520	+2.2913821176
	+0.6301970492	+0.1300996300	-0.7654578796	-1.4024419879
	+0.9654306830	-0.2239802061	+0.1333284 052	+2.6046593160
	+0.6573512651	+0.3239580635	-0.6803973011	-1.1264258208
50	+0.0032289983	-0.4548 147128	-0.8905802325	-2.0429631414
	+0.9356342410	-0.0354413228	+0.3511872431	+1.6713743953
	+0.1586354334	+0.9136505094	-0.3742693494	-0.3887904565
	+0.9629083970	-0.24963604 82	-0.1024171004	-2.7522680068
	+0.6426052600	-0.5008348989	-0.5798472936	-2.2832109099
55	+0.8075056792	-0.2889889474	+0.5142178199	+2.0828037153
	+0.0813298092	+0.8658286612	+0.4936863292	+0.5182114748
	+0.9174567332	+0.0871077423	-0.3881821529	-1.3500538627
	+0.3929513910	+0.7369399394	-0.5500079363	-0.6411547493

	+0.7806917982	+0.2200573207	-0.5848889568	-1.2109409244
	+0.9346424861	-0.2026066277	-0.2922224794	-2.1770317769
	+0.1978944792	+0.3572474236	-0.9128044990	-1.1977487014
	+0.6740988383	-0.7348211168	+0.0750245455	+3.0398461584
5	+0.7441028354	+0.0915186213	-0.6617668112	-1.4333736223
	+0.4139577381	+0.1881867689	-0.8906316473	-1.3625633420
	+0.8430998552	+0.0833343547	+0.5312607829	+1.4152027298
	+0.8110513873	-0.4347288296	+0.3914160087	+2.4085741702
	+0.8159468530	+0.3962738182	+0.4209486834	+0.8155825635
10	+0.3467357751	-0.6034625715	-0.7180579552	-2.2696960676
	+0.8767794930	-0.4783122710	+0.0497502966	+3.0379531551
	+0.7654177110	+0.1189796549	+0.6324393800	+1.3848416227
	+0.4654463452	-0.6219724798	+0.6296903478	+2.3500284764
	+0.9749415698	-0.2157367831	+0.0542823713	+2.8950956126
15	+0.4647556176	+0.6910844956	-0.5535381069	-0.6753322655
	+0.9239935155	+0.3815026499	-0.0263004072	-0.0688300872
	+0.4397223848	-0.8242059755	-0.3568315208	-2.7330162417
	+0.5248911023	+0.7932032251	+0.3087360919	+0.3711849279
	+0.3753894048	-0.4514509892	+0.8094904564	+2.0795302863
20	+0.8203977680	-0.3321825831	+0.4654054509	+2.1906901997
	+0.2324055695	-0.2613744951	+0.9368409815	+1.8428733909
	+0.9879111923	-0.1545667618	-0.0118571640	-3.0650303530
	+0.9794481669	-0.1502452150	+0.1345647193	+2.4111949633
	+0.9641572402	-0.1214680139	+0.2358947598	+2.0463122004
25	+0.5803025357	+0.7107162895	+0.3976572932	+0.5101199618
	+0.4075261828	-0.8995248242	-0.1574087068	-2.9683557647
	+0.4921600547	-0.7487392276	-0.4440360905	-2.6063027840
	+0.9571279815	+0.2479283719	-0.1497916868	-0.5434824075
	+0.3161818907	+0.6993344895	+0.6410618408	+0.7419513282
30	+0.5115264425	+0.3180326916	-0.7982455172	-1.1916573955
	+0.9959214502	+0.0698543892	+0.0571036721	+0.6853012986
	+0.8121668934	-0.0338308640	+0.5824434822	+1.6288155093
	+0.7771570002	-0.6148826349	-0.1339639590	-2.9270757300
	+0.3723787028	+0.5657285661	-0.7357209329	-0.9152805738
35	+0.7467445916	-0.0110499187	-0.6650191082	-1.5874107395
	+0.6999396297	+0.4889870786	-0.5205536973	-0.8166562738
	+0.6681898374	-0.4126772186	+0.6190475381	+2.1587752881
	+0.6097782155	-0.7822061114	-0.1277659080	-2.9796820182
	+0.7654237560	-0.4022908998	+0.5022832923	+2.2461006192
40	+0.7559739506	-0.6318617625	+0.1710382974	+2.8772383495
	+0.9338528955	-0.3240456897	+0.1513709370	+2.7045864193
	+0.8032047806	-0.3330630592	-0.4938937933	-2.1641073595
	+0.8834451962	-0.4506112441	-0.1283514393	-2.8641028532
	+0.8507616395	+0.0042656483	+0.5255344299	+1.5626797232
45	+0.2741697513	-0.3261402117	-0.9046897312	-1.9167940445
	+0.3351106859	-0.2256324478	+0.9147627161	+1.8126259856
	+0.8439565039	+0.3219623202	+0.4290427529	+0.9270263863
	+0.9139384265	+0.0136911114	+0.4056218757	+1.5370557512
	+0.4510271400	-0.8919810280	+0.0307305163	+3.1071542904
50	+0.8834634975	+0.2647493469	+0.3865230030	+0.9702418751
	+0.7363592708	+0.5996773227	-0.3133083673	-0.4814549885
	+0.9584494608	-0.2837749398	+0.0290932061	+3.0394274894
	+0.8610603184	-0.4366280773	+0.2606358574	+2.6034344770
	+0.6509092187	+0.0315951238	-0.7584978162	-1.5291655293
55	+0.6181814161	+0.7249028405	+0.3039203987	+0.3969960115
	+0.7258555210	-0.1264180155	+0.6761303483	+1.7556349776
	+0.6669550742	-0.5677206741	-0.4825600120	-2.4371012082
	+0.5729243912	+0.5828653484	+0.5762166499	+0.7796620502

	+0.8366872430	-0.2336007721	-0.4953636409	-2.0114459073
	+0.6672683520	-0.7184393145	-0.1964634770	-2.8746599461
	+0.7298944118	+0.2126508532	+0.6496412566	+1.2544532114
	+0.3404769658	-0.9153516652	+0.2149575885	+2.9109360488
5	+0.8201722644	-0.4910427823	+0.2935889008	+2.6027270709
	+0.8183029790	-0.5534418966	-0.1551847341	-2.8682136952
	+0.3673638106	+0.9289759442	-0.0452495948	-0.0486706463
	+0.8851996712	+0.0449833009	+0.4630313648	+1.4739506652
	+0.3970373448	+0.3749641457	+0.8377130990	+1.1499362923
10	+0.8180104039	+0.4696545154	-0.3320897700	-0.6154710177
	+0.7652522539	-0.4418581841	-0.4681349518	-2.3273267251
	+0.7133111026	+0.1124687653	+0.6917644452	+1.4096240847
	+0.6149380901	+0.2635506139	+0.7432309326	+1.2300282982
	+0.6729510107	+0.1501363653	+0.7242900034	+1.3664033421
15	+0.6346741933	-0.7162207267	+0.2902008599	+2.7566256976
	+0.9893826782	-0.1050502341	+0.1004308932	+2.3786713132
	+0.9905564517	-0.0427269609	+0.1302778677	+1.8877102592
	+0.3833477652	-0.7407215453	+0.5517028940	+2.5014161486
	+0.5221862987	+0.8325776197	+0.1847592395	+0.2183736175
20	+0.3778648392	+0.8311431554	+0.4079451172	+0.4562800052
	+0.9027279012	+0.4159460147	-0.1098692366	-0.2582448135
	+0.7240546365	-0.5384819244	-0.4310244778	-2.4665812055
	+0.1814359068	-0.9230014660	-0.3393365666	-2.7892860359
	+0.3141043988	-0.7724808559	-0.5519164375	-2.5212194025
25	+0.2590454170	+0.0702954667	+0.9633037004	+1.497952 1273
	+0.9123748250	-0.2942409512	-0.2845952236	-2.3728569507
	+0.6497049140	+0.5479300018	-0.5269309612	-0.7658641303
	+0.7990571705	+0.3258804368	+0.5052816830	+0.9979807663
	+0.7441149323	+0.3637 144830	+0.5603612605	+0.9950741586
30	+0.4547602207	-0.0314525295	+0.8900583577	+1.6061192322
	+0.7871762014	+0.1646193198	+0.5943518382	+1.3005969039
	+0.6337858419	-0.3042056890	-0.7111781811	-1.9749930165
	+0.6841882512	+0.6876301571	+0.2430045351	+0.3396954330
	+0.3186097877	+0.2746181639	-0.9072335241	-1.2768657502
35	+0.6980539867	+0.5874616075	-0.4094013817	-0.6086416942
	+0.5144963207	+0.7523674934	+0.4113838728	+0.5003721575
	+0.1786369613	-0.0384234946	-0.9831645188	-1.6098578975
	+0.8921309046	-0.3840796486	-0.2378765908	-2.5870724884
	+0.9722617530	-0.1825266579	-0.1462569754	-2.4660649881
40	+0.8349700647	-0.5107158643	+0.2049251009	+2.7600085472
	+0.9875442348	-0.1292163663	-0.0897748019	-2.5343898390
	+0.4570837443	+0.8063557018	-0.3753197743	-0.4356291487
	+0.8896414066	+0.1804095107	+0.4195123074	+1.1646596063
	+0.6895979957	+0.7129119574	+0.1273229958	+0.1767323579
45	+0.8276565358	-0.0366396613	-0.5600376719	-1.6361267883
	+0.5431703051	-0.2530419288	-0.8005846625	-1.8769315543
	+0.7776195301	-0.5050799283	+0.3744357522	+2.5036572800
	+0.9703637715	-0.2398866545	-0.0291297765	-3.0207528697
	+0.4320597007	+0.6121722310	-0.6622458567	-0.8246693272
50	+0.9667438532	+0.2430722677	+0.0795122319	+0.3161423418
	+0.7782890143	+0.1403674981	-0.6120156662	-1.3453427222
	+0.7703258698	+0.5295732722	-0.3551762994	-0.5907786525
	+0.6066697657	+0.7876497717	-0.1075157318	-0.1356635027
	+0.4657570196	+0.6516422028	+0.5986926074	+0.7430751183
55	+0.8119994363	+0.2168035616	+0.5418977128	+1.1902191970
	+0.5536576914	-0.2027691155	+0.8076805350	+1.8167640491
	+0.2269817002	+0.3218426485	+0.9191825811	+1.2339967335
	+0.7064489301	+0.4725618829	+0.5268919964	+0.8397045144

