(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 525 664 B9**

(12) **CORRECTED EUROPEAN PATENT SPECIFICATION**

(15) Correction information:
Corrected version no 1 (W1 B1)
Corrections, see
Claims DE 1-2
Claims EN 1-2
Claims FR 1-2

(48) Corrigendum issued on:
10.09.2014 Bulletin 2014/37

(45) Date of publication and mention of the grant of the patent:
02.05.2012 Bulletin 2012/18

(21) Application number: **03763216.3**

(22) Date of filing: **03.07.2003**

(51) Int Cl.:
H03M 13/11 *(2006.01)* ***H03M 13/25*** *(2006.01)*
H03M 13/29 *(2006.01)* ***H04L 27/20*** *(2006.01)*
H04L 27/34 *(2006.01)* ***H04L 27/36*** *(2006.01)*
H03M 13/15 *(2006.01)* ***H04L 1/00*** *(2006.01)*

(86) International application number:
PCT/US2003/021071

(87) International publication number:
WO 2004/006441 (15.01.2004 Gazette 2004/03)

(54) METHOD AND SYSTEM FOR MEMORY MANAGEMENT IN LOW DENSITY PARITY CHECK (LDPC) DECODERS

METHODE UND VERFAHREN FÜR DIE SPEICHERVERWALTUNG IN LOW DENSITY PARITY CHECK (LDPC) DECODERN

PROCEDE ET SYSTEME POUR LE ROUTAGE DANS DES DECODEURS A CONTROLE DE PARITE FAIBLE DENSITE

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR

(30) Priority:
03.07.2002 US 393457 P
26.07.2002 US 398760 P
15.08.2002 US 403812 P
25.10.2002 US 421505 P
29.10.2002 US 421999 P
04.11.2002 US 423710 P
15.01.2003 US 440199 P
14.02.2003 US 447641 P
20.03.2003 US 456220 P
09.05.2003 US 469356 P
24.06.2003 US 482112 P
24.06.2003 US 482107 P

(43) Date of publication of application:
27.04.2005 Bulletin 2005/17

(73) Proprietor: **DTVG LICENSING, INC**
El Segundo CA 90245 (US)

(72) Inventors:
- **EROZ, Mustafa**
  Germantown, MD 20874 (US)
- **LEE, Lin-Nan**
  Potomac, MD 20854 (US)
- **SUN, Feng-Wen**
  Germantown, MD 20874 (US)
- **CASSAGNOL, Bob**
  Silver Spring, MD 20904 (US)
- **VON ANCKEN, Adam**
  New Market, MD 21774 (US)

(74) Representative: **Brunner, John Michael Owen et al**
Carpmaels & Ransford LLP
One Southampton Row
London WC1B 5HA (GB)

(56) References cited:
WO-A-02/103631

- **TONG ZHANG ET AL: "Joint code and decoder design for implementation-oriented (3, k)-regular LDPC codes" PROC., 35TH. ASILOMAR CONFERENCE ON SIGNALS, SYSTEMS, & COMPUTERS. PACIFIC GROOVE, CA, USA, vol. 1 OF 2. CONF. 35, 4 - 7 November 2001, pages 1232-1236, XP010582236 ISBN: 0-7803-7147-X**

Printed by Jouve, 75001 PARIS (FR)

(Cont. next page)

- MANSOUR M M ET AL: "Low power VLSI decoder architectures for LDPC codes" PROC., IEEE INTERNATIONAL SYMPOSIUM ON LOWER POWER ELECTRONICS AND DESIGN, ISLPED'02, 12 - 14 August 2002, pages 284-289, XP010600916
- BOUTILLION E ET AL: "Decoder-first code design" PROC., INTERNATIONAL SYMPOSIUM ON TURBO CODES AND RELATED TOPICS, BREST, FRANCE, 4 - 7 September 2000, pages 459-462, XP008011934
- AL-RAWI G., CIOFFI J., HOROWITZ M.: "Optimizing the mapping of low-density parity check codes on parallel decoding architectures" PROC., IEEE CONFERENCE ON INFORMATION TECHOLOGY: CODING AND COMPUTING, LAS VEGAS, NV, USA, 2 - 4 April 2001, pages 578-586, XP002260920
- SELVARATHINAM A., CHOI G. NARAYANAN K.: "A massively scaleable decoder architecture for low-density parity-check codes" PROC., IEEE INTERNATIONAL SYMPOSIUM ON CIRCUITS AND SYSTEMS, ISCAS'03, vol. 2, 25 - 28 May 2003, pages 61-64, XP002260921
- ECHARD R. ET AL.: "THE PI-ROTATION LOW-DENSITY PARITY CHECK CODES", PROC., IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE, GLOBECOM 2001, SAN ANTONIO, TX,, 25 November 2001 (2001-11-25), - 29 November 2001 (2001-11-29), pages 980-984, XP001099251, DOI: 10.1109/GLOCOM. 2001.965564 ISBN: 978-0-7803-7206-1

Description

FIELD OF THE INVENTION

[0001] The present invention relates to communication systems, and more particularly to coded systems.

BACKGROUND OF THE INVENTION

[0002] Communication systems employ coding to ensure reliable communication across noisy communication channels. These communication channels exhibit a fixed capacity that can be expressed in terms of bits per symbol at certain signal to noise ratio (SNR), defining a theoretical upper limit (known as the Shannon limit). As a result, coding design has aimed to achieve rates approaching this Shannon limit. One such class of codes that approach the Shannon limit is Low Density Parity Check (LDPC) codes.

[0003] Traditionally, LDPC codes have not been widely deployed because of a number of drawbacks. One drawback is that the LDPC encoding technique is highly complex. Encoding an LDPC code using its generator matrix would require storing a very large, non-sparse matrix. Additionally, LDPC codes require large blocks to be effective; consequently, even though parity check matrices of LDPC codes are sparse, storing these matrices is problematic.

[0004] Zhang T et al: "Joint code and decoder design for implementation-orientated (3,k)-regular LDPC codes" describes retrieving edge values associated with a structured parity check matrix from memory for decoding an LDPC coded signal. WO 02/103631 describes vectorized, partly-parallel decoding of LDPC codes having a structured parity check matrix.

[0005] From an implementation perspective, a number of challenges are confronted. For example, storage is an important reason why LDPC codes have not become widespread in practice. Also, a key challenge in LDPC code implementation has been how to achieve the connection network between several processing engines (nodes) in the decoder. Further, the computational load in the decoding process, specifically the check node operations, poses a problem.

[0006] Therefore, there is a need for a LDPC communication system that employs simple encoding and decoding processes. There is also a need for using LDPC codes efficiently to support high data rates, without introducing greater complexity. There is also a need to improve performance of LDPC encoders and decoders. There is also a need to minimize storage requirements for implementing LDPC coding. There is a further need for a scheme that simplifies the communication between processing nodes in the LDPC decoder.

SUMMARY OF THE INVENTION

[0007] These and other needs are addressed by the present invention, which is defined by the appendant claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which like reference numerals refer to similar elements and in which:

FIG. 1 is a diagram of a communications system configured to utilize Low Density Parity Check (IDPC) codes, according to an embodiment of the present invention;
FIG. 2 is a diagram of an exemplary transmitter in the system of FIG. 1;
FIG. 3 is a diagram of an exemplary receiver in the system of FIG. 1;
FIG. 4 is a diagram of a sparse parity check matrix, in accordance with an embodiment of the present invention;
FIG. 5 is a diagram of a bipartite graph of an LDPC code of the matrix of FIG. 4;
FIG. 6 is a diagram of a sub-matrix of a sparse parity check matrix, wherein the sub-matrix contains parity check values restricted to the lower triangular region, according to an embodiment of the present invention;
FIG. 7 is a graph showing performance between codes utilizing unrestricted parity check matrix (H matrix) versus restricted H matrix having a sub-matrix as in FIG. 6;
FIGs. 8A and 8B are, respectively, a diagram of a non-Gray 8-PSK modulation scheme, and a Gray 8-PSK modulation, each of which can be used in the system of FIG. 1;
FIG. 9 is a graph showing performance between codes utilizing Gray labeling versus non-Gray labeling;
FIG. 10 is a flow chart of the operation of the LDPC decoder using non-Gray mapping, according to an embodiment of the present invention;
FIG. 11 is a flow chart of the operation of the LDPC decoder of FIG. 3 using Gray mapping, according to an embodiment of the present invention;

FIGs. 12A-12C are diagrams of the interactions between the check nodes and the bit nodes in a decoding process, according to an embodiment of the present invention;

FIGs. 13A and 13B are flowcharts of processes for computing outgoing messages between the check nodes and the bit nodes using, respectively, a forward-backward approach and a parallel approach, according to various embodiments of the present invention;

FIGs. 14A-14 are graphs showing simulation results of LDPC codes generated in accordance with various embodiments of the present invention;

FIGs. 15A and 15B are diagrams of the top edge and bottom edge, respectively, of memory organized to support structured access as to realize randomness in LDPC coding, according to an embodiment of the present invention; and

FIG. 16 is a diagram of a computer system that can perform the processes of encoding and decoding of LDPC codes, in accordance with embodiments of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0009] A system, method, and software for efficiently decoding structured Low Density Parity Check (LDPC) codes are described. In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It is apparent, however, to one skilled in the art that the present invention may be practiced without these specific details or with an equivalent arrangement. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the present invention.

[0010] FIG. 1 is a diagram of a communications system configured to utilize Low Density Parity Check (LDPC) codes, according to an embodiment of the present invention. A digital communications system 100 includes a transmitter 101 that generates signal waveforms across a communication channel 103 to a receiver 105. In this discrete communications system 100, the transmitter 101 has a message source that produces a discrete set of possible messages; each of the possible messages has a corresponding signal waveform. These signal waveforms are attenuated, or otherwise altered, by communications channel 103. To combat the noise channel 103, LDPC codes are utilized.

[0011] The LDPC codes that are generated by the transmitter 101 enables high speed implementation without incurring any performance loss. These structured LDPC codes output from the transmitter 101 avoid assignment of a small number of check nodes to the bit nodes already vulnerable to channel errors by virtue of the modulation scheme (e.g., 8-PSK).

[0012] Such LDPC codes have a parallelizable decoding algorithm (unlike turbo codes), which advantageously involves simple operations such as addition, comparison and table look-up. Moreover, carefully designed LDPC codes do not exhibit any sign of error floor.

[0013] According to one embodiment of the present invention, the transmitter 101 generates, using a relatively simple encoding technique, LDPC codes based on parity check matrices (which facilitate efficient memory access during decoding) to communicate with the receiver 105. The transmitter 101 employs LDPC codes that can outperform concatenated turbo+RS (Reed-Solomon) codes, provided the block length is sufficiently large.