	+0.7376675893	+0.1802499707	-0.6506584940	-1.3005466083
	+0.0948921381	+0.0212318959	+0.9952611159	+1.5494665717
	+0.4838083764	+0.0850556970	+0.8710309888	+1.4734554891
	+0.6186633755	+0.0940975822	+0.7800008159	+1.4507387026
5	+0.1387877087	-0.4785544921	-0.8670199363	-2.0751379350
	+0.2101309455	+0.9317575895	+0.2960958968	+0.3076897810
	+0.5172880011	-0.8557575440	-0.0095994737	-3.1303756084
	+0.7781423153	-0.3351859548	+0.5311731477	+2.1337197567
	+0.7238354357	+0.6039041967	+0.3337094293	+0.5048269943
10	+0.6058583268	-0.6183822984	-0.5005387305	-2.4611265916
	+0.3170753517	+0.9405293666	+0.1219333089	+0.1289241932
	+0.1319256596	-0.9760444799	+0.1730109639	+2.9661576504
	+0.8609678864	-0.2791883148	-0.4251919371	-2.1518092611
	+0.3590421320	-0.8556621197	-0.3727346030	-2.7307700394
15	+0.4902390111	-0.8582195410	+0.1520688377	+2.9662218197
	+0.9855658198	+0.0117674449	-0.1688832202	-1.5012307629
	+0.9446019428	+0.1461587869	+0.2938788502	+1.1092760363
	+0.5384692283	-0.6176309845	+0.5732214731	+2.3934694199
	+0.8868650615	-0.1706607818	+0.4293544693	+1.9491303499
20	+0.4443531968	-0.7830416860	+0.4351964549	+2.6343250498
	+0.3969146210	+0.3926019991	-0.8296520077	-1.1288071461
	+0.3214813837	+0.9130919924	-0.2508241084	-0.2680849785
	+0.4900967107	-0.2647432676	+0.8304915511	+1.8793912972
	+0.7340386741	-0.6746275301	+0.0778775994	+3.0266634434
25	+0.9199624773	+0.1868144749	+0.3446293550	+1.0740590053
	+0.4422221640	-0.5110494703	+0.7370671588	+2.1770488713
	+0.3349195523	-0.9297487508	-0.1529580131	-2.9785378012
	+0.9595189736	+0.1734505556	-0.2218969221	-0.9073314879
	+0.3926687024	+0.0028412451	+0.9196756045	+1.5677069374
30	+0.9955882059	-0.0794020286	+0.0499944203	+2.5796661272
	+0.9193866585	+0.3151952784	+0.2353297868	+0.6413317244
	+0.8999294135	-0.4360338199	-0.0012484769	-3.1387294044
	+0.5680203874	-0.7384060255	+0.3634685420	+2.6841771339
	+0.6238722783	+0.2517237165	-0.7398773891	-1.2428574427
35	+0.2189863154	-0.7101488321	+0.6691290084	+2.3859257998
	+0.7759729796	+0.5807882688	+0.2460709690	+0.4007558531
	+0.6056256946	+0.6360672631	+0.4781589221	+0.6446155045
	+0.9091616208	+0.0951647879	+0.4054242351	+1.3402412865
	+0.8643785614	+0.2136532598	+0.4551944498	+1.1319540241
40	+0.6791229091	-0.5635975709	+0.4702657254	+2.4462252911
	+0.6771402002	+0.4031733835	-0.6155748306	-0.9909461735
	+0.6485747138	-0.7587186336	-0.0608019387	-3.0616258812
	+0.8284216648	+0.2658882803	+0.4929715688	+1.0761600647
	+0.9978962323	+0.0583863230	-0.0281806096	-0.4496777801
45	+0.4964215117	-0.7981653735	+0.3413176223	+2.7374984282
	+0.9613634076	-0.1586509818	-0.2249672520	-2.1850158046
	+0.5791592858	-0.7772890329	-0.2457565482	-2.8353665429
	+0.7268578463	-0.2087845324	+0.6542833409	+1.8796864282
	+0.3152720034	+0.8320828170	+0.4563351286	+0.5016332950
50	+0.3237211265	+0.0005023452	+0.9461524084	+1.5702653921
	+0.4789358492	-0.6572588644	-0.5819203017	-2.4169168988
	+0.4119539856	+0.8828278696	-0.2256299324	-0.2502200756
	+0.9889673023	+0.0885008511	-0.1187908846	-0.9304940162
	+0.5926342495	+0.8044061830	+0.0414166518	+0.0514418128
55	+0.9631189232	+0.1704217153	+0.2082267485	+0.8849104124
	+0.8449471227	-0.5330321004	+0.0440583666	+3.0591239996
	+0.8623426851	-0.1056045262	+0.4951896380	+1.7809095131
	+0.2918097470	-0.9525390350	+0.0866975102	+3.0508254671

	+0.8713969438	+0.1231579373	+0.4748678646	+1.3170353194
	+0.9958432829	+0.0101403447	+0.0905170109	+1.4592345266
	+0.5261644700	+0.6375977441	-0.5626900276	-0.7230708654
	+0.4017560096	+0.1947197812	+0.8948051830	+1.3565255185
5	+0.5511459977	+0.8299467162	+0.0861773604	+0.1034640358
	+0.8209043344	+0.2393225402	-0.5184985974	-1.1383639148
	+0.8406130943	+0.5354305560	+0.0817541762	+0.1515184049
	+0.8336149056	-0.2286454287	+0.5027996192	+1.9975888808
	+0.9102196410	+0.2755397260	+0.3091570223	+0.8428302026
10	+0.6919874643	-0.3230643120	-0.6455871743	-2.0347793569
	+0.8876998509	+0.0856914728	-0.4523781009	-1.3835899357
	+0.8805087566	+0.4608548962	+0.1109824053	+0.2363188009
	+0.9649354022	+0.0001043894	+0.2624874446	+1.5703986339
	+0.8512151589	+0.3053036418	-0.4268752037	-0.9499378286
15	+0.4464133179	+0.5065869728	-0.7376210332	-0.9689947415
	+0.8377010782	-0.1286043962	-0.5307709608	-1.8085123999
	+0.7022769401	+0.0153788861	-0.7117377251	-1.5491921700
	+0.8609227691	+0.2215475660	-0.4579614194	-1.1202175774
	+0.8325510073	+0.4524470485	+0.3196099006	+0.6150102891
20	+0.5013185312	+0.8612473753	+0.0832627701	+0.0963774338
	+0.9059822253	+0.1555728666	-0.3936918726	-1.1944658295
	+0.9783955504	+0.1525871658	+0.1394966081	+0.7406103159
	+0.5150132621	+0.8259462440	-0.2292905185	-0.2707906140
	+0.5771934818	+0.5403410719	-0.6122738036	-0.8477256268
25	+0.5115863010	+0.5575489947	-0.6537725714	-0.8646685613
	+0.3329216070	-0.1685196632	-0.9277738554	-1.7504761100
	+0.2977742543	+0.6499736638	-0.6991886225	-0.8218601570
	+0.5247526192	-0.0621519138	+0.8489828198	+1.6438734692

Table 11 (9 bit, Codebook optimized including orthogonal precoding vectors)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.6892282875	+0.4960891507	+0.5280718911	+0.8166162518
	+0.9151397305	+0.0935728835	-0.3921267514	-1.3365479139
	+0.5918771401	-0.7025676707	+0.3950697648	+2.6293378719
	+0.7195887275	+0.1314315981	+0.6818488089	+1.3803741304
	+0.9286573332	-0.3423916118	+0.1427008818	+2.7467076924
10	+0.6089832683	-0.7505038545	+0.2566775084	+2.8120562922
	+0.9380857344	+0.0743555594	-0.3383288426	-1.3544625111
	+0.7011463258	-0.6967518680	+0.1514287433	+2.9275854929
	+0.9578865817	-0.2854988223	+0.0307200109	+3.0344038792
	+0.8540900952	+0.4616998758	-0.2395064381	-0.4785342109
15	+0.6115795592	+0.4477641728	+0.6522865078	+0.9692201398
	+0.8962122044	-0.2096718093	-0.3909493791	-2.0630717340
	+0.7402519247	-0.0430703413	-0.6709486073	-1.6349015738
	+0.2428459854	-0.9693917541	-0.0361310737	-3.1043379973
	+0.1189576373	-0.9877914593	-0.1005838630	-3.0401153972
20	+0.3413278717	+0.9279523786	-0.1496651829	-0.1599083384
	+0.5715524017	+0.7364963149	-0.3618024742	-0.4566216722
	+0.9918805390	+0.1212814253	-0.0382598004	-0.3055819607
	+0.8123645807	-0.3442458394	+0.4707001063	+2.2022532557
	+0.9907013486	+0.0675965058	-0.1180743422	-1.0508496232
25	+0.1148670379	+0.6904850478	+0.7141680211	+0.8022569380
	+0.9521692495	-0.0933000393	+0.2909790767	+1.8810812984
	+0.8651677794	-0.2997564279	-0.4020333287	-2.2114760875
	+0.4677240239	+0.1371365456	+0.8731711203	+1.4150131341
	+0.7524412637	+0.6226039602	-0.2149336023	-0.3324076445
30	+0.2402968413	+0.0736800144	-0.9678991081	-1.4948192069
	+0.9707759783	-0.2393181253	-0.0179118611	-3.0668865417
	+0.6266697735	+0.6909461464	-0.3603864839	-0.4807653679
	+0.3750534482	+0.2559331123	-0.8909731494	-1.2910763184
	+0.1285757858	-0.7762696817	-0.6171496161	-2.4698959237
35	+0.8091986689	-0.0230305300	+0.5870835621	+1.6100049310
	+0.5806595823	-0.6611123993	+0.4751471825	+2.5184206066
	+0.5111450401	-0.8484494519	+0.1373472810	+2.9811045317
	+0.9070905159	-0.2617883743	-0.3296265206	-2.2419887883
	+0.5633882463	-0.5589775099	+0.6083895359	+2.3138919870
40	+0.4315133434	-0.0277360381	+0.9016800689	+1.6015470288
	+0.5464379927	+0.3328003088	+0.7685372304	+1.1621432125
	+0.5681088913	-0.0699738514	-0.8199731384	-1.6559268367
	+0.7274346229	-0.6860242989	+0.0144751785	+3.1204956882
	+0.4740894866	-0.0096757137	+0.8804234999	+1.5817857248
45	+0.5881001118	+0.6973397512	+0.4097017573	+0.5311932406
	+0.9302479896	+0.3421069596	+0.1326706681	+0.3699491345
	+0.8852152521	-0.4038249158	-0.2309099278	-2.6221612826
	+0.4231972459	+0.1173188331	+0.8984099190	+1.4409461167
	+0.7893115825	-0.2219960593	+0.5724552170	+1.9407382742
50	+0.7320539423	+0.3732207513	+0.5699151659	+0.9910046716
	+0.3404693866	+0.9258529485	+0.1639418020	+0.1752545167
	+0.6316157577	-0.6902069385	+0.3530947703	+2.6687255064
	+0.9826898122	+0.1295216719	+0.1324570474	+0.7966023277
	+0.5888541050	-0.3103607511	-0.7462754499	-1.9649166402
55	+0.3313130143	-0.8871943072	-0.3211198340	-2.7943120171
	+0.5362129545	+0.7354370478	+0.4142559790	+0.5129807516
	+0.6000495010	-0.5905595642	+0.5396109686	+2.4012444386
	+0.8790873063	+0.4112215587	+0.2410442649	+0.5301856405

	+0.8790873063	+0.4112215587	+0.2410442649	+0.5301856405
	+0.3868837697	-0.8354930951	+0.3902207538	+2.7046471198
	+0.6269857790	+0.7337971017	-0.2615925200	-0.3424462566
	+0.4983868525	-0.7174316893	+0.4867261206	+2.5454913692
5	+0.6047549158	+0.7532886462	+0.2585105556	+0.3305826104
	+0.3466640860	-0.8250907501	-0.4461493760	-2.6458961965
	+0.5849322464	-0.7202368747	-0.3729787012	-2.6637628127
	+0.5825111989	-0.7495308366	+0.3144586270	+2.7443552281
	+0.8973118410	+0.3963424815	+0.1942784018	+0.4557592551
10	+0.0861183828	+0.2599106293	+0.9617848454	+1.3068628550
	+0.8505616791	-0.5187218783	-0.0864432937	-2.9764633950
	+0.4372490908	-0.8985392363	+0.0379535700	+3.0993785566
	+0.9367005395	-0.3500135708	-0.0090884271	-3.1156325592
	+0.9804361590	+0.1842318869	-0.0693076472	-0.3598204618
15	+0.3505648303	+0.0041864946	-0.9365291096	-1.5663261328
	+0.2550375739	+0.3065346817	-0.9170563368	-1.2482125629
	+0.3633423967	-0.9131157341	-0.1849377165	-2.9417609742
	+0.8353978806	-0.5218738246	+0.1725053402	+2.8223492781
	+0.9958872096	+0.0508945242	+0.0749560755	+0.9743097391
20	+0.7069573474	-0.3564267479	+0.6108774692	+2.0989703822
	+0.3689465762	+0.6706338250	+0.6435283185	+0.7647753933
	+0.7003796882	+0.2122645062	-0.6814778585	-1.2688439464
	+0.9114212749	-0.4075274174	-0.0568565189	-3.0029716230
	+0.7579105105	-0.0859306276	+0.6466742497	+1.7029032585
25	+0.6305590973	-0.3218127209	-0.7062802542	-1.9983343043
	+0.5821352199	+0.5923947551	-0.5569443778	-0.7545637990
	+0.6330151098	+0.7727316867	+0.0466648818	+0.0603162510
	+0.7488374726	-0.1664650982	-0.6415074518	-1.8246871004
	+0.5455741935	-0.3861367793	+0.7438058800	+2.0496356694
30	+0.8382923854	+0.3243633451	-0.4382399992	-0.9336290658
	+0.8711263228	-0.3272503483	+0.3661231205	+2.3001898640
	+0.5403125844	-0.6967984156	+0.4717353910	+2.5464674625
	+0.5654934302	+0.4426025999	+0.6959311166	+1.0043357872
	+0.8315746650	-0.5542591476	+0.0357823110	+3.0771233102
35	+0.6788083309	+0.4078561484	-0.6106329603	-0.9819240623
	+0.9410696916	-0.2446272979	+0.2335493965	+2.3793573090
	+0.6295899343	-0.6478898676	-0.4287834349	-2.5569562046
	+0.9159824745	-0.3852922993	-0.1119193930	-2.8588932768
	+0.6746916875	+0.4762116276	-0.5639269568	-0.8695295287
40	+0.7533103613	+0.4733656660	-0.4565615466	-0.7673297701
	+0.6096244156	+0.2026392913	+0.7663520011	+1.3122920123
	+0.7692912245	-0.3815701837	+0.5124404421	+2.2108412944
	+0.4741943240	+0.3453713220	+0.8098508462	+1.1676872620
	+0.6670578914	+0.6807257820	+0.3027311995	+0.4184529739
45	+0.5210285422	+0.5494295888	-0.6531893946	-0.8714632355
	+0.7032879325	+0.5795489375	-0.4117148444	-0.6176755417
	+0.9885213517	+0.0617362309	+0.1378918963	+1.1498444707
	+0.1365543361	+0.9877686287	-0.0752731652	-0.0760582578
	+0.3095799500	+0.4916532838	-0.8139025145	-1.0273902797
50	+0.4303413167	-0.4781415484	-0.7656285070	-2.1290421615
	+0.4775917586	-0.0654469356	-0.8761408624	-1.6453569528
	+0.5878970434	+0.7392403246	+0.3284825852	+0.4181467565
	+0.8217934823	-0.1472847667	+0.5504204484	+1.8322567539
	+0.6231248593	-0.7143172974	-0.3185376092	-2.7221260443
55	+0.9589869402	-0.2454548533	+0.1417602324	+2.6178508692
	+0.4416267626	+0.8033540248	-0.3994848101	-0.4614621772
	+0.3447866396	-0.9137387488	+0.2149503943	+2.9105506824
	+0.6834075284	-0.1083679321	+0.7219491266	+1.7197886351

	+0.1909219986	-0.8643654118	-0.4652109471	-2.6478455527
	+0.7784698157	-0.6091727793	-0.1513052247	-2.8981409932
	+0.6833682100	-0.7293480740	+0.0325465282	+3.0969981017
	+0.7800894143	-0.1627439970	+0.6041315230	+1.8339349009
5	+0.7424958247	+0.3657622274	-0.5611755014	-0.9931717324
	+0.9598403128	+0.1753522670	+0.2189935076	+0.8956171108
	+0.8314059584	+0.5251547338	-0.1815947079	-0.3329218209
	+0.9426455406	-0.0666202987	+0.3270796852	+1.7717299108
	+0.6266299961	+0.6243863159	-0.4663438393	-0.6415035656
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	+0.4944121287	-0.4823670534	+0.7231035007	+2.1590842354
	+0.4590290220	-0.5874808367	+0.6664522665	+2.2932985766
	+0.9705639947	-0.0521576595	-0.2351278602	-1.7890884215
	+0.3903134187	+0.1217239853	-0.9125999707	-1.4381974347
15	+0.4076929026	+0.6069759907	-0.6821778682	-0.8436664217
	+0.8031499108	+0.4938249822	+0.3332973262	+0.5937016189
	+0.3331924276	+0.5312777171	+0.7789266933	+0.9722097662
	+0.7077673298	-0.2044321770	-0.6762195589	-1.8643767857
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20	+0.2369817910	+0.6585830804	-0.7142184239	-0.8259028644
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	+0.9103800767	+0.4033562841	+0.0922595471	+0.2248615416
	+0.3628474338	-0.5232314890	+0.7710840088	+2.1669918376
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25	+0.8833298152	+0.1726272929	-0.4358075897	-1.1936487851
	+0.6267417977	-0.4283808304	+0.6509105800	+2.1528624604
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	+0.5277048715	-0.6431518266	+0.5548723245	+2.4297491333
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	+0.7239962774	-0.1358884244	-0.6762867191	-1.7690889902
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	+0.9926195009	+0.0116785330	-0.1207068282	-1.4743453108
	+0.7847123438	-0.4448632931	+0.4316516975	+2.3712662179
	+0.5228771255	+0.2684280197	+0.8090401164	+1.2504392012
55	+0.4273415725	+0.7546378668	-0.4978964454	-0.5832211060
	+0.7039090230	+0.3103152224	-0.6389182655	-1.1186633683
	+0.2500877098	-0.7272263549	+0.6392166816	+2.4205135097
	+0.6232198465	-0.0437936502	-0.7808195304	-1.6268244025

	+0.8560639298	-0.3927787864	-0.3359752565	-2.4339832992
	+0.6062438770	-0.7880915969	-0.1066770661	-3.0070491555
	+0.2241468412	+0.8966553112	-0.3817950320	-0.4025473047
	+0.6729856239	+0.6132972688	+0.4134692372	+0.5931821797
5	+0.9746503264	-0.2149125721	-0.0622039195	-2.8598534780
	+0.8341820512	-0.3048950957	+0.4595424747	+2.1565862890
	+0.3867586546	-0.0183463567	+0.9219984568	+1.5906921691
	+0.5746803509	-0.1350539246	-0.8071573154	-1.7365810494
	+0.4203315819	-0.3049840832	-0.8545794698	-1.9135889545
10	+0.9710592946	-0.2069274822	-0.1192680323	-2.6187248959
	+0.7396804094	-0.6670485274	-0.0889896289	-3.0089677317
	+0.7076190240	-0.6724061614	+0.2171296178	+2.8292482827
	+0.0107883038	+0.3026854003	-0.9530294649	-1.2632688744
	+0.8606391974	+0.1921572378	-0.4715673525	-1.1838529451
15	+0.5663141738	-0.5725251299	-0.5928770802	-2.3387328091
	+0.4470464923	+0.6197647314	-0.6450124894	-0.8053577300
	+0.6843682117	-0.2685376043	-0.6778847291	-1.9479711384
	+0.8239784126	+0.4772806253	+0.3053895549	+0.5692090702
	+0.9082164061	+0.1479983943	-0.3914580883	-1.2093372392
20	+0.5736492537	+0.8064911198	+0.1431733474	+0.1756957970
	+0.8486807385	+0.0749202978	+0.5235722998	+1.4286667047
	+0.3134319379	+0.8978784673	-0.3091515457	-0.3315998091
	+0.7849183474	-0.3955889224	-0.4768779639	-2.2632912076
	+0.5484510663	+0.6796508326	+0.4871100221	+0.6218504608
25	+0.6898032735	-0.4498095238	+0.5673119390	+2.2411798725
	+0.6362274127	-0.7495791212	+0.1826083801	+2.9026327965
	+0.8062338542	-0.2922398819	+0.5143761501	+2.0874631092
	+0.2396006741	-0.8812953204	+0.4073206049	+2.7086528251
	+0.2928345000	-0.3205627178	+0.9008260096	+1.9126769185
30	+0.9168983157	+0.1924562654	-0.3496542071	-1.0676316014
	+0.9983626185	-0.0484203220	-0.0304557767	-2.5801310681
	+0.2057617517	+0.0289698007	+0.9781732220	+1.5411887537
	+0.2390411581	+0.9496354468	-0.2026125438	-0.2102064052
	+0.6602205370	-0.7440148878	+0.1027165479	+3.0044027561
35	+0.8136998386	-0.1993602925	-0.5460293458	-1.9208674680
	+0.9069631604	+0.2609941716	-0.3306053057	-0.9025255738
	+0.3118641540	-0.7384701103	+0.5978316198	+2.4610530369
	+0.8351514408	-0.5494196864	-0.0256920051	-3.0948646177
	+0.3163075413	-0.9384916988	-0.1385022401	-2.9950706707
40	+0.9608830341	+0.1663634718	-0.2214203921	-0.9264339131
	+0.9649344289	-0.1316141006	+0.2271107139	+2.0960172446
	+0.8322446671	+0.4959902883	-0.2477144486	-0.4631947628
	+0.4807031169	+0.0785979007	-0.8733538134	-1.4810426305
	+0.9359466732	-0.1450300254	+0.3208895708	+1.9952810001
45	+0.6812036955	+0.0648754718	-0.7292137536	-1.4820636110
	+0.7399883636	-0.3974819493	-0.5426097324	-2.2030274107
	+0.9473217773	-0.2152859543	-0.2371358433	-2.3079365925
	+0.8261793375	+0.0106618980	-0.5633063343	-1.5518712332
	+0.6078774980	-0.7577687380	-0.2372161190	-2.8382108638
50	+0.7466346898	-0.2094734701	+0.6313933047	+1.8911336766
	+0.5599010358	+0.1135650605	-0.8207397926	-1.4333002503
	+0.6510495793	-0.1474375280	+0.7445781494	+1.7662823586
	+0.3777323439	+0.1548848256	+0.9128685377	+1.4027285995
	+0.9170743317	-0.1786114237	-0.3564724805	-2.0352855726
55	+0.6303024472	-0.2920732833	+0.7193135772	+1.9565025487
	+0.8745745198	+0.2630967808	+0.4073076151	+0.9972796673
	+0.3635452379	-0.3036095354	-0.8807134097	-1.9027697955
	+0.1951589671	+0.9575657352	-0.2120868698	-0.2179667279