[0014] FIG. 2 is a diagram of an exemplary transmitter in the system of FIG. 1. A transmitter 200 is equipped with an LDPC encoder 203 that accepts input from an information source 201 and outputs coded stream of higher redundancy suitable for error correction processing at the receiver 105. The information source 201 generates k signals from a discrete alphabet, X. LDPC codes are specified with parity check matrices. On the other hand, encoding LDPC codes require, in general, specifying the generator matrices. Even though it is possible to obtain generator matrices from parity check matrices using Gaussian elimination, the resulting matrix is no longer sparse and storing a large generator matrix can be complex.

[0015] Encoder 203 generates signals from alphabet Y to a modulator 205 using a simple encoding technique that makes use of only the parity check matrix by imposing structure onto the parity check matrix. Specifically, a restriction is placed on the parity check matrix by constraining certain portion of the matrix to be triangular. The construction of such a parity check matrix is described more fully below in FIG. 6. Such a restriction results in negligible performance loss, and therefore, constitutes an attractive trade-off.

[0016] Modulator 205 maps the encoded messages from encoder 203 to signal waveforms that are transmitted to a transmit antenna 207, which emits these waveforms over the communication channel 103. Accordingly, the encoded messages are modulated and distributed to a transmit antenna 207. The transmissions from the transmit antenna 207 propagate to a receiver, as discussed below.

[0017] FIG. 3 is a diagram of an exemplary receiver in the system of FIG. 1. At the receiving side, a receiver 300 includes a demodulator 301 that performs demodulation of received signals from transmitter 200. These signals are received at a receive antenna 303 for demodulation. After demodulation, the received signals are forwarded to a decoder 305, which attempts to reconstruct the original source messages by generating messages, X', in conjunction with a bit metric generator 307. With non-Gray mapping, the bit metric generator 307 exchanges probability information with the

decoder 305 back and forth (iteratively) during the decoding process, which is detailed in FIG. 10. Alternatively, if Gray mapping is used (according to one embodiment of the present invention), one pass of the bit metric generator is sufficient, in which further attempts of bit metric generation after each LDPC decoder iteration are likely to yield limited performance improvement; this approach is more fully described with respect to FIG. 11. To appreciate the advantages offered by the present invention, it is instructive to examine how LDPC codes are generated, as discussed in FIG. 4.

[0018] FIG. 4 is a diagram of a sparse parity check matrix, in accordance with an embodiment of the present invention. LDPC codes are long, linear block codes with sparse parity check matrix $H_{(n-k)xn}$. Typically the block length, n, ranges from thousands to tens of thousands of bits. For example, a parity check matrix for an LDPC code of length n=8 and rate ½ is shown in FIG. 4. The same code can be equivalently represented by the bipartite graph, per FIG. 5.

[0019] FIG. 5 is a diagram of a bipartite graph of an LDPC code of the matrix of FIG. 4. Parity check equations imply that for each check node, the sum (over GF (Galois Field)(2)) of all adjacent bit nodes is equal to zero. As seen in the figure, bit nodes occupy the left side of the graph and are associated with one or more check nodes, according to a predetermined relationship. For example, corresponding to check node m_1, the following expression exists $n_1 + n_4 + n_5 + n_8 = 0$ with respect to the bit nodes.

[0020] Returning the receiver 303, the LDPC decoder 305 is considered a message passing decoder, whereby the decoder 305 aims to find the values of bit nodes. To accomplish this task, bit nodes and check nodes iteratively communicate with each other. The nature of this communication is described below.

[0021] From check nodes to bit nodes, each check node provides to an adjacent bit node an estimate ("opinion") regarding the value of that bit node based on the information coming from other adjacent bit nodes. For instance, in the above example if the sum of n_4 , n_5 and n_8 "looks like" 0 to m_1, then m_1 would indicate to n_1 that the value of n_1 is believed to be 0 (since $n_1 + n_4 + n_5 + n_8 = 0$); otherwise m_1 indicate to n_1 that the value of n_1 is believed to be 1. Additionally, for soft decision decoding, a reliability measure is added.

[0022] From bit nodes to check nodes, each bit node relays to an adjacent check node an estimate about its own value based on the feedback coming from its other adjacent check nodes. In the above example n_1 has only two adjacent check nodes m_1 and m_3. If the feedback coming from m_3 to n_1 indicates that the value of n_1 is probably 0, then n_1 would notify m_1 that an estimate of n_1's own value is 0. For the case in which the bit node has more than two adjacent check nodes, the bit node performs a majority vote (soft decision) on the feedback coming from its other adjacent check nodes before reporting that decision to the check node it communicates. The above process is repeated until all bit nodes are considered to be correct (i.e., all parity check equations are satisfied) or until a predetermined maximum number of iterations is reached, whereby a decoding failure is declared.

[0023] FIG. 6 is a diagram of a sub-matrix of a sparse parity check matrix, wherein the sub-matrix contains parity check values restricted to the lower triangular region, according to an embodiment of the present invention. As described previously, the encoder 203 (of FIG. 2) can employ a simple encoding technique by restricting the values of the lower triangular area of the parity check matrix. According to an embodiment of the present invention, the restriction imposed on the parity check matrix is of the form:

$$H_{(n-k)xn} = [A_{(n-k)xk}\ B_{(n-k)x(n-k)}]$$

, where **B** is lower triangular.

[0024] Any information block $i = (i_0, i_1, ..., i_{k-1})$ is encoded to a codeword $c = (i_0, i_1, ..., i_{k-1}, p_0, p_1, ...p_{n-k-1})$ using $\boldsymbol{Hc}^T = \mathbf{0}$, and recursively solving for parity bits; for example,

$$a_{00}i_0 + a_{01}i_1 + ... + a_{0,k-1}i_{k-1} + p_0 = 0 \Rightarrow Solve\ p_0 \quad ,$$

$$a_{10}i_0 + a_{11}i_1 + ... + a_{1,k-1}i_{k-1} + b_{10}p_0 + p_1 = 0 \Rightarrow Solve\ p_1$$

and similarly for $p_2, p_3, ...p_{n-k-1}$.

[0025] FIG. 7 is a graph showing performance between codes utilizing unrestricted parity check matrix (H matrix) versus restricted H matrix of FIG. 6. The graph shows the performance comparison between two LDPC codes: one with a general parity check matrix and the other with a parity check matrix restricted to be lower triangular to simplify encoding. The modulation scheme, for this simulation, is 8-PSK. The performance loss is within 0.1 dB. Therefore, the performance loss is negligible based on the restriction of the lower triangular H matrices, while the gain in simplicity of the encoding technique is significant. Accordingly, any parity check matrix that is equivalent to a lower triangular or upper triangular under row and/or column permutation can be utilized for the same purpose.

[0026] FIGs. 8A and 8B are, respectively, a diagram of a non-Gray 8-PSK modulation scheme, and a Gray 8-PSK modulation, each of which can be used in the system of FIG. 1. The non-Gray 8-PSK scheme of FIG. 8A can be utilized in the receiver of FIG. 3 to provide a system that requires very low Frame Erasure Rate (FER). This requirement can also be satisfied by using a Gray 8-PSK scheme, as shown in FIG. 8B, in conjunction with an outer code, such as Bose, Chaudhuri, and Hocquenghem (BCH), Hamming, or Reed-Solomon (RS) code.

[0027] Under this scheme, there is no need to iterate between the LDPC decoder 305 (FIG. 3) and the bit metric generator 307, which may employ 8-PSK modulation. In the absence of an outer code, the LDPC decoder 305 using Gray labeling exhibit an earlier error floor, as shown in FIG. 9 below.

[0028] FIG. 9 is a graph showing performance between codes utilizing Gray labeling versus non-Gray labeling of FIGs. 8A and 8B. The error floor stems from the fact that assuming correct feedback from LDPC decoder 305, regeneration of 8-PSK bit metrics is more accurate with non-Gray labeling since the two 8-PSK symbols with known two bits are further apart with non-Gray labeling. This can be equivalently seen as operating at higher Signal-to-Noise Ratio (SNR). Therefore, even though error asymptotes of the same LDPC code using Gray or non-Gray labeling have the same slope (i.e., parallel to each other), the one with non-Gray labeling passes through lower FER at any SNR.

[0029] On the other hand, for systems that do not require very low FER, Gray labeling without any iteration between LDPC decoder 305 and 8-PSK bit metric generator 307 may be more suitable because re-generating 8-PSK bit metrics before every LDPC decoder iteration causes additional complexity. Moreover, when Gray labeling is used, re-generating 8-PSK bit metrics before every LDPC decoder iteration yields only very slight performance improvement. As mentioned previously, Gray labeling without iteration may be used for systems that require very low FER, provided an outer code is implemented.

[0030] The choice between Gray labeling and non-Gray labeling depends also on the characteristics of the LDPC code. Typically, the higher bit or check node degrees, the better it is for Gray labeling, because for higher node degrees, the initial feedback from LDPC decoder 305 to 8-PSK (or similar higher order modulation) bit metric generator 307 deteriorates more with non-Gray labeling.

[0031] When 8-PSK (or similar higher order) modulation is utilized with a binary decoder, it is recognized that the three (or more) bits of a symbol are not received "equally noisy". For example with Gray 8-PSK labeling, the third bit of a symbol is considered more noisy to the decoder than the other two bits. Therefore, the LDPC code design does not assign a small number of edges to those bit nodes represented by "more noisy" third bits of 8-PSK symbol so that those bits are not penalized twice.

[0032] FIG. 10 is a flow chart of the operation of the LDPC decoder using non-Gray mapping, according to an embodiment of the present invention. Under this approach, the LDPC decoder and bit metric generator iterate one after the other. In this example, 8-PSK modulation is utilized; however, the same principles apply to other higher modulation schemes as well. Under this scenario, it is assumed that the demodulator 301 outputs a distance vector, d, denoting the distances between received noisy symbol points and 8-PSK symbol points to the bit metric generator 307, whereby the vector components are as follows:

$$d_i = -\frac{E_s}{N_0}\{(r_x - s_{i,x})^2 + (r_y - s_{i,y})^2\} \qquad i = 0,1,...7.$$

[0033] The 8-PSK bit metric generator 307 communicates with the LDPC decoder 305 to exchange *a priori* probability information and *a posteriori* probability information, which respectively are represented as **u**, and **a**. That is, the vectors **u** and **a** respectively represent *a priori* and *a posteriori* probabilities of log likelihood ratios of coded bits.