	+0.9263514255	+0.2839535030	-0.2474741294	-0.7168615730
	+0.3013988215	-0.7435737327	-0.5968725613	-2.4652026901
	+0.9888221608	+0.1177534535	-0.0914596005	-0.6603738919
	+0.7908424105	-0.0797543990	-0.6068010527	-1.7014814169
5	+0.8236230739	+0.5643782088	-0.0558772723	-0.0986851755
	+0.7859293400	-0.0379030623	-0.6171534901	-1.6321352234
	+0.5720578934	+0.7837886264	+0.2417129616	+0.2991366089
	+0.4199912449	+0.0028678752	-0.9075236247	-1.5676362265
	+0.1805403137	+0.6081274961	+0.7730369613	+0.9042344434
10	+0.7621397622	-0.3443690567	-0.5482270841	-2.1316578842
	+0.1136928881	-0.6893326213	+0.7154680037	+2.3375923005
	+0.3100704769	-0.9482774713	+0.0680157102	+3.0699897376
	+0.8496323233	+0.1307838114	-0.5109016636	-1.3201915109
	+0.6246751505	+0.6331668372	+0.4570346953	+0.6252229426
15	+0.7008559838	+0.0003424796	-0.7133027216	-1.5703161946
	+0.0520260661	-0.9982915136	-0.0265959093	-3.1149575282
	+0.6999560542	+0.4835751807	-0.5255630950	-0.8269818696
	+0.1783976214	-0.4550017978	+0.8724377644	+2.0515186063
	+0.2969596658	+0.6265544459	-0.7205862080	-0.8550861307
20	+0.4280209357	+0.1217214960	-0.8955344527	-1.4357036793
	+0.9069548695	-0.1079565986	-0.4071587375	-1.8299786742
	+0.3802431303	+0.7913337321	-0.4787547245	-0.5440858426
	+0.9554062767	-0.0225709173	+0.2944306373	+1.6473062264
	+0.5208471759	-0.5567683631	-0.6470913453	-2.2813069676
25	+0.8877327786	-0.3621374181	-0.2842305475	-2.4761460729
	+0.6905908362	+0.1523202691	-0.7070239264	-1.3586009503
	+0.8279445589	-0.2135431825	+0.5185625484	+1.9614321051
	+0.8275633417	+0.2762572718	+0.488692 9867	+1.0562837633
	+0.9192887029	+0.0518805165	+0.3901495773	+1.4385959370
30	+0.8669182718	+0.1274199563	+0.4818888511	+1.3122947376
	+0.5915892225	-0.7903737360	+0.1591588806	+2.9428785271
	+0.6304324703	+0.3334774313	+0.7009619842	+1.1267423228
	+0.6319938746	+0.1536006176	+0.7595989684	+1.3712740040
	+0.8490368216	-0.2470451182	-0.4670173285	-2.0573620895
35	+0.8571117838	-0.5126063254	+0.0509327524	+3.0425573415
	+0.5218657371	+0.4783249810	+0.7063011857	+0.9755195279
	+0.8972922040	-0.2540771737	-0.3609868285	-2.1840952043
	+0.5053040597	-0.8139594511	+0.2865969631	+2.8030462249
	+0.4068578400	+0.7155421104	-0.5678610625	-0.6708321702
40	+0.5139622508	-0.7248810760	-0.4586831481	-2.5774252768
	+0.8881959936	-0.2479259487	-0.3868340742	-2.1407550483
	+0.7017515937	+0.3643356155	+0.6122125938	+1.0339780272
	+0.8666264856	-0.3795101985	+0.3239298437	+2.4350428944
	+0.6361848392	+0.7148837177	+0.2901898009	+0.3856044311
45	+0.9270317977	+0.3738124331	+0.0296025481	+0.0790259931
	+0.8654573031	+0.2219752306	+0.4491220919	+1.1117653080
	+0.6719659902	-0.2110144125	+0.7098835297	+1.8597302644
	+0.7403288660	-0.2314773915	-0.6311349994	-1.9223266294
	+0.8853235103	+0.3238296760	+0.3336714298	+0.8003654674
50	+0.7435944606	-0.5055832720	+0.4375532349	+2.4282014767
	+0.3109282521	+0.8005530752	+0.5122874153	+0.5692542121
	+0.3109282521	+0.8005530752	+0.5122874153	+0.5692542121
	+0.9841724772	-0.1770742438	-0.0070176390	-3.1019823280
	+0.4688809058	+0.8258914032	-0.3131358912	-0.3624031699
55	+0.9428095535	-0.2922348139	+0.1603401366	+2.6397720202
	+0.9735809584	-0.1693345737	-0.1531858986	-2.4062229434
	+0.3895335690	+0.3110763682	+0.8668881657	+1.2262657703
	+0.5523427231	+0.0744536985	+0.8302855912	+1.4813631337

	+0.8621505338	-0.4832679794	+0.1521463677	+2.8365881670
	+0.8975313651	+0.0467738218	+0.4384628356	+1.4645214229
	+0.6336603120	+0.6838512635	+0.361693 3210	+0.4865044312
	+0.5889510861	-0.4548666790	+0.6680066785	+2.1686095625
5	+0.9338992543	+0.1475310474	-0.3256789415	-1.1454542559
	+0.4554635808	-0.8775601066	-0.1498038245	-2.9725174600
	+0.8621719384	-0.1280851316	-0.4901568603	-1.8263953272
	+0.7756410733	+0.6170810611	+0.1326344202	+0.2117172875
	+0.5309038718	+0.7644753158	-0.3656754989	-0.4461660895
10	+0.9744726106	+0.0645541877	-0.2150253195	-1.2791407543
	+0.9776352430	+0.0456030228	+0.2053039113	+1.3522205334
	+0.6269200699	-0.6263468858	+0.4633150166	+2.5047097767
	+0.8267590511	+0.3531025535	+0.4379361347	+0.8922331152
	+0.7050045076	-0.0749008968	-0.7052364851	-1.6766064555
15	+0.8797540425	-0.1310261710	+0.4570174692	+1.8500055780
	+0.6881054222	-0.4715215308	-0.5515236840	-2.2781532948
	+0.7470208140	-0.6388852091	+0.1838085772	+2.8614562272
	+0.6038489015	-0.5216282044	+0.6027192717	+2.2841963735
	+0.4397770538	-0.4628444165	+0.7696565397	+2.1122188147
20	+0.9344401482	-0.0333403001	+0.3545561081	+1.6645545453
	+0.2682306860	-0.8483102097	-0.4565326793	-2.6478795391
	+0.2895116766	-0.2763491174	-0.9164137463	-1.8636790856
	+0.4898531185	-0.8711877184	-0.0328006333	-3.1039599519
	+0.7054496770	-0.6932991953	-0.1472310393	-2.9323384248
25	+0.4719751798	-0.6816527871	-0.5590965100	-2.4546511347
	+0.5750104606	-0.7787983427	-0.2506713218	-2.8301949146
	+0.5649585575	+0.6122154277	+0.5531854106	+0.7347893003
	+0.9245847927	-0.3716327303	+0.0838574673	+2.9196633519
	+0.9948192355	-0.0969538325	-0.0305719314	-2.8361365298
30	+0.7636562755	+0.0014667895	-0.6456213607	-1.5685244272
	+0.3326693488	-0.1437288653	-0.9320263503	-1.7238022030
	+0.8408022855	+0.0592325674	-0.5380920179	-1.4611588624
	+0.4123871587	+0.7138497982	+0.5659993789	+0.6703862252
	+0.5260371718	+0.8324505409	-0.1741005193	-0.2061704629
35	+0.6350855524	-0.3848310291	-0.6697547463	-2.0923186651
	+0.3663198282	-0.6065013703	-0.7056669692	-2.2807640377
	+0.1659924180	-0.1353506900	+0.9767940970	+1.7084857986
	+0.4139095527	-0.6054200291	-0.6798128202	-2.2983762703
	+0.6757722520	-0.6705281774	-0.3061434741	-2.7132880406
40	+0.8942133670	+0.4290375122	-0.1277077424	-0.2893095599
	+0.5137966218	+0.5862284746	+0.6263778468	+0.8184960532
	+0.8050764941	-0.5743150734	+0.1483712742	+2.8887756754
	+0.8018663450	+0.0986473374	-0.5893038839	-1.404937 7413
	+0.2102430340	-0.5643832634	+0.7982915499	+2.1861974425
45	+0.9624977744	+0.2650883473	-0.0576732385	-0.2142239858
	+0.4381743447	+0.8985904988	+0.0232025677	+0.0258153332
	+0.9057764709	-0.1344076496	+0.4018750657	+1.8935527391
	+0.6472531049	+0.5395685759	+0.5384507128	+0.7843612036
	+0.6421578995	+0.3854380459	-0.6626241355	-1.0439531402
50	+0.3278415977	-0.0342675674	+0.9441110214	+1.6070765209
	+0.9709560606	+0.1652138791	+0.1730569343	+0.8085797383
	+0.9709560606	+0.1652138791	+0.1730569343	+0.8085797383