[0034] The 8-PSK bit metric generator 307 generates the *a priori* likelihood ratios for each group of three bits as follows. First, extrinsic information on coded bits is obtained:

$$e_j = a_j - u_j \qquad j = 0,1,2.$$

Next, 8-PSK symbol probabilities, p_i i = 0,1,...,7, are determined.

* $y_j = -f(0,e_j)$ j = 0,1,2 where $f(a,b) = \max(a,b) + LUT_f(a,b)$ with

$LUT_f(a,b) = \ln(1+ e^{-|a-b|})$

*$x_j = y_j + e_j$ j = 0,1,2

*$p_0 = x_0 + x_1 + x_2$ $p_4 = y_0 + y_1 + x_2$

$p_1 = x_0 + x_1 + y_2$ $p_5 = y_0 + x_1 + y_2$

$p_2 = x_0 + y_1 + x_2$ $p_6 = y_0 + y_1 + x_2$

$p_3 = x_0 + y_1 + y_2$ $p_7 = y_0 + y_1 + y_2$

[0035] Next, the bit metric generator 307 determines *a priori* log likelihood ratios of the coded bits as input to LDPC decoder 305, as follows:

$$u_0 = f(d_0 + p_0, d_1 + p_1, d_2 + p_2, d_3 + p_3) - f(d_4 + p_4, d_5 + p_5, d_6 + p_6, d_7 + p_7) - e_0$$

$$u_1 = f(d_0 + p_0, d_1 + p_1, d_4 + p_4, d_5 + p_5) - f(d_2 + p_2, d_3 + p_3, d_6 + p_6, d_7 + p_7) - e_1$$

$$u_2 = f(d_0 + p_0, d_2 + p_2, d_4 + p_4, d_6 + p_6) - f(d_1 + p_1, d_3 + p_3, d_5 + p_5, d_7 + p_7) - e_2$$

[0036] It is noted that the function $f(.)$ with more than two variables can be evaluated recursively; e.g. $f(a,b,c) = f(f(a,b),c)$.

[0037] The operation of the LDPC decoder 305 utilizing non-Gray mapping is now described. In step 1001, the LDPC decoder 305 initializes log likelihood ratios of coded bits, v, before the first iteration according to the following (and as shown in FIG. 12A):

$$v_{n \to k_i} = u_n, \quad n = 0,1,\ldots,N-1, \quad i = 1,2,\ldots,\deg(bit\ node\ n)$$

Here, $v_{n \to ki}$ denotes the message that goes from bit node n to its adjacent check node k_i,
u_n denotes the demodulator output for the bit n and N is the codeword size.

[0038] In step 1003, a check node, k, is updated, whereby the input v yields the output w. As seen in FIG. 12B, the incoming messages to the check node k from its d_c adjacent bit nodes are denoted by $v_{n1} \to k$, $v_{n2} \to k$,..., $v_{ndc} \to k$. The goal is to compute the outgoing messages from the check node k back to d_c adjacent bit nodes. These messages are denoted by $w_{k \to n_1}$, $w_{k \to n_2}$,..., $w_{k \to n_{dc}}$, where

$$w_{k \to n_i} = g(v_{n_1 \to k}, v_{n_2 \to k}, \ldots, v_{n_{i-1} \to k}, v_{n_{i+1} \to k}, \ldots, v_{n_{dc} \to k}).$$

The function $g(\ )$ is defined as follows:

$$g(a,b) = sign(a) \times sign(b) \times \{\min(|a|, |b|)\} + LUT_g(a,b),$$

where $LUT_g(a,b) = \ln(1+e^{-|a+b|}) - \ln(1+e^{-|a-b|})$. Similar to function , function g with more than two variables can be evaluated recursively.

[0039] Next, the decoder 305, per step 1205, outputs *a posteriori* probability information (FIG. 12C), such that:

$$a_n = u_n + \sum_j w_{k_j \to n}.$$

[0040] Per step 1007, it is determined whether all the parity check equations are satisfied. If these parity check equations are not satisfied, then the decoder 305, as in step 1009, re-derives 8-PSK bit metrics and channel input u_n. Next, the bit node is updated, as in step 1011. As shown in FIG. 14C, the incoming messages to the bit node n from its d_v adjacent check nodes are denoted by $w_{k1 \to n}$, $w_{k2 \to n}$,..., $w_{kdv \to n}$ The outgoing messages from the bit node n are computed back to d_v adjacent check nodes; such messages are denoted by $v_{n \to k1}$, $v_{n \to k2}$,..., $v_{n \to kdv}$, and computed as follows:

$$v_{n \to k_i} = u_n + \sum_{j \neq i} w_{k_j \to n}$$

In step 1013, the decoder 305 outputs the hard decision (in the case that all parity check equations are satisfied):

$$\hat{c}_n = \begin{cases} 0, & a_n \geq 0 \\ 1, & a_n < 0 \end{cases} \qquad \text{Stop if } H\hat{c}^T = 0$$

[0041] The above approach is appropriate when non-Gray labeling is utilized. However, when Gray labeling is implemented, the process of FIG. 11 is executed.

[0042] FIG. 11 is a flow chart of the operation of the LDPC decoder of FIG. 3 using Gray mapping, according to an embodiment of the present invention. When Gray labeling is used, bit metrics are advantageously generated only once before the LDPC decoder, as re-generating bit metrics after every LDPC decoder iteration may yield nominal performance improvement. As with steps 1001 and 1003 of FIG. 10, initialization of the log likelihood ratios of coded bits, *v*, are performed, and the check node is updated, per steps 1101 and 1103. Next, the bit node *n* is updated, as in step 1105. Thereafter, the decoder outputs the *a posteriori* probability information (step 1107). In step 1109, a determination is made whether all of the parity check equations are satisfied; if so, the decoder outputs the hard decision (step 1111). Otherwise, steps 1103-1107 are repeated.

[0043] FIG. 13A is a flowchart of process for computing outgoing messages between the check nodes and the bit nodes using a forward-backward approach, according to an embodiment of the present invention. For a check node with d_c adjacent edges, the computation of $d_c(d_c\text{-}1)$ and numerous $g(.,.)$ functions are performed. However, the forward-backward approach reduces the complexity of the computation to $3(d_c\text{-}2)$, in which $d_c\text{-}1$ variables are stored.

[0044] Referring to FIG. 12B, the incoming messages to the check node *k* from d_c adjacent bit nodes are denoted by $v_{n1\to k}, v_{n2\to k}, \ldots, v_{ndc\to k}$. It is desired that the outgoing messages are computed from the check node *k* back to d_c adjacent bit nodes; these outgoing messages are denoted by $w_{k\text{-}n_1}, w_{k\to n_2}, \ldots, w_{k\to ndc}$.

[0045] Under the forward-backward approach to computing these outgoing messages, forward variables, $f_1, f_2, \ldots, f_{dc}$, are defined as follows:

$$\begin{aligned} f_1 &= v_{1\to k} \\ f_2 &= g(f_1, v_{2\to k}) \\ f_3 &= g(f_2, v_{3\to k}) \\ &\vdots \\ f_{dc} &= g(f_{dc-1}, v_{dc\to k}) \end{aligned}$$

In step 1301, these forward variables are computed, and stored, per step 1303.

[0046] Similarly, backward variables, $b_1, b_2, \ldots, b_{dc}$, are defined by the following:

$$\begin{aligned} b_{dc} &= v_{dc\to k} \\ b_{dc-1} &= g(b_{dc}, v_{dc-1\to k}) \\ &\vdots \\ b_1 &= g(b_2, v_{1\to k}) \end{aligned}$$

In step 1305, these backward variables are then computed. Thereafter, the outgoing messages are computed, as in step 1307, based on the stored forward variables and the computed backward variables. The outgoing messages are computed as follows:

$$w_{k\to 1} = b_2$$

$$w_{k\to i} = g(f_{i-1}, b_{i+1}) \qquad i = 2,3,\ldots,d_c - 1$$

$$w_{k\to dc} = f_{dc-1}$$

[0047] Under this approach, only the forward variables, $f_2, f_3, \ldots, f_{dc}$, are required to be stored. As the backward variables b_i are computed, the outgoing messages, $w_{k\to i}$, are simultaneously computed, thereby negating the need for storage of the backward variables.

[0048] The computation load can be further enhance by a parallel approach, as next discussed.

[0049] FIG. 13B is a flowchart of process for computing outgoing messages between the check nodes and the bit nodes using a parallel approach, according to an embodiment of the present invention. For a check node k with inputs $v_{n_1\to k}, v_{n_2\to k}, \ldots, v_{ndc}\to k$ from d_c adjacent bit nodes, the following parameter is computed, as in step 1311:

$$\gamma_k = g(v_{n_1\to k}, v_{n_2\to k}, \ldots, v_{n_{dc}\to k}).$$

[0050] It is noted that the $g(.,.)$ function can also be expressed as follows:

$$g(a,b) = \ln\frac{1+e^{a+b}}{e^a+e^b}.$$

[0051] Exploiting the recursive nature of the g(.,.) function, the following expression results:

$$\gamma_k = \ln\frac{1+e^{g(v_{n_1\to k},\ldots,v_{n_{i-1}\to k},v_{n_{i+1}\to k},\ldots,v_{n_{dc}\to k})+v_{n_i\to k}}}{e^{g(v_{n_1\to k},\ldots,v_{n_{i-1}\to k},v_{n_{i+1}\to k},\ldots,v_{n_{dc}\to k})}+e^{v_{n_i\to k}}} = \ln\frac{1+e^{w_{k\to n_i}+v_{n_i\to k}}}{e^{w_{k\to n_i}}+e^{v_{n_i\to k}}}$$

[0052] Accordingly, $w_{k\to ni}$ can be solved in the following manner:

$$w_{k\to n_i} = \ln\frac{e^{v_{n_i\to k}+\gamma_k}-1}{e^{v_{n_i\to k}-\gamma_k}-1} - \gamma_k$$

[0053] The ln(.) term of the above equation can be obtained using a look-up table LUT_x that represents the function $\ln|e^x - 1|$ (step 1313). Unlike the other look-up tables LUT_f or LUT_g, the table LUT_x would likely requires as many entries as the number of quantization levels. Once γ_k is obtained, the calculation of $w_{k\to ni}$, for all n_i can occur in parallel using the above equation, per step 1315.

[0054] The computational latency of γ_k is advantageously $\log_2(d_c)$.

[0055] FIGs. 14A-14C are graphs showing simulation results of LDPC codes generated in accordance with various embodiments of the present invention. In particular, FIGs. 14A-14C show the performance of LDPC codes with higher order modulation and code rates of 3/4 (QPSK, 1.485 bits/symbol), 2/3 (8-PSK, 1.980 bits/symbol), and 5/6 (8-PSK, 2.474 bits/symbol).

[0056] Two general approaches exist to realize the interconnections between check nodes and bit nodes: (1) a fully parallel approach, and (2) a partially parallel approach. In fully parallel architecture, all of the nodes and their interconnections are physically implemented The advantage of this architecture is speed.

[0057] The fully parallel architecture, however, may involve greater complexity in realizing all of the nodes and their connections. Therefore with fully parallel architecture, a smaller block size may be required to reduce the complexity. In that case, for the same clock frequency, a proportional reduction in throughput and some degradation in FER versus Es/No performance may result.

[0058] The second approach to implementing LDPC codes is to physically realize only a subset of the total number of the nodes and use only these limited number of "physical" nodes to process all of the "functional" nodes of the code. Even though the LDPC decoder operations can be made extremely simple and can be performed in parallel, the further challenge in the design is how the communication is established between "randomly" distributed bit nodes and check nodes. The decoder 305 (of FIG. 3), according to one embodiment of the present invention, addresses this problem by accessing memory in a structured way, as to realize a seemingly random code. This approach is explained with respect to FIGs. 15A and 15B.

[0059] FIGs. 15A and 15B are diagrams of the top edge and bottom edge, respectively, of memory organized to support structured access as to realize randomness in LDPC coding, according to an embodiment of the present invention.

Structured access can be achieved without compromising the performance of a truly random code by focusing on the generation of the parity check matrix. In general, a parity check matrix can be specified by the connections of the check nodes with the bit nodes. For example, the bit nodes can be divided into groups of a fixed size, which for illustrative purposes is 392. Additionally, assuming the check nodes connected to the first bit node of degree 3, for instance, are numbered as *a, b* and *c*, then the check nodes connected to the second bit node are numbered as *a*+*p, b*+*p* and *c*+*p,* the check nodes connected to the third bit node are numbered as *a*+2*p*, *b*+2*p* and *c*+2*p* etc.; where *p*=(number of check nodes)/392. For the next group of 392 bit nodes, the check nodes connected to the first bit node are different from *a, b, c* so that with a suitable choice of *p,* all the check nodes have the same degree. A random search is performed over the free constants such that the resulting LDPC code is cycle-4 and cycle-6 free. Because of the structural characteristics of the parity check matrix of the present invention, the edge information can stored to permit concurrent access to a group of relevant edge values during decoding.

[0060] In other words, the approach of the present invention facilitates memory access during check node and bit node processing. The values of the edges in the bipartite graph can be stored in a storage medium, such as random access memory (RAM). It is noted that for a truly random LDPC code during check node and bit node processing, the values of the edges would need to be accessed one by one in a random fashion. However, such a conventional access scheme would be too slow for a high data rate application. The RAM of FIGs. 15A and 15B are organized in a manner, whereby a large group of relevant edges can be fetched in one clock cycle; accordingly, these values are placed "together" in memory, according to a predetermined scheme or arrangement. It is observed that, in actuality, even with a truly random code, for a group of check nodes (and respectively bit nodes), the relevant edges can be placed next to one another in RAM, but then the relevant edges adjacent to a group of bit nodes (respectively check nodes) will be randomly scattered in RAM. Therefore, the "togetherness," under the present invention, stems from the design of the parity check matrices themselves. That is, the check matrix design ensures that the relevant edges for a group of bit nodes and check nodes are simultaneously placed together in RAM.

[0061] As seen in FIGs. 15A and 15B, each box contains the value of an edge, which is multiple bits (e.g., 6). Edge RAM, according to one embodiment of the present invention, is divided into two parts: top edge RAM 1501 (FIG. 15A) and bottom edge RAM 1503 (FIG. 15B). Bottom edge RAM 1503 contains the edges between bit nodes of degree 2, for example, and check nodes. Top edge RAM 1501 contains the edges between bit nodes of degree greater than 2 and check nodes. Therefore, for every check node, 2 adjacent edges are stored in the bottom edge RAM 1503, and the rest of the edges are stored in the top edge RAM 1501. For example, the size of the top edge RAM 1501 and bottom edge RAM 1503 for various code rates are given in Table 1

Table 1

	1/2	2/3	3/4	5/6
Top Edge RAM	400 x 392	440 x 392	504 x 392	520 x 392
Bottom Edge RAM	160 x 392	110 x 392	72 x 392	52 x 392

[0062] Based on Table 1, an edge RAM of size 576 x 392 is sufficient to store the edge metrics for all the code rates of 1/2, 2/3, 3/4, and 5/6.

[0063] As noted, under this exemplary scenario, a group of 392 bit nodes and 392 check nodes are selected for processing at a time. For 392 check node processing, $q = d_c$-2 consecutive rows are accessed from the top edge RAM 1501, and 2 consecutive rows from the bottom edge RAM 1503. The value of d_c depends on the specific code, for example d_c=7 for rate ½, *dc*=10 for rate 2/3, *dc*=16 for rate ¾ and d_c=*22* for rate 5/6 for the above codes. Of course other values of d_c for other codes are possible. In this instance, *q*+2 is the degree of each check node.

[0064] For bit node processing, if the group of 392 bit nodes has degree 2, their edges are located in 2 consecutive rows of the bottom edge RAM 1503. If the bit nodes have degree *d* > 2, their edges are located in some *d* rows of the top edge RAM 1501. The address of these *d* rows can be stored in non-volatile memory, such as Read-Only Memory (ROM). The edges in one of the rows correspond to the first edges of 392 bit nodes, the edges in another row correspond to the second edges of 392 bit nodes, etc. Moreover for each row, the column index of the edge that belongs to the first bit node in the group of 392 can also be stored in ROM. The edges that correspond to the second, third, etc. bit nodes follow the starting column index in a "wrapped around" fashion. For example, if the j^{th} edge in the row belongs to the first bit node, then the (*j*+1)st edge belongs to the second bit node, (*j*+2)nd edge belongs to the third bit node, ..., and (*j*-1)st edge belongs to the 392^{th} bit node.

[0065] In Tables 2-5, the row index and the starting column index of top edge RAM 1501 are specified for every group of 392 bit nodes of degree 3 or larger, for the respective code rates of 2/3; 5/6, 1/2, and 3/4. Each row in the Tables 2-5 represents a group of 392 bit nodes. The first number denotes the row index and the second number denotes the starting column index. For example in Table 2, the first row completely determines the addresses of adjacent edges for the first

group of 392 bit nodes of degree 13. Specifically, the entry 0/0 indicates that the first adjacent edges for all of the 392 bit nodes are stored in row number 0. Moreover in that row, the column indexed 0 carries the information for the first adjacent edge of the first bit node, column indexed 1 carries the information for the first adjacent edge of the second bit node etc., and finally column indexed 391 carries the information for the first adjacent edge of the 392th bit node.

[0066] Similarly the entry 433/323 specifies that the second adjacent edges for all of the 392 bit nodes are stored in row number 433. Moreover in that row, the column indexed 323 carries the information for the second adjacent edge of the first bit node, column indexed 324 carries the information for the second adjacent edge of the second bit node etc. The column indexed 322 carries the information for the second adjacent edge of the 392th bit node.

[0067] Similarly, other entries in the first row of Table 2 determine the addresses of the remaining adjacent edges for the first group of 392 bit nodes. Likewise, the entries in the second row of Table 2 determine the addresses of the adjacent edges for the second group of 392 bit nodes, etc.

Table 2

Row Index/Starting Column Index (Rate 2/3)
0/0 433/323 242/150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/280 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/275 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/21 419/219 427/378 395/10 347/167 68/221 260/310 396/54 308/268 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/264 194/335 131/362 403/326 315/180 275/137 203/86 2041303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 27/109 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23
296/0 385/42 210/267
304/0 17/7 258/227

(continued)

Row Index/Starting Column Index (Rate 2/3)
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118
376/0 369/228 370/202
384/0 225/71 74/136
392/0 1/314 346/289
400/0 353/286 322/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
77/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/87
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262
189/0 94/239 271/38
197/0 198/207 231/297
205/0 22/32 167/205
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
245/0 150/340 359/100
253/0 294/75 415/189
261/0 222/321 391/78

(continued)

Row Index/Starting Column Index (Rate 2/3)
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/256 103/242
325/0 278/22 7/154
333/0 342/192 423/330
341/0 14/181 431/16
349/0 38/367 383/16
357/0 270/91 223/195
365/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 295/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Table 3

Row Index/Starting Column Index (Rate 5/6)
0/0 221/158 442/14 503/323 283/150 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/285 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/58 206/72 166/26 87/302 7/362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 285/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 267/362
120/0 61/31 502/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 487/264
160/0 441/191 382/360 423/282 203/2 84/58 64/347 425/249 5/267 466/232 46/275 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/259 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126
420/0 81/202 202/206
440/0 481/156 242/263

(continued)

Row Index/Starting Column Index (Rate 5/6)
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101
108/0 309/208 510/162
128/0 349/147 330/242
148/0 29/263 490/54
168/0 69/312 250/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 389/160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 232/219 193/30
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
351/0 132/155 493/50
371/0 512/292 453/214
391/0 172/387 53/114

(continued)

Row Index/Starting Column Index (Rate 5/6)
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287
54/0 115/137 196/57
74/0 95/161 416/206
94/0 295/273 336/209
114/0 255/184 296/287
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386
217/0 498/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188
317/0 518/249 399/229
337/0 278/333 279/330

(continued)

Row Index/Starting Column Index (Rate 5/6)
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/158
437/0 358/377 259/364
457/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26
517/0 198/115 39/342

Table 4

Row Index/Starting Column Index (Rate 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/277 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263
305/0 46/232 282/193 293/175 378/349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 142/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 259/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/54 303/391 153/132 254/145 209/307 74/126
370/0 91/25 382/139 238/269 128/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1
10/0 86/124 267/2
15/0 321/291 197/8

(continued)

Row Index/Starting Column Index (Rate 1/2)
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181/73 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 357/107
145/0 271/218 207/370
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84
230/0 351/11 17/303
235/0 231/55 117/265

Table 5

Row Index/Starting Column Index (Rate 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/20 467/48 243/275 370/284 356/114 77/201 7/214

(continued)

Row Index/Starting Column Index (Rate 3/4)
14/0 29/350 44/366 185/335 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178
182/0 43/340 212/289 381/152 115/273 172/111 368/2 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114157
336/0 85/227 282/298
350/0 491/101 324/74
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189
176/0 93/332 94/299
190/0 163/385 416/307

(continued)

Row Index/Starting Column Index (Rate 3/4)
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/26
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191/240 234/244
358/0 9/13 248/94
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/281
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296
53/0 320/345 111/194
67/0 208/221 13/84
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/257
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44
361/0 376/295 97/70
375/0 124/166 69/108

(continued)

Row Index/Starting Column Index (Rate 3/4)
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/264
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320
487/0 278/80 307/248
501/0 152/153 363/334

[0068] With the organization shown in FIGs. 15A and 15B, speed of memory access is greatly enhanced during LDPC coding.