Table 12 (10 bit, Codebook optimized including orthogonal precoding vectors)

	v1	real (v2)	imag (v2)	angle (v2)
5	+0.937384 6252	-0.2110946674	+0.2770362899	+2.2219173511
	+0.9771358373	+0.1781358515	-0.116074 0017	-0.5775018615
	+0.7576752372	+0.4691571585	-0.4536736664	-0.7686214814
	+0.5254788351	+0.7383965249	+0.4226612897	+0.5198812969
	+0.7040044244	+0.5527534976	-0.4459162941	-0.6788239883
10	+0.5338575689	-0.6911730171	+0.4871097992	+2.5276804503
	+0.8027513430	+0.4863582479	+0.3450303408	+0.6170175373
	+0.2897341926	-0.27919044 86	-0.9154817262	-1.8668024833
	+0.7254490819	+0.3809726470	-0.5732220092	-0.984214 6045
	+0.8012580628	+0.4049471164	-0.4404581136	-0.8273781901
15	+0.343052 6147	-0.1726852302	+0.9233064036	+1.7556893983
	+0.6085496282	+0.0522381972	+0.7917944940	+1.5049173597
	+0.6636414956	-0.7199490621	-0.2031091166	-2.8666229067
	+0.7101152107	+0.5950394197	-0.3763834169	-0.5639995912
	+0.8688544214	-0.4763489779	+0.1348467490	+2.8657265028
20	+0.8835993532	-0.3603875060	+0.2989532213	+2.4491015701
	+0.7440515049	+0.18358404 18	-0.6424050574	-1.2924394767
	+0.2736003493	-0.9458687492	+0.1745713552	+2.9590845005
	+0.9849730545	-0.1331871141	-0.1099512374	-2.4514716208
	+0.9091816469	-0.1908503931	-0.3700876387	-2.0469167878
25	+0.9295270361	-0.1564012361	+0.3339433224	+2.0088021459
	+0.7566247022	-0.2840410039	+0.5889310386	+2.0201833342
	+0.1893578229	-0.9793555648	+0.0707551591	+3.0694713101
	+0.6628812429	-0.7453504973	-0.0710006614	-3.0466211368
	+0.0644026534	-0.78050024 15	-0.6218292943	-2.4688634238
30	+0.9524689277	-0.2598797564	+0.1589511056	+2.5926631599
	+0.6798942329	+0.4666395730	-0.5656777713	-0.8810431848
	+0.7846757876	+0.5854029958	+0.2039295000	+0.3352107822
	+0.9854514738	-0.1696169128	+0.0107468911	+3.0783174504
	+0.2636951104	-0.5136662101	+0.8164630508	+2.1323642402
35	+0.7628565059	-0.2627604733	-0.5907680468	-1.9892989361
	+0.4808474011	-0.8649021747	+0.1439791829	+2.9766365510
	+0.7804865892	+0.6023724175	-0.1672966070	-0.2709020560
	+0.5556443989	-0.2201316456	+0.8017489386	+1.8387574368
	+0.1466610441	-0.0032454668	+0.9891814824	+1.5740772770
40	+0.7118498816	-0.0901670507	-0.6965196688	-1.6995340758
	+0.868092 6374	+0.4037299952	-0.2888204700	-0.6209738793
	+0.8335785812	-0.0591678342	-0.5492230115	-1.6781125130
	+0.7639469209	-0.5119228424	+0.3928359777	+2.487064 9657
	+0.8733576739	+0.3603207729	-0.3277427558	-0.7380860996
45	+0.8967713784	+0.2850450914	+0.3384529373	+0.8708479825
	+0.5257728090	-0.5375105192	+0.6592764178	+2.2547993978
	+0.4721450137	+0.0153060558	+0.8813880023	+1.5534322177
	+0.8849976841	-0.1900242423	-0.4250528042	-1.9912029245
	+0.6524738387	-0.7135595381	-0.2551679357	-2.7981645288
50	+0.1021459291	+0.4803434030	+0.8711121767	+1.0668682007
	+0.8555213825	+0.3027129156	-0.4200572042	-0.9463473740
	+0.7562597312	-0.4639152322	+0.4613608960	+2.3589551036
	+0.9801149026	+0.1247100315	-0.1543443736	-0.8911972079
	+0.6454192964	-0.1343916002	+0.7519127806	+1.7476617225
55	+0.1719476749	+0.9714 987570	+0.1631691214	+0.1664029773
	+0.6313528693	+0.4795071534	-0.6094804707	-0.904188 6616
	+0.8015664178	+0.3538811403	-0.4819329999	-0.9374222176
	+0.5412594672	+0.4794990569	-0.6907378979	-0.9639845295

	+0.5544321528	-0.1556265178	-0.8175483930	-1.7589033531
	+0.7351627623	+0.6028729288	-0.3099676510	-0.4749041244
	+0.8693107203	+0.1224130310	-0.4788673317	-1.3205255566
	+0.7169681778	-0.2942890777	+0.6319419046	+2.0066212470
5	+0.5569847731	-0.8166070174	-0.1513966371	-2.9582768796
	+0.3640135895	+0.9288356123	+0.0689819681	+0.0741310511
	+0.6600548776	+0.3633476174	-0.6574998612	-1.0659437738
	+0.7201176463	+0.2679406983	-0.6400299662	-1.1743268891
	+0.6326348415	-0.0382557321	-0.7735047875	-1.6202137143
10	+0.3778035453	-0.0063693710	-0.9258638735	-1.5776756000
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	+0.9065086243	-0.4201390352	+0.0415367929	+3.0430484853
	+0.7809115910	+0.4325250945	+0.4506652079	+0.8059345790
	+0.9655525669	+0.1631819419	-0.2026817564	-0.8929447949
15	+0.2067489785	+0.9193261518	+0.3348048484	+0.3492555320
	+0.5596222153	-0.7444327648	-0.3642016403	-2.6865950734
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	+0.2960574974	+0.6249855823	-0.7223177834	-0.8575151106
	+0.8787759171	+0.4300096101	-0.2069894266	-0.4486247214
20	+0.3306277234	+0.8641834544	+0.3793049771	+0.4135993362
	+0.4416034919	+0.2709418811	-0.8553226602	-1.2640246898
	+0.6590583438	-0.7498664368	+0.0578137215	+3.0646461825
	+0.5882358899	-0.7102409766	-0.3866992281	-2.6430112005
	+0.3400383382	-0.9231458872	-0.1793755821	-2.9496751206
25	+0.9404127864	+0.0066015287	+0.3399708974	+1.5513808437
	+0.7825644678	+0.4619648247	-0.4173503976	-0.7347039401
	+0.6479577904	+0.2550222557	-0.7177146723	-1.2293851725
	+0.4039802758	+0.6276328786	+0.6654899747	+0.8146655189
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15	+0.6774316421	+0.4125065552	-0.6090358875	-0.9754608965
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	+0.3934117075	-0.7903573524	-0.4696408030	-2.6054389889
	+0.4771189526	+0.7137676337	-0.5127311870	-0.622932 0274
	+0.7745617162	+0.4680219963	+0.4254521815	+0.7377889013

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	+0.5968962669	-0.7650994213	+0.2415320311	+2.8358068592
	+0.7217613118	+0.4790297113	-0.4995909772	-0.8064055277
	+0.9462978192	+0.0540685165	+0.3187428948	+1.4027653133
5	+0.9400162788	+0.1463640140	+0.3081346637	+1.1273478615
	+0.9417451064	+0.3320831877	-0.0532626607	-0.1590350293
	+0.9534015926	+0.3002054472	-0.0300348573	-0.0997158561
	+0.1599045954	-0.9076311420	-0.3881188354	-2.7375071667
	+0.7281673449	+0.0387592944	+0.6843025902	+1.5142162028
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	+0.6395462942	-0.3184875764	-0.6996757829	-1.9979604218
	+0.9930892693	+0.0696718214	+0.0944433187	+0.9352070500
	+0.9454783130	+0.0280531186	-0.3244746248	-1.4845537334
15	+0.5028715356	-0.7724034296	+0.3879602565	+2.6761253326
	+0.5061274411	+0.5643740945	+0.6521632425	+0.8574364247
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	+0.2068250614	-0.1389442382	+0.9684616113	+1.7132929695
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	+0.9746621059	-0.2220819659	-0.0267091697	-3.0219003578
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	+0.7460811362	+0.6599342109	+0.0885989592	+0.1334562339
	+0.0738476812	-0.8656639845	+0.4951488522	+2.6220254044
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	+0.6942370125	+0.1658720656	-0.7003723497	-1.3382469509
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	+0.1607902133	-0.1771101762	+0.9709678124	+1.7512185977
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5	+0.4393481243	-0.4538575697	+0.7752332115	+2.1004459877
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	+0.5317702949	-0.2408463840	+0.8119195605	+1.8591660851
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10	+0.8668149527	+0.4063898406	+0.2889275604	+0.6180449030
	+0.6368488345	-0.2398438790	-0.7327335640	-1.8871319687
	+0.8577467360	+0.4315843274	-0.2792946567	-0.5743607003
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15	+0.6337417021	-0.7601819067	-0.1431604824	-2.9554488265
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	+0,6746329679	-0,1579280177	+0,7210610930	+1,7864132928
	+0,3658154691	+0,7812493899	+0,5057948531	+0,5745579062
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	+0.5270556560	-0.1118088480	-0.8424435393	-1.7027448891
55	+0.9694131350	+0.2139291886	+0.1203016042	+0.5122702681
	+0.8784543236	-0.3686591977	-0.3039874953	-2.4520449990
	+0.2695831021	+0.8569881644	-0.4391995414	-0.4735911593
	+0.6148288097	+0.1666196186	+0.7708588960	+1.3579231353

	+0.7214433407	-0.6747760842	+0.1555530207	+2.9150253286
	+0.9760022271	+0.1434960967	+0.1637941478	+0.8513573232
	+0.2251228703	-0.2299316058	-0.9468110424	-1.8090328880
	+0.4547040153	-0.3704929246	-0.8099254604	-1.9998207416
5	+0.2769774242	-0.8330345446	+0.4788913803	+2.6198517364
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	+0.4361849547	-0.7611663851	+0.4799671025	+2.5789994580
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	+0.0282078118	-0.1754531341	-0.9840835925	-1.7472332951
	+0.0282078118	-0.1754531341	-0.9840835925	-1.7472332951
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15	+0.3802085695	-0.8945836408	-0.2348649684	-2.8848458780
	+0.3892725435	-0.2357244754	+0.8904498069	+1.8295852421
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20	+0.8012939251	-0.5921949113	-0.0850484132	-2.9989524137
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	+0.7176585743	-0.4836432356	-0.5010542798	-2.3385147157
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	+0.7478607292	+0.0970733406	+0.6567199527	+1.4240435620
	+0.3107429123	-0.2032494423	+0.9285087542	+1.7862960168
	+0.5348421836	+0.5851845972	-0.6095103164	-0.8057567990
	+0.9551539508	+0.0925569221	-0.2812723705	-1.2528920841
55	+0.4509567719	+0.7721072853	+0.4477592320	+0.5255227420
	+0.7317118136	+0.6706946625	-0.1215174537	-0.1792371065
	+0.5677090465	+0.1719408302	+0.8050731578	+1.3603857758
	+0.6444075905	-0.4527395964	-0.6162513409	-2.2044119555

	+0.6086120186	+0.7933328317	+0.0146433944	+0.0184559761
	+0.9157344596	+0.2780377150	+0.2900438389	+0.8065295251
	+0.3994424701	-0.1567554601	+0.9032571278	+1.7426295602
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5	+0.3659523561	-0.8790433411	-0.3055514320	-2.8070616105
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	+0.9707682631	+0.2163664632	-0.1038967413	-0.4476733683
15	+0.4678289582	+0.8670916261	+0.1711378914	+0.1948654585
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	+0.9210745379	+0.1773757457	-0.3466403618	-1.0978328795
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	+0.9816324974	-0.1490490224	+0.1190883239	+2.4674693202
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	+0.6339753723	-0.5176998551	+0.5745103023	+2.3042271131

Claims

1. A communication device for wired data transmission, the communication device (100) comprising:

a transmitter unit (110) configured to transmit at least two transmit signals via different transmission paths of a transmission channel (300);

5 a codebook memory unit (188) configured to store a codebook table comprising a plurality of codebook entries, each codebook entry including at least one predefined precoder value for each of the at least two transmit signals;

a precoder unit (114) configurable to beamform the transmit signals; and

10 a precoder control unit (184) configured to construct, on the basis of precoder values assigned to a codebook entry identified by a codebook index, a precoding matrix for beamforming the at least two transmit signals and to configure the precoder unit (114) according to the constructed precoding matrix.