[0069] FIG. 16 illustrates a computer system upon which an embodiment according to the present invention can be implemented. The computer system 1600 includes a bus 1601 or other communication mechanism for communicating information, and a processor 1603 coupled to the bus 1601 for processing information. The computer system 1600 also includes main memory 1605, such as a random access memory (RAM) or other dynamic storage device, coupled to the bus 1601 for storing information and instructions to be executed by the processor 1603. Main memory 1605 can also be used for storing temporary variables or other intermediate information during execution of instructions to be executed by the processor 1603. The computer system 1600 further includes a read only memory (ROM) 1607 or other static storage device coupled to the bus 1601 for storing static information and instructions for the processor 1603. A storage device 1609, such as a magnetic disk or optical disk, is additionally coupled to the bus 1601 for storing information and instructions.

[0070] The computer system 1600 may be coupled via the bus 1601 to a display 1611, such as a cathode ray tube (CRT), liquid crystal display, active matrix display, or plasma display, for displaying information to a computer user. An input device 1613, such as a keyboard including alphanumeric and other keys, is coupled to the bus 1601 for communicating information and command selections to the processor 1603. Another type of user input device is cursor control 1615, such as a mouse, a trackball, or cursor direction keys for communicating direction information and command selections to the processor 1603 and for controlling cursor movement on the display 1611.

[0071] According to one embodiment of the invention, generation of LDPC codes is provided by the computer system 1600 in response to the processor 1603 executing an arrangement of instructions contained in main memory 1605. Such instructions can be read into main memory 1605 from another computer-readable medium, such as the storage device 1609. Execution of the arrangement of instructions contained in main memory 1605 causes the processor 1603 to perform the process steps described herein. One or more processors in a multi-processing arrangement may also be employed to execute the instructions contained in main memory 1605. In alternative embodiments, hard-wired circuitry may be used in place of or in combination with software instructions to implement the embodiment of the present invention. Thus, embodiments of the present invention are not limited to any specific combination of hardware circuitry and software.

[0072] The computer system 1600 also includes a communication interface 1617 coupled to bus 1601. The communication interface 1617 provides a two-way data communication coupling to a network link 1619 connected to a local network 1621. For example, the communication interface 1617 may be a digital subscriber line (DSL) card or modem, an integrated services digital network (ISDN) card, a cable modem, or a telephone modem to provide a data communication connection to a corresponding type of telephone line. As another example, communication interface 1617 may be a local area network (LAN) card (e.g. for Ethernet™ or an Asynchronous Transfer Model (ATM) network) to provide a data communication connection to a compatible LAN. Wireless links can also be implemented. In any such implementation, communication interface 1617 sends and receives electrical, electromagnetic, or optical signals that carry digital data streams representing various types of information. Further, the communication interface 1617 can include peripheral interface devices, such as a Universal Serial Bus (USB) interface, a PCMCIA (Personal Computer Memory Card International Association) interface, etc.

[0073] The network link 1619 typically provides data communication through one or more networks to other data devices. For example, the network link 1619 may provide a connection through local network 1621 to a host computer 1623, which has connectivity to a network 1625 (e.g. a wide area network (WAN) or the global packet data communication network now commonly referred to as the "Internet") or to data equipment operated by service provider. The local network 1621 and network 1625 both use electrical, electromagnetic, or optical signals to convey information and instructions. The signals through the various networks and the signals on network link 1619 and through communication interface

1617, which communicate digital data with computer system 1600, are exemplary forms of carrier waves bearing the information and instructions.

[0074] The computer system 1600 can send messages and receive data, including program code, through the network(s), network link 1619, and communication interface 1617. In the Internet example, a server (not shown) might transmit requested code belonging to an application program for implementing an embodiment of the present invention through the network 1625, local network 1621 and communication interface 1617. The processor 1603 may execute the transmitted code while being received and/or store the code in storage device 169, or other non-volatile storage for later execution. In this manner, computer system 1600 may obtain application code in the form of a carrier wave.

[0075] The term "computer-readable medium" as used herein refers to any medium that participates in providing instructions to the processor 1603 for execution. Such a medium may take many forms, including but not limited to non-volatile media, volatile media, and transmission media. Non-volatile media include, for example, optical or magnetic disks, such as storage device 1609. Volatile media include dynamic memory, such as main memory 1605. Transmission media include coaxial cables, copper wire and fiber optics, including the wires that comprise bus 1601. Transmission media can also take the form of acoustic, optical, or electromagnetic waves, such as those generated during radio frequency (RF) and infrared (IR) data communications. Common forms of computer-readable media include, for example, a floppy disk, a flexible disk, hard disk, magnetic tape, any other magnetic medium, a CD-ROM, CDRW, DVD, any other optical medium, punch cards, paper tape, optical mark sheets, any other physical medium with patterns of holes or other optically recognizable indicia, a RAM, a PROM, and EPROM, a FLASH-EPROM, any other memory chip or cartridge, a carrier wave, or any other medium from which a computer can read.

[0076] Various forms of computer-readable media may be involved in providing instructions to a processor for execution. For example, the instructions for carrying out at least part of the present invention may initially be borne on a magnetic disk of a remote computer. In such a scenario, the remote computer loads the instructions into main memory and sends the instructions over a telephone line using a modem. A modem of a local computer system receives the data on the telephone line and uses an infrared transmitter to convert the data to an infrared signal and transmit the infrared signal to a portable computing device, such as a personal digital assistance (PDA) and a laptop. An infrared detector on the portable computing device receives the information and instructions borne by the infrared signal and places the data on a bus. The bus conveys the data to main memory, from which a processor retrieves and executes the instructions. The instructions received by main memory may optionally be stored on storage device either before or after execution by processor.

[0077] Accordingly, the various embodiments of the present invention provide an approach for generating structured Low Density Parity Check (LDPC) codes, as to simplify the encoder and decoder. Structure of the LDPC codes is provided by restricting the parity check matrix to be lower triangular. Also, the approach can advantageously exploit the unequal error protecting capability of LDPC codes on transmitted bits to provide extra error protection to more vulnerable bits of high order modulation constellations (such as 8-PSK (Phase Shift Keying)). The decoding process involves iteratively regenerating signal constellation bit metrics into an LDPC decoder after each decoder iteration or several decoder iterations. The above approach advantageously yields reduced complexity without sacrificing performance.

[0078] While the present invention has been described in connection with a number of embodiments and implementations, the present invention is not so limited but covers various obvious modifications and equivalent arrangements, which fall within the scope of the appended claims.

Claims

1. A method for processing a low density parity check (LDPC) coded signal, the method comprising:

generating an LDPC encoded signal using a structured parity check matrix specifying the connection of bit nodes to check nodes;
transmitting the LDPC encoded signal across a communication channel to a receiver;
receiving the LDPC encoded signal at the receiver;
retrieving, from memory in the receiver, edge values associated with the structured parity check matrix used to generate the LDPC coded signal,
outputting a decoded signal corresponding to the LDPC coded signal based on the retrieved edge values,
wherein the edge values specify a relationship of bit nodes and check nodes,
wherein the bit nodes are divided into groups of 392,
wherein the edge values in the retrieving step are stored in memory (1501, 1503) according to a predetermined scheme **characterised in that** the memory comprises top edge RAM and bottom edge RAM,
wherein the bottom edge RAM stores the edge values for bit nodes of degree two,
wherein the top edge RAM stores the edge values for bit nodes of degree greater than two,

wherein storage of edge values in the top edge RAM is defined by one of tables 1-4 below,
wherein each successive row of each table denotes the row indices and staring column indices for corresponding successive groups of 392 bit nodes for a particular LDPC encoding scheme having the code rate stated in the title of each table,
wherein a first number at each table location in each table denotes a row index for storage of edge values in the top edge RAM and a second number at each table location denotes a starting column index for storage of edge values in the top edge RAM of successive bit nodes in a corresponding group of bit nodes,
wherein successive table locations in each row denote the row and column indices for corresponding successive edge values for said corresponding group of bit nodes,
such that a group of 392 bit nodes and 392 check nodes can be selected for processing at one time,
wherein for bit node processing, in the retrieving step, for a group of bit nodes of degree two, two consecutive rows of bottom edge RAM are accessed, and, for a group of bit nodes of degree, d, greater than two, the edge values are obtained from d rows of top edge RAM,
wherein for check node processing, in the retrieving step, q consecutive rows are accessed from top edge RAM and two consecutive rows are accessed from bottom edge RAM,
wherein $q=d_c-2$, wherein d_c is the degree of the check nodes dependent on the predetermined scheme, wherein $d_c=7$ for code rate ½, dc=10 for code rate $^2/_3$, d_c 16 for code rate ¾ and dc=22 for code rate $^5/_6$,
wherein the tables 1-4 are as follows:-

Table 1

Row Index/Starting Column Index (Rate 2/3)
0/0 433/323 242/150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/280 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/275 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/21 419/219 427/378 395/10 347/167 68/221 260/310 396/54 308/268 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/264 194/335 131/362 403/326 315/180 275/137 203/86 204/303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 27/109 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289

(continued)

Row Index/Starting Column Index (Rate 2/3)
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23
296/0 385/42 210/267
304/0 17/7 258/227
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118
376/0 369/228 370/202
384/0 225/71 74/136
392/0 1/314 346/289
400/0 353/286 322/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
77/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/87
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262
189/0 94/239 271/38
197/0 198/207 231/297
205/0 22/32 167/205

(continued)

Row Index/Starting Column Index (Rate 2/3)
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
245/0 150/340 359/100
253/0 294/75 415/189
261/0 222/321 391/78
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/256 103/242
325/0 278/22 7/154
333/0 342/192 423/330
341/0 14/181 431/16
349/0 38/367 383/16
357/0 270/91 223/195
365/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 295/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Table 2

Row Index/Starting Column Index (Rate 5/6)
0/0 221/158 442/14 503/323 283/150 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/285 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/58 206/72 166/26 87/302 7/362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 285/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 267/362
120/0 61/31 502/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 487/264
160/0 441/191 382/360 423/282 203/2 84/58 64/347 425/249 5/267 466/232 46/275 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/259 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147

(continued)

Row Index/Starting Column Index (Rate 5/6)
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126
420/0 81/202 202/206
440/0 481/156 242/263
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101
108/0 309/208 510/162
128/0 349/147 330/242
148/0 29/263 490/54
168/0 69/312 250/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 389/160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 232/219 193/30
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88

(continued)

Row Index/Starting Column Index (Rate 5/6)
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
351/0 132/155 493/50
371/0 512/292 453/214
391/0 172/387 53/114
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287
54/0 115/137 196/57
74/0 95/161 416/206
94/0 295/273 336/209
114/0 255/184 296/287
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386

(continued)

Row Index/Starting Column Index (Rate 5/6)
217/0 498/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188
317/0 518/249 399/229
337/0 278/333 279/330
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/158
437/0 358/377 259/364
457/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26
517/0 198/115 39/342

Table 3

Row Index/Starting Column Index (Rate 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/277 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263
305/0 46/232 282/193 293/175 378/349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 142/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 259/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/54 303/391 153/132 254/145 209/307 74/126
370/0 91/25 382/139 238/269 128/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335

(continued)

Row Index/Starting Column Index (Rate 1/2)
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1
10/0 86/124 267/2
15/0 321/291 197/8
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181/73 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 357/107
145/0 271/218 207/370
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84

(continued)

Row Index/Starting Column Index (Rate 1/2)
230/0 351/11 17/303
235/0 231/55 117/265

Table 4

Row Index/Starting Column Index (Rate 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/20 467/48 243/275 370/284 356/114 77/201 7/214
14/0 29/350 44/366 185/335 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178
182/0 43/340 212/289 381/152 115/273 172/111 368/2 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114/57
336/0 85/227 282/298
350/0 491/101 324/74
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255

(continued)

Row Index/Starting Column Index (Rate 3/4)
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189
176/0 93/332 94/299
190/0 163/385 416/307
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/26
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191/240 234/244
358/0 9/13 248/94
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/281
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296
53/0 320/345 111/194
67/0 208/221 13/84
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/257
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201

(continued)

Row Index/Starting Column Index (Rate 3/4)
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44
361/0 376/295 97/70
375/0 124/166 69/108
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/264
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320
487/0 278/80 307/248
501/0 152/153 363/334

2. A system for processing a low density parity check (LDPC) coded signal, comprising:

an encoder for generating an LDPC encoded signal using a structured parity check matrix specifying the connection of bit nodes to check nodes and transmitting the LDPC encoded signal across a communication channel to a receiver

a receiver for receiving the LDPC encoded signal and comprising a decoder comprising:

memory (1501, 1503) for storing edge values associated with the structured parity check matrix used to generate the LDPC coded signal specifying a relationship of bit nodes and check nodes, wherein the bit nodes are divided into groups of 392;

means for retrieving edge values from the memory (1501, 1503); and

means for outputting a decoded signal corresponding to the LDPC coded signal based on the retrieved edge values, wherein the edge values are stored in memory according to a predetermined scheme **characterised in that** the memory comprises top edge RAM and bottom edge RAM,

wherein the bottom edge RAM stores the edge values for bit nodes of degree two,

wherein the top edge RAM stores the edge values for bit nodes of degree greater than two,

wherein storage of edge values in the top edge RAM is defined by one of tables 104 below,

wherein each successive row of each table denotes the row indices and staring column indices for corresponding successive groups of 392 bit nodes for a particular LDPC encoding scheme having the code rate stated in the title of each table,

wherein a first number at each table location in each table denotes a row index for storage of edge values in the top edge RAM and a second number at each table location denotes a starting column index for storage of edge values in the top edge RAM of successive bit nodes in a corresponding group of bit nodes,

wherein successive table locations in each row denote the row and column indices for corresponding successive edge values for said corresponding group of bit nodes,

such that a group of 392 bit nodes and 392 check nodes can be selected for processing at one time,

wherein for bit node processing, in the retrieving step, for a group of bit nodes of degree two, two consecutive rows of bottom edge RAM are accessed, and, for a group of bit nodes of degree, d, greater than two, the edge values are obtained from d rows of top edge RAM,

wherein for check node processing, in the retrieving step, q consecutive rows are accessed from top edge RAM and two consecutive rows are accessed from bottom edge RAM,

wherein $q = d_c - 2$, wherein d_c is the degree of the check nodes dependent on the predetermined scheme, wherein d_c=7 for code rate ½, d_c=10 for code rate ¾, d_c=16 for code rate ¾ and d_c=22 for code rate 5/6,

wherein the tables 1-4 are as follows:-

Table 1

Row Index/Starting Column Index (Rate 2/3)
0/0 433/323 242/150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/280 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/275 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/21 419/219 427/378 395/10 347/167 68/221 260/310 396/54 308/268 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/264 194/335 131/362 403/326 315/180 275/137 203/86 204/303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 27/109 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23
296/0 385/42 210/267
304/0 17/7 258/227
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118
376/0 369/228 370/202
384/0 225/71 74/136

(continued)

Row Index/Starting Column Index (Rate 2/3)
392/0 1/314 346/289
400/0 353/286 322/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
77/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/87
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262
189/0 94/239 271/38
197/0 198/207 231/297
205/0 22/32 167/205
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
245/0 150/340 359/100
253/0 294/75 415/189
261/0 222/321 391/78
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/256 103/242
325/0 278/22 7/154
333/0 342/192 423/330
341/0 14/181 431/16

(continued)

Row Index/Starting Column Index (Rate 2/3)
349/0 38/367 383/16
357/0 270/91 223/195
365/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 295/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Table 2

Row Index/Starting Column Index (Rate 5/6)
0/0 221/158 442/14 503/323 283/150 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/285 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/58 206/72 166/26 87/302 7/362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 285/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 267/362
120/0 61/31 502/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 487/264
160/0 441/191 382/360 423/282 203/2 84/58 64/347 425/249 5/267 466/232 46/275 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/259 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126
420/0 81/202 202/206
440/0 481/156 242/263
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101
108/0 309/208 510/162
128/0 349/147 330/242

(continued)

Row Index/Starting Column Index (Rate 5/6)
148/0 29/263 490/54
168/0 69/312 250/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 389/160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 232/219 193/30
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
351/0 132/155 493/50
371/0 512/292 453/214
391/0 172/387 53/114
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287
54/0 115/137 196/57
74/0 95/161 416/206

(continued)

Row Index/Starting Column Index (Rate 5/6)
94/0 295/273 336/209
114/0 255/184 296/287
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386
217/0 498/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188
317/0 518/249 399/229
337/0 278/333 279/330
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/158
437/0 358/377 259/364
457/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26
517/0 198/115 39/342

Table 3

Row Index/Starting Column Index (Rate 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/277 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263
305/0 46/232 282/193 293/175 378/349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 142/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 259/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/54 303/391 153/132 254/145 209/307 74/126
370/0 91/25 382/139 238/269 128/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1
10/0 86/124 267/2
15/0 321/291 197/8
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105

(continued)

Row Index/Starting Column Index (Rate 1/2)
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181/73 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 357/107
145/0 271/218 207/370
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84
230/0 351/11 17/303
235/0 231/55 117/265

Table 4

Row Index/Starting Column Index (Rate 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/20 467/48 243/275 370/284 356/114 77/201 7/214
14/0 29/350 44/366 185/335 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178

(continued)

Row Index/Starting Column Index (Rate 3/4)
182/0 43/340 212/289 381/152 115/273 172/111 368/2 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114/57
336/0 85/227 282/298
350/0 491/101 324/74
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189
176/0 93/332 94/299
190/0 163/385 416/307
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/26
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191/240 234/244
358/0 9/13 248/94

(continued)

Row Index/Starting Column Index (Rate 3/4)
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/281
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296
53/0 320/345 111/194
67/0 208/221 13/84
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/257
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44
361/0 376/295 97/70
375/0 124/166 69/108
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/264
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320
487/0 278/80 307/248
501/0 152/153 363/334

Patentansprüche

1. Verfahren zum Verarbeiten eines mit Low Density Parity Check bzw. LDPC codierten Signals, wobei das Verfahren die folgenden Schritte umfasst:

Erzeugen eines LDPC-codierten Signals unter Verwendung einer strukturierten Paritätsprüfmatrix, die die Verbindung von Bitknoten mit Prüfknoten spezifiziert;
Übertragen des LDPC-codierten Signals über einen Kommunikationskanal zu einem Empfänger;
Empfangen des LDPC-codierten Signals im Empfänger;
Abrufen von Kantenwerten, die mit der zum Erzeugen des LDPC-codierten Signals verwendeten strukturierten Paritätsprüfmatrix assoziiert sind, aus Speicher in dem Empfänger,
Ausgeben eines dem LDPC-codierten Signal entsprechenden decodierten Signals auf der Basis der abgerufenen Kantenwerte,
wobei die Kantenwerte eine Beziehung von Bitknoten und Prüfknoten spezifizieren,
wobei die Bitknoten in Gruppen von 392 unterteilt sind,
wobei die Kantenwerte in dem Abrufschritt gemäß einem vorbestimmten Schema in Speicher (1501, 1503) gespeichert werden, **dadurch gekennzeichnet, dass** der Speicher einen Oberkanten-RAM und einen Unterkanten-RAM umfasst,
wobei der Unterkanten-RAM die Kantenwerte für Bitknoten des Grads zwei speichert,
wobei der Oberkanten-RAM die Kantenwerte für Bitknoten des Grads größer als zwei speichert,
wobei Speicherung von Kantenwerten in dem Oberkanten-RAM durch eine der nachfolgenden Tabellen 1-4 definiert wird,
wobei jede sukzessive Zeile jeder Tabelle die Zeilenindizes und Startspaltenindizes für entsprechende sukzessive Gruppen von 392 Bitknoten für ein bestimmtes LDPC-Codierungsschema bezeichnet, das die in dem Titel jeder Tabelle angegebene Coderate aufweist,
wobei eine erste Zahl an jeder Tabellenstelle in jeder Tabelle einen Zeilenindex zur Speicherung von Kantenwerten in dem Oberkanten-RAM bezeichnet und eine zweite Zahl an jeder Tabellenstelle einen Startspaltenindex zur Speicherung von Kantenwerten in dem Oberkanten-RAM sukzessiver Bitknoten in einer entsprechenden Gruppe von Bitknoten bezeichnet,
wobei sukzessive Tabellenstellen in jeder Zeile die Zeilen- und Spaltenindizes für entsprechende sukzessive Kantenwerte für die entsprechende Gruppe von Bitknoten bezeichnen,
dergestalt, dass zu einem Zeitpunkt eine Gruppe von 392 Bitknoten und 392 Prüfknoten für Verarbeitung ausgewählt werden kann,
wobei für die Bitknotenverarbeitung in dem Abrufschritt für eine Gruppe von Bitknoten des Grads 2 auf 2 aufeinanderfolgende Zeilen des Unterkanten-RAM zugegriffen wird und für eine Gruppe von Bitknoten des Grads d größer als zwei die Kantenwerte aus d Zeilen des Oberkanten-RAM erhalten werden,
wobei zur Prüfknotenverarbeitung in dem Abrufschritt auf q aufeinanderfolgende Zeilen aus dem Oberkanten-RAM zugegriffen wird und auf zwei aufeinanderfolgende Zeilen aus dem Unterkanten-RAM zugegriffen wird,
wobei $q=d_c-2$ ist, wobei d_c der Grad der Prüfknoten abhängig von dem vorbestimmten Schema ist, mit $d_c=7$ für Coderate ½, $d_c=10$ für Coderate 2/3, $d_c=16$ für Coderate ¾ und $d_c=22$ für Coderate $^5/_6$,
wobei die Tabellen 1-4 wie folgt sind:

Tabelle 1

Zeilenindex/Startspaltenindex (Rate 2/3)
0/0 433/323 2421150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/180 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/275 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/21 419/219 427/378 395/10 347/167 68/221 260/310 396/54 308/168 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/264 194/335 131/362 403/326 315/180 275/137 203/86 204/303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 271/09 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 2/3)
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23
296/0 385/42 210/267
304/0 17/7 258/227
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118
376/0 369/228 370/202
384/0 225/71 74/136
392/0 1/314 346/289
400/0 353/286 327/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 2/3)
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
71/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/97
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262
189/0 94/239 271/38
197/0 198/207 231/297
205/0 22/32 167/205
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
243/0 150/340 359/100
253/0 294/75 415/189
261/0 222/321 391/78
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/256 103/242
325/0 278/22 7/154
333/0 342/192 423/330
341/0 14/181 431/16
349/0 38/367 383/16
357/0 270/91 223/195
365/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 295/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Tabelle 2

Zeilenindex/Startspaltenindex (Rate 5/6)
0/0 221/158 442/14 503/323 283/130 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/285 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/58 206/72 166/26 87/302 7/362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 285/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 2671362
120/0 61/31 302/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 497/264
160/0 441/191 382/360 423/282 203/2 84/58 64/347 425/249 5/267 466/232 46/175 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/259 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126
420/0 81/202 202/206
440/0 481/156 242/263
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101
108/0 309/208 510/162
128/0 349/147 330/242
148/0 29/263 490/54
168/0 69/312 230/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 3891160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 5/6)
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 237/219 193/30
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
331/0 132/155 493/50
371/0 512/292 453/214
391/0 172/387 53/114
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287
54/0 115/137 196/57
74/0 95/161 416/206
94/0 295/273 336/209
114/0 255/184 296/287
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 5/6)
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386
217/0 499/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188
317/0 518/249 399/229
337/0 278/333 279/330
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/138
437/0 358/377 259/364
457/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26
517/0 198/115 39/342

Tabelle 3

Zeilenindex/Startspaltenindex (Rate 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/277 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 1/2)
305/0 46/232 282/193 293/175 378/349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 112/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 259/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/34 303/391 153/132 254/145 209/307 74/126
370/0 91/25 382/139 238/269 128/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1
10/0 86/124 267/2
15/0 321/291 197/8
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181173 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 357/107
145/0 271/218 207/370

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 1/2)
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84
230/0 351/11 17/303
235/0 231/55 117/265

Tabelle 4

Zeilenindex/Startspaltenindex (Rate 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/20 467/48 243/275 370/284 356/114 77/201 7/214
14/0 29/350 44/366 185/335 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178
182/0 43/340 212/289 381/152 115/273 172/111 368/2 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114/57
336/0 85/227 282/298
350/0 491/101 324/74

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 3/4)
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189
176/0 93/332 94/299
190/0 163/385 416/307
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/26
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191/240 234/244
358/0 9/13 248/94
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/281
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 3/4)
53/0 320/345 111/194
67/0 208/221 13/84
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/257
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44
361/0 376/295 97/70
375/0 124/166 69/108
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/264
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320
487/0 278/80 307/248
501/0 152/153 363/334

2. System zum Verarbeiten eines mit Low Density Parity Check bzw. LDPC codierten Signals, umfassend:

einen Codierer zum Erzeugen eines LDPC-codierten Signals unter Verwendung einer strukturierten Paritätsprüfmatrix, die die Verbindung von Bitknoten mit Prüfknoten spezifiziert, und Übertragen des LDPC-codierten Signals über einen Kommunikationskanal zu einem Empfänger,
einen Empfänger zum Empfangen des LDPC-codierten Signals und mit einem Decoder, umfassend:

Speicher (1501, 1503) zum Speichern von Kantenwerten, die mit der strukturierten Paritätsprüfmatrix assoziiert sind, die zum Erzeugen des LDPC-codierten Signals verwendet wird, die eine Beziehung von Bitknoten und Prüfknoten spezifizieren, wobei die Bitknoten in Gruppen von 392 unterteilt sind;
Mittel zum Abrufen von Kantenwerten aus dem Speicher (1501, 1503); und
Mittel zum Ausgeben eines dem LDPC-codierten Signal entsprechenden decodierten Signals auf der Basis der abgerufenen Kantenwerte, wobei die Kantenwerte in Speicher gemäß einem vorbestimmten Schema gespeichert werden, **dadurch gekennzeichnet, dass** der Speicher Oberkanten-RAM und Unterkanten-RAM umfasst,
wobei der Unterkanten-RAM die Kantenwerte für Bitknoten des Grads zwei speichert,
wobei der Oberkanten-RAM die Kantenwerte für Bitknoten des Grads größer als zwei speichert,

wobei Speicherung von Kantenwerten in dem Oberkanten-RAM durch eine der nachfolgenden Tabellen 1-4 definiert wird,
wobei jede sukzessive Zeile jeder Tabelle die Zeilenindizes und Startspaltenindizes für entsprechende sukzessive Gruppen von 392 Bitknoten für ein bestimmtes LDPC-Codierungsschema bezeichnet, das die in dem Titel jeder Tabelle angegebene Coderate aufweist,
wobei eine erste Zahl an jeder Tabellenstelle in jeder Tabelle einen Zeilenindex zur Speicherung von Kantenwerten in dem Oberkanten-RAM bezeichnet und eine zweite Zahl an jeder Tabellenstelle einen Startspaltenindex zur Speicherung von Kantenwerten in dem Oberkanten-RAM sukzessiver Bitknoten in einer entsprechenden Gruppe von Bitknoten bezeichnet,
wobei sukzessive Tabellenstellen in jeder Zeile die Zeilen- und Spaltenindizes für entsprechende sukzessive Kantenwerte für die entsprechende Gruppe von Bitknoten bezeichnen,
dergestalt, dass zu einem Zeitpunkt eine Gruppe von 392 Bitknoten und 392 Prüfknoten für Verarbeitung ausgewählt werden kann,
wobei für die Bitknotenverarbeitung in dem Abrufschritt für eine Gruppe von Bitknoten des Grads 2 auf 2 aufeinanderfolgende Zeilen des Unterkanten-RAM zugegriffen wird und für eine Gruppe von Bitknoten des Grads d größer als zwei die Kantenwerte aus d Zeilen des Oberkanten-RAM erhalten werden,
wobei zur Prüfknotenverarbeitung in dem Abrufschritt auf q aufeinanderfolgende Zeilen aus dem Oberkanten-RAM zugegriffen wird und auf zwei aufeinanderfolgende Zeilen aus dem Unterkanten-RAM zugegriffen wird,
wobei $q=d_c-2$ ist, wobei d_c der Grad der Prüfknoten abhängig von dem vorbestimmten Schema ist, mit $d_c=7$ für Coderate ½, $d_c=10$ für Coderate 2/3, $d_c=16$ für Coderate ¾ und $d_c=22$ für Coderate 5/6,
wobei die Tabellen 1-4 wie folgt sind:

Tabelle 1

Zeilenindex/Startspaltenindex (Rate 2/3)
0/0 433/323 242/150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/280 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/275 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/21 419/219 427/378 395/10 347/167 68/221 260/310 396/54 308/268 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/264 194/335 131/362 403/326 315/180 275/137 203/86 204/303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 27/109 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 2/3)
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23
296/0 385/42 210/267
304/0 17/7 258/227
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118
376/0 369/228 370/202
384/0 225/71 74/136
392/0 1/314 346/289
400/0 353/286 322/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
77/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/87
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 2/3)
189/0 94/239 271/38
197/0 198/207 131/297
205/0 22/32 167/205
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
245/0 150/340 359/100
253/0 294/75 415/189
261/0 222/321 391/78
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/256 103/242
325/0 278/22 7/154
333/0 342/192 423/330
341/0 14/181 431/16
349/0 38/367 383/16
357/0 270/91 223/195
363/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 293/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Tabelle 2

Zeilenindex/Startspaltenindex (Rate 5/6)
0/0 221/158 442/14 503/323 283/150 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/283 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/38 206/72 166/26 87/302 7/362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 285/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 267/362
120/0 61/31 502/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 487/264
160/0 441/191 382/360 423/282 203/2 84/38 64/347 425/249 5/267 466/232 46/275 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/259 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 5/6)
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126
420/0 81/202 202/206
440/0 481/156 242/263
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101
108/0 309/208 510/162
128/0 349/147 330/242
148/0 29/263 490/54
168/0 69/312 250/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 389/160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 232/219 193/30

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 5/6)
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
351/0 132/155 493/50
371/0 512/292 453/214
391/0 172/387 53/114
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287
54/0 115/137 196/57
74/0 95/161 4161106
94/0 295/273 336/209
114/0 255/184 296/187
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 5/6)
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386
217/0 498/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188
317/0 518/249 399/229
337/0 278/333 279/330
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/158
437/0 358/377 259/364
457/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26
517/0 198/115 39/342

Tabelle 3

Zeilenindex/Startspaltenindex (Rate 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/277 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263
305/0 46/232 282/193 293/175 378/349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 142/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 239/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/54 303/391 153/132 254/145 209/307 74/126

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 1/2)
370/0 91/25 382/139 238/269 118/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1
10/0 86/124 267/2
15/0 321/291 197/8
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181/73 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 357/107
145/0 271/218 207/370
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 1/2)
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84
230/0 351/11 17/303
235/0 231/55 117/265