2. The communication device of claim 1, wherein

15 the transmitter unit (110) is configured to transmit and precode multi-carrier signals; and

the precoder control unit (184) is configured to construct, for each or a subset of the sub-carriers respectively, on the basis of precoder values assigned to a codebook entry identified by a codebook index for the respective sub-carrier, a precoding matrix for beamforming the at least two transmit signals and to
20 configure the precoder unit (114) for the respective sub-carrier according to the constructed precoding matrix.

3. The communication device of claim 2, wherein

25 the precoder control unit (184) is further configured to interpolate the precoder values for precoding matrices for sub-carriers between two pilot sub-carriers on the basis of the precoder values assigned to the codebook entries identified by codebook indices assigned to the two pilot sub-carriers.

30 4. The communication device of any of the preceding claims, wherein

the entries in the codebook table represent uniformly distributed precoding vectors.

5. The communication device of any of the preceding claims, wherein

35 the codebook memory unit (188) stores at least two codebook tables of different length and

the precoder control unit (184) is configured to access a selected one of the codebook tables.

6. The communication device of any of the preceding claims, wherein

5 the codebook table includes the first and at least one of the second, third and fourth column of one of the codebook tables defined in tables 1 to 12.

7. The communication device of any of the preceding claims, further comprising a receiver unit (120) configured to receive at least one receive signal

10 containing information about at least two further transmit signals, the at least two further transmit signals received via different transmission paths of the wired transmission channel (300);

a codebook control unit (183) configured to identify, on the basis of channel state information describing the transmission channel (300), that one of the
15 codebook entries whose precoder values approximate a perfect precoding matrix for beamforming the at least two further transmit signals at best among all or a subset of the codebook entries.

8. The communication device of claim 7, wherein

20 the codebook control unit (183) is configured to identify that one of the codebook entries whose precoder values approximate the perfect precoding matrix at best among all of the codebook entries.

9. The communication device of any of the preceding claims, wherein

25 the perfect precoding matrix is obtained by singular value or QR decomposition of a channel matrix of the transmission channel (300).

10. The communication device of claim 2, wherein

30 the codebook table contains a codebook entry for each sub-carrier.

11. A communications system comprising

a first communication device according to any of claims 1 to 10 and
a second communication device according to any of claims 7 and 8.

35 12. A communications method for a communications system comprising a first and a second communication device (100) connected by a wired transmission channel (300),

identifying, in the first communication device, in a codebook table comprising a plurality of codebook entries, each codebook entry including at least

one predefined precoder value for each transmit signal on the basis of channel state information describing the transmission channel (300), that one of a plurality of codebook entries, whose precoder values approximate a perfect precoding matrix for beamforming transmit signals at best among all or a subset
5 of the codebook entries for obtaining a codebook index; and

using, in the first and/or the second communication device, the codebook index for constructing a precoding matrix for beamforming the transmit signals on the basis of the precoder values assigned to the codebook entry identified by the codebook index.

Fig. 1

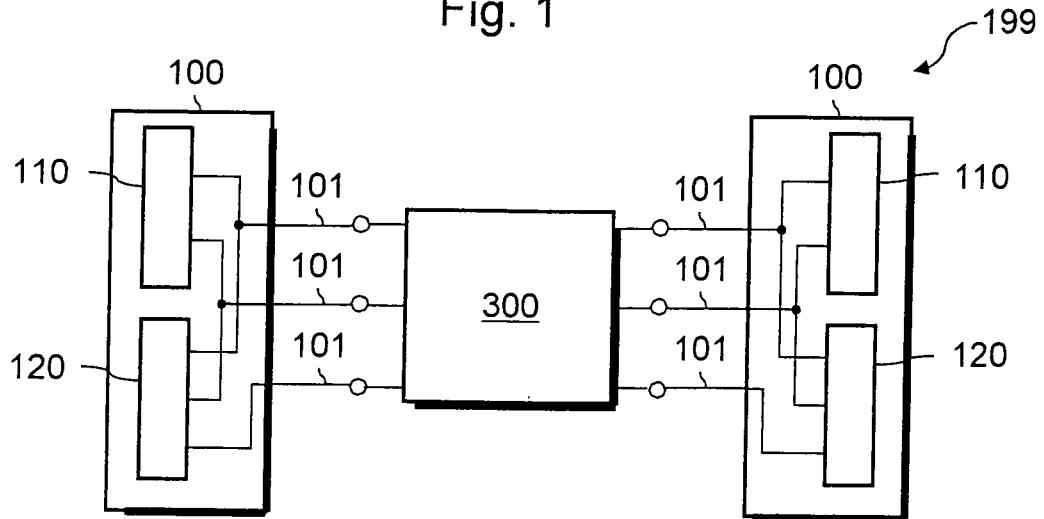


Fig. 2A

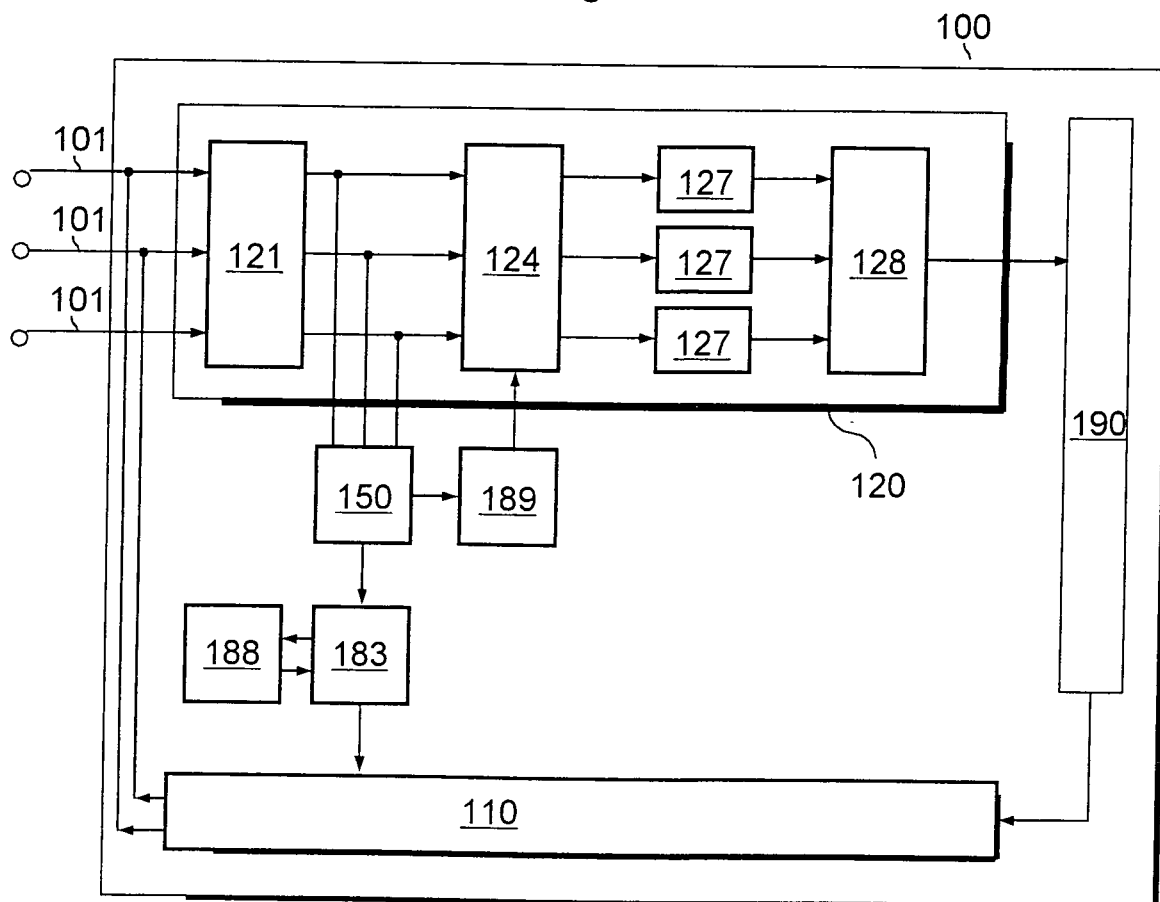


Fig. 2B

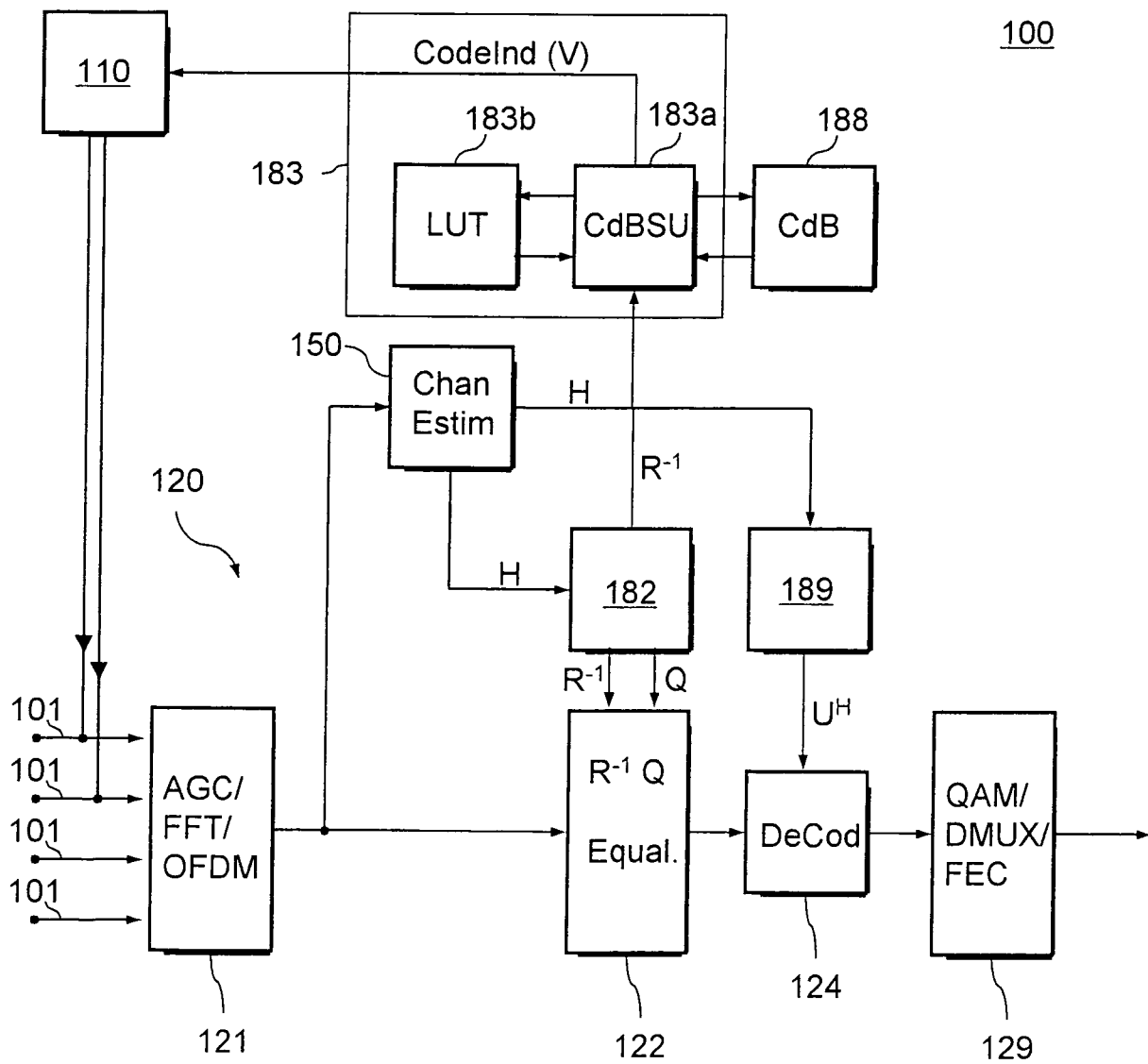


Fig. 3A

310

v_{11}	$\text{Re}\{v_{21}\}$	$\text{Im}\{v_{21}\}$	305
v_{12}	$\text{Re}\{v_{22}\}$	$\text{Im}\{v_{22}\}$	305
v_{13}	$\text{Re}\{v_{23}\}$	$\text{Im}\{v_{23}\}$	305
⋮			
v_{1i}	$\text{Re}\{v_{2i}\}$	$\text{Im}\{v_{2i}\}$	305
⋮			
v_{1m}	$\text{Re}\{v_{2m}\}$	$\text{Im}\{v_{2m}\}$	305

Fig. 3B

320

v_{11}	φ_{21}	305
v_{12}	φ_{22}	305
v_{13}	φ_{23}	305
⋮		
v_{1i}	φ_{2i}	305
⋮		
v_{1m}	φ_{2m}	305

Fig. 4A

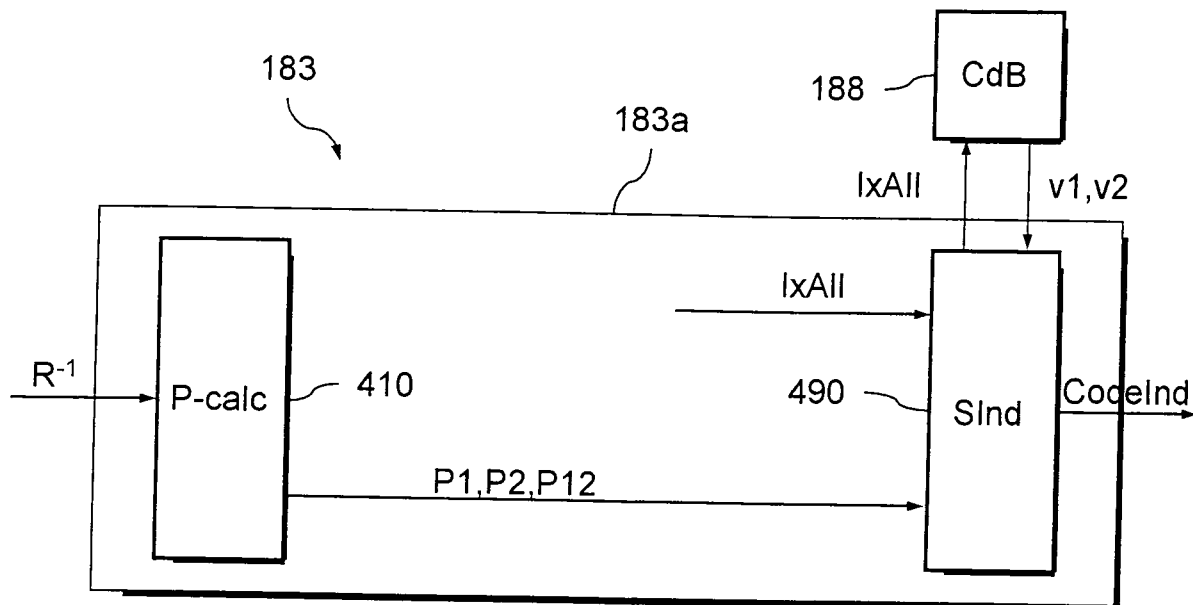


Fig. 4B

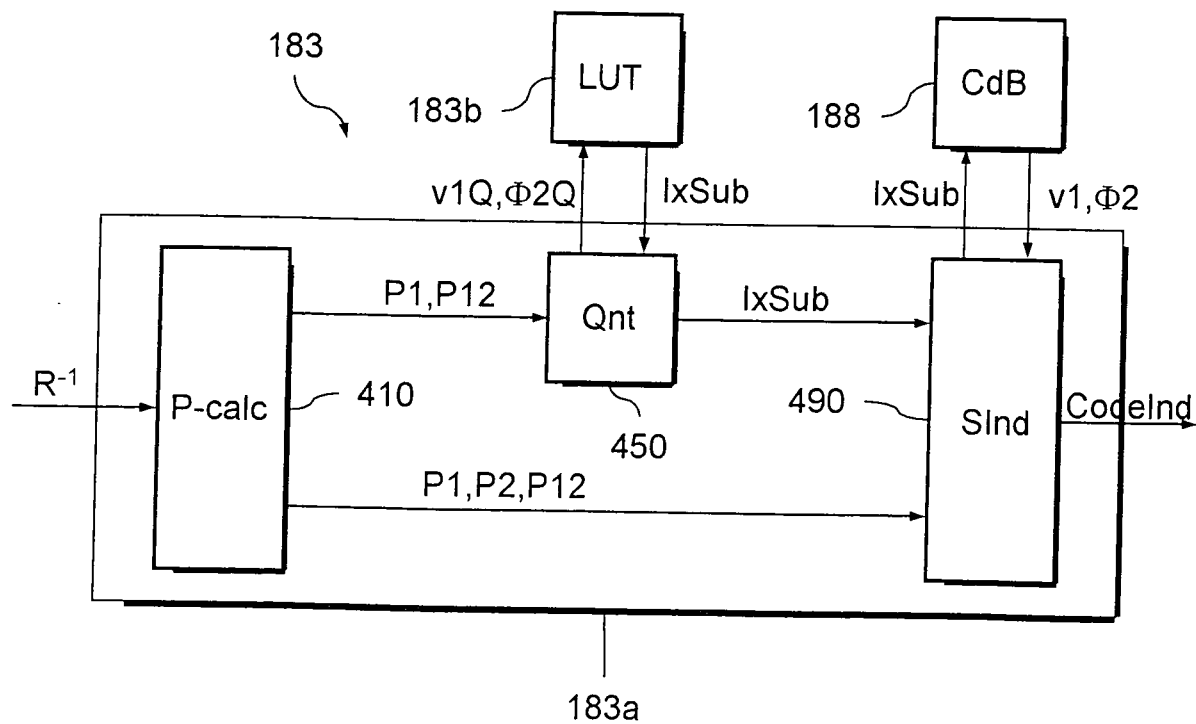


Fig. 4C

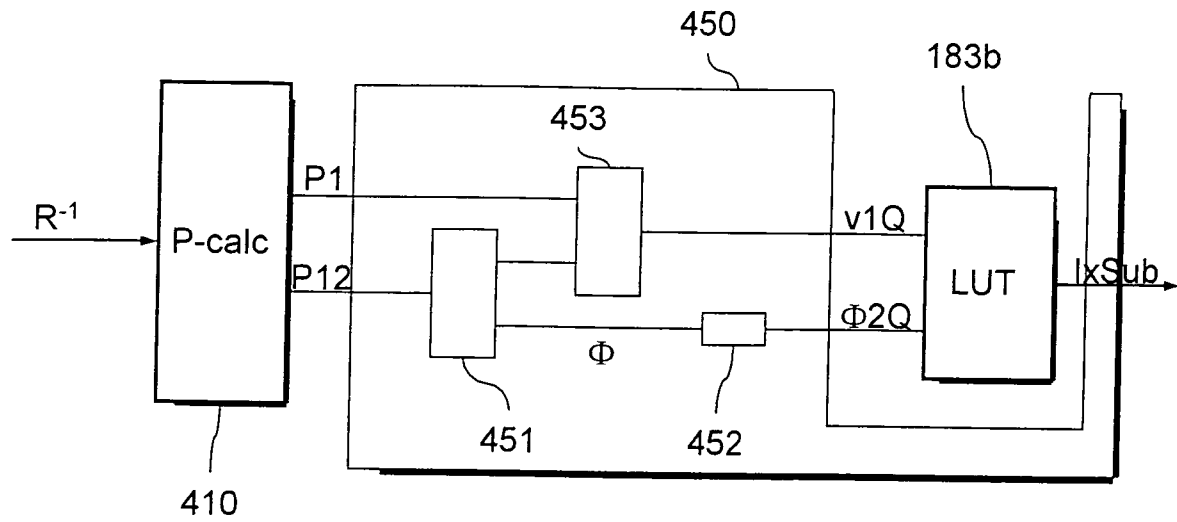


Fig. 5A

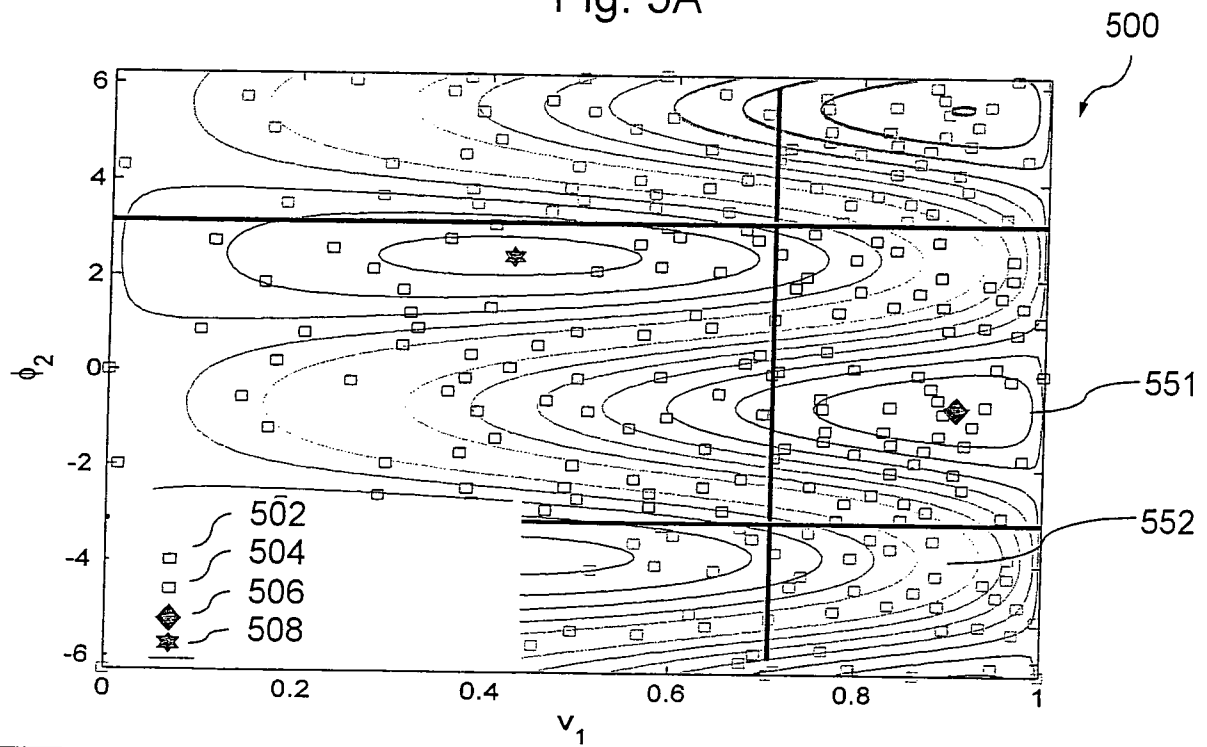


Fig. 5B

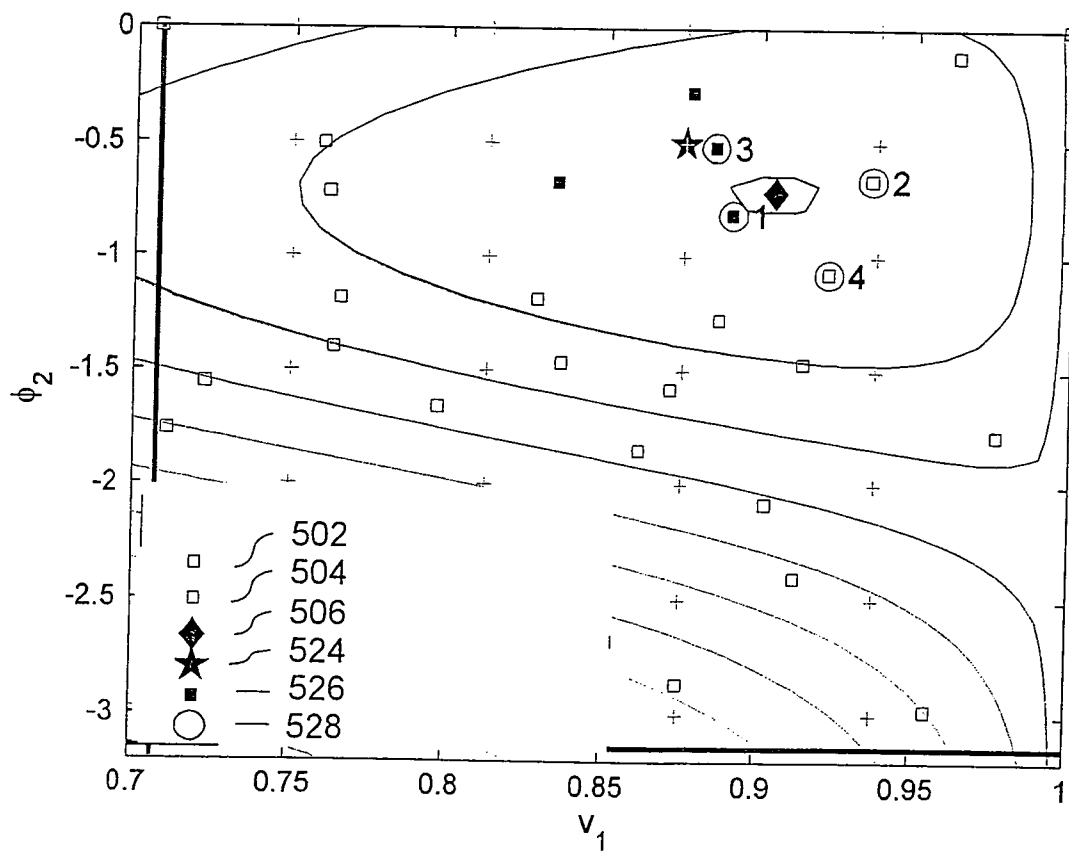


Fig. 6A

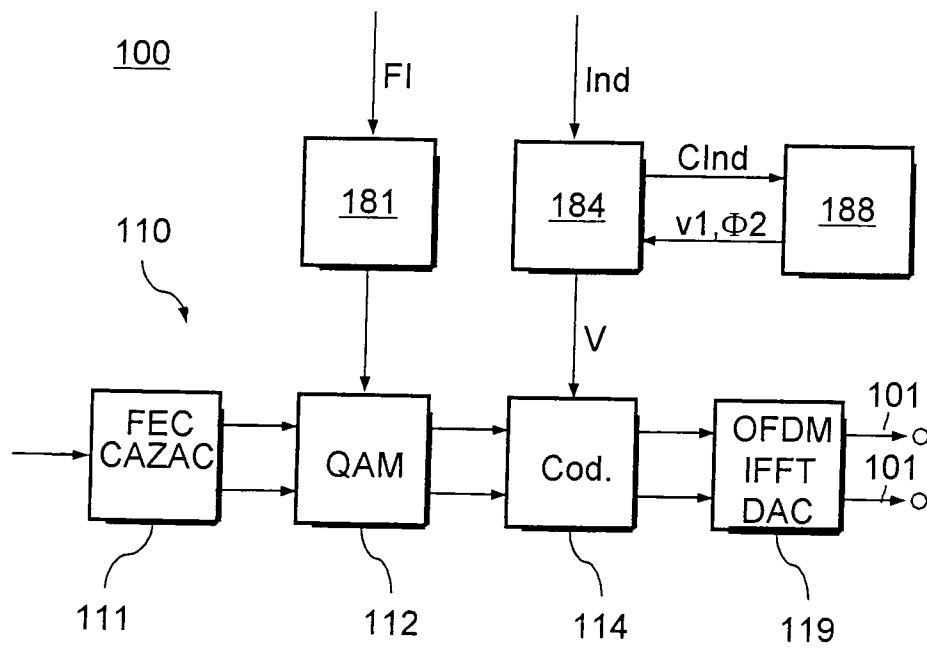


Fig. 6B

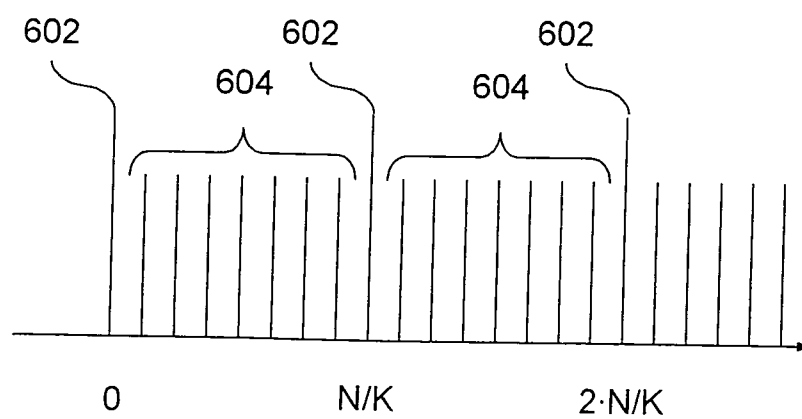
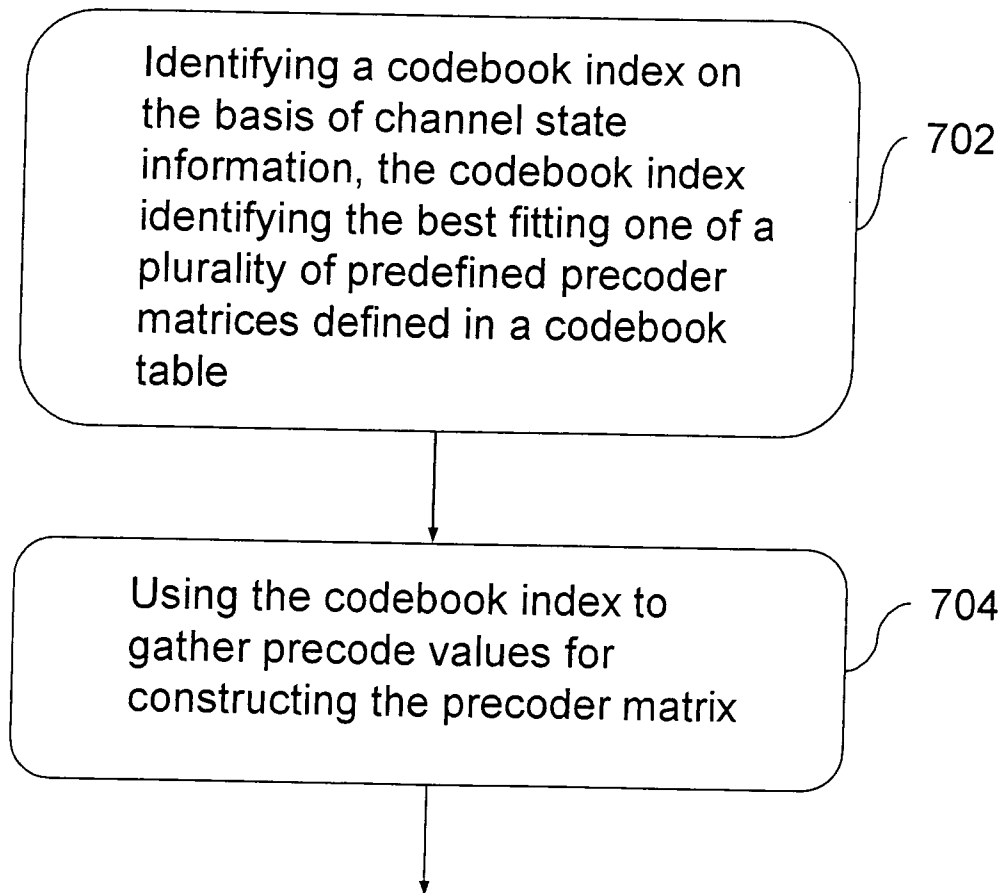


Fig. 7



INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2011/004118

A. CLASSIFICATION OF SUBJECT MATTER
 INV. H04B3/54 H04L27/26
 ADD.

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)
 H04B H04L

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 practical, search terms used)

EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DANIEL SCHNEIDER ET AL: "Precoded Spatial Multiplexing MIMO for Inhome Power Line Communications", GLOBAL TELECOMMUNICATIONS CONFERENCE, 2008. IEEE GLOBECOM 2008. IEEE, IEEE, PISCATAWAY, NJ, USA, 30 November 2008 (2008-11-30) , pages 1-5 , XP031370239 , ISBN: 978-1-4244-2324-8 page 1, right-hand column, line 22 - page 2, left-hand column, line 18; figure 1 page 2, right-hand column, line 28 - page 3, left-hand column, line 14 page 4, left-hand column, lines 14-48 -----	1-12
X,P	W0 2011/017247 A2 (TEXAS INSTRUMENTS INC [US] ; KIM HAN [US] ; VARADARAJAN BADRI N [US] ; DA) 10 February 2011 (2011-02-10) paragraphs [0012] - [0015] -----	1-4,7 , 9-12



Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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"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

2 January 2012

Date of mailing of the international search report

11/01/2012

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
 NL - 2280 HV Rijswijk
 Tel. (+31-70) 340-2040,
 Fax: (+31-70) 340-3016

Authorized officer

De Iulius, M

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2011/004118

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011017247 A2	10-02-2011	US 2011026621 A1 WO 2011017247 A2	03-02-2011 10-02-2011