Tabelle 4

Zeilenindex/Startspaltenindex (Rate 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/20 467/48 243/273 370/284 356/114 77/201 7/214
14/0 29/350 44/366 185/333 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178
182/0 43/340 212/289 381/152 115/273 172/111 368/2 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114/57
336/0 85/227 282/298
350/0 491/101 324/74
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 3/4)
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189
176/0 93/332 94/299
190/0 163/385 416/307
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/26
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191f240 234/244
358/0 9/13 248/94
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/281
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296
53/0 320/345 111/194
67/0 208/221 13/84
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/257
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119

(fortgesetzt)

Zeilenindex/Startspaltenindex (Rate 3/4)
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44
361/0 376/295 97/70
375/0 124/166 69/108
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/264
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320
487/0 278/80 307/248
501/0 152/153 363/334

Revendications

1. Procédé de traitement d'un signal à codage de contrôle de parité de faible densité (LDPC), le procédé comprenant les étapes consistant à :

générer un signal à codage LDPC à partir d'une matrice de contrôle de parité structurée indiquant le lien entre des noeuds de bits et des noeuds de contrôle ;
transmettre le signal à codage LDPC à un récepteur par un canal de communication ;
recevoir le signal à codage LDPC au niveau du récepteur ;
extraire d'une mémoire dans le récepteur des valeurs d'arêtes associées à la matrice de contrôle de parité structurée utilisée pour générer le signal à codage LDPC ;
fournir un signal décodé correspondant au signal à codage LDPC en fonction des valeurs d'arêtes extraites,
les valeurs d'arêtes indiquant une relation entre des noeuds de bits et des noeuds de contrôle,
les noeuds de bits étant divisés en groupes de 392,
les valeurs d'arêtes à l'étape d'extraction étant enregistrées dans une mémoire (1501, 1503) conformément à un schéma prédéfini,
le procédé étant **caractérisé en ce que** la mémoire comprend une RAM d'arêtes supérieure et une RAM d'arêtes inférieure,
la RAM d'arêtes inférieure enregistrant les valeurs d'arêtes pour des noeuds de bits de degré deux,
la RAM d'arêtes supérieure enregistrant les valeurs d'arêtes pour des noeuds de bits de degré supérieur à deux,
l'enregistrement de valeurs d'arêtes dans la RAM d'arêtes supérieure étant défini par l'une des tables 1 à 4 ci-dessous,
chaque ligne successive de chaque table désignant les indices de ligne et les indices de colonne de départ pour des groupes successifs correspondants de 392 noeuds de bits pour un schéma de codage LDPC particulier dont le taux de codage est indiqué dans l'intitulé de chaque table,
un premier nombre à chaque position de table dans chaque table désignant un indice de ligne pour l'enregistrement de valeurs d'arêtes dans la RAM d'arêtes supérieure et un deuxième nombre à chaque position de table désignant un indice de colonne de départ pour l'enregistrement de valeurs d'arêtes dans la RAM d'arêtes supérieure de noeuds de bits successifs dans un groupe correspondant de noeuds de bits,
des positions de table successives dans chaque ligne désignant les indices de ligne et de colonne pour des valeurs d'arêtes successives correspondantes pour ledit groupe correspondant de noeuds de bits,

de façon à permettre la sélection d'un groupe de 392 noeuds de bits et de 392 noeuds de contrôle à la fois pour le traitement,
pour le traitement des noeuds de bits, à l'étape d'extraction, pour un groupe de noeuds de bits de degré deux, deux lignes consécutives de la RAM d'arêtes inférieure faisant l'objet d'un accès, et, pour un groupe de noeuds de bits de degré d supérieur à deux, les valeurs d'arêtes étant obtenues à partir de d lignes de la RAM d'arêtes supérieure,
pour le traitement des noeuds de contrôle, à l'étape d'extraction, q lignes consécutives faisant l'objet d'un accès dans la RAM d'arêtes supérieure et deux lignes consécutives faisant l'objet d'un accès dans la RAM d'arêtes inférieure,
où $q=d_c-2$, d_c représentant le degré des noeuds de contrôle en fonction du schéma prédéfini, $d_c=7$ pour un taux de codage de 1/2, $d_c=10$ pour un taux de codage de 2/3, $d_c=16$ pour un taux de codage de 3/4 et $d_c=22$ pour un taux de codage de 5/6,
les tables 1 à 4 s'établissant comme suit :

Table 1

Index de ligne/Index de colonne de départ (Taux 2/3)
0/0 433/323 242/150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/280 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/275 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/21 419/219 427/378 395/10 347/167 68/221 260/310 396/54 308/168 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/264 194/335 131/362 403/326 315/180 275/137 203/86 204/303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 27/109 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23

(suite)

Index de ligne/Index de colonne de départ (Taux 2/3)
296/0 385/42 210/267
304/0 17/7 258/227
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118
376/0 369/228 370/202
384/0 225/71 74/136
392/0 1/314 346/289
400/0 353/286 322/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
77/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/87
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262
189/0 94/239 271/38
197/0 198/207 231/297
205/0 22/32 167/205
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
245/0 150/340 359/100

(suite)

Index de ligne/Index de colonne de départ (Taux 2/3)
253/0 294/75 415/189
261/0 222/321 391/78
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/256 103/242
325/0 278/22 7/154
333/0 342/192 423/330
341/0 14/181 431/16
349/0 38/367 383/16
357/0 270/91 223/195
365/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 295/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Table 2

Index de ligne/Index de colonne de départ (Taux 5/6)
0/0 221/158 442/14 503/323 283/150 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/285 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/58 206/72 166/26 87/302 7/362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 285/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 267/362
120/0 61/31 502/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 487/164
160/0 441/191 382/360 423/282 203/2 84/58 64/347 425/249 5/267 466/232 46/275 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/259 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126

(suite)

Index de ligne/Index de colonne de départ (Taux 5/6)
420/0 81/202 202/206
440/0 481/156 242/263
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101
108/0 309/208 510/162
128/0 349/147 330/242
148/0 29/263 490/54
168/0 69/312 250/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 389/160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 232/219 193/30
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
351/0 132/155 493/50

(suite)

Index de ligne/Index de colonne de départ (Taux 5/6)
371/0 512/292 453/214
391/0 172/387 53/114
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287
54/0 115/137 196/57
74/0 95/161 416/206
94/0 295/273 336/209
114/0 255/184 296/287
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386
217/0 498/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188

(suite)

Index de ligne/Index de colonne de départ (Taux 5/6)
317/0 518/249 399/229
337/0 278/333 279/330
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/158
437/0 358/377 259/364
437/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26
517/0 198/115 39/342

Table 3

Index de ligne/Index de colonne de départ (Taux 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/177 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263
305/0 46/232 282/193 293/175 378/349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 142/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 259/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/54 303/391 153/132 254/145 209/307 74/126
370/0 91/25 382/139 238/269 128/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1

(suite)

Index de ligne/Index de colonne de départ (Taux 1/2)
10/0 86/124 267/2
15/0 321/291 197/8
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181/73 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 3571/07
145/0 271/218 207/370
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84
230/0 351/11 17/303
235/0 231/55 117/265

Table 4

Index de ligne/Index de colonne de départ (Taux 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/10 467/48 243/275 370/284 356/114 77/201 7/214
14/0 29/350 44/366 185/335 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178
182/0 43/340 212/289 381/152 115/273 172/111 368/2 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114/57
336/0 85/227 282/298
350/0 491/101 324/74
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189

(suite)

Index de ligne/Index de colonne de départ (Taux 3/4)
176/0 93/332 94/299
190/0 163/385 416/307
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/16
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191/240 234/244
358/0 9/13 248/94
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/181
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296
53/0 320/345 111/194
67/0 208/121 13/84
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/237
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44

(suite)

Index de ligne/Index de colonne de départ (Taux 3/4)
361/0 376/295 97/70
375/0 124/166 69/108
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/164
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320
487/0 278/80 307/248
501/0 152/153 363/334

2. Système de traitement d'un signal à codage de contrôle de parité de faible densité (LDPC), le système comprenant :

un codeur conçu pour générer un signal à codage LDPC à partir d'une matrice de contrôle de parité structurée indiquant le lien entre des noeuds de bits et des noeuds de contrôle, et transmettre le signal à codage LDPC à un récepteur par un canal de communication ;
un récepteur conçu pour recevoir le signal à codage LDPC et comprenant un décodeur comprenant :

une mémoire (1501, 1503) conçue pour enregistrer des valeurs d'arêtes associées à la matrice de contrôle de parité structurée utilisée pour générer le signal à codage LDPC et indiquant une relation entre des noeuds de bits et des noeuds de contrôle, les noeuds de bits étant divisés en groupes de 392 ;
un moyen conçu pour extraire des valeurs d'arêtes de la mémoire (1501, 1503) ; et
un moyen conçu pour fournir un signal décodé correspondant au signal à codage LDPC en fonction des valeurs d'arêtes extraites, les valeurs d'arêtes étant enregistrées en mémoire conformément à un schéma prédéfini,
le système étant **caractérisé en ce que** la mémoire comprend une RAM d'arêtes supérieure et une RAM d'arêtes inférieure,
la RAM d'arêtes inférieure enregistrant les valeurs d'arêtes pour des noeuds de bits de degré deux,
la RAM d'arêtes supérieure enregistrant les valeurs d'arêtes pour des noeuds de bits de degré supérieur à deux,
l'enregistrement de valeurs d'arêtes dans la RAM d'arêtes supérieure étant défini par l'une des tables 1 à 4 ci-dessous,
chaque ligne successive de chaque table désignant les indices de ligne et les indices de colonne de départ pour des groupes successifs correspondants de 392 noeuds de bits pour un schéma de codage LDPC particulier dont le taux de codage est indiqué dans l'intitulé de chaque table,
un premier nombre à chaque position de table dans chaque table désignant un indice de ligne pour l'enregistrement de valeurs d'arêtes dans la RAM d'arêtes supérieure et un deuxième nombre à chaque position de table désignant un indice de colonne de départ pour l'enregistrement de valeurs d'arêtes dans la RAM d'arêtes supérieure de noeuds de bits successifs dans un groupe correspondant de noeuds de bits,
des positions de table successives dans chaque ligne désignant les indices de ligne et de colonne pour des valeurs d'arêtes successives correspondantes pour ledit groupe correspondant de noeuds de bits,
de façon à permettre la sélection d'un groupe de 392 noeuds de bits et de 392 noeuds de contrôle à la fois pour le traitement,
pour le traitement des noeuds de bits, à l'étape d'extraction, pour un groupe de noeuds de bits de degré deux, deux lignes consécutives de la RAM d'arêtes inférieure faisant l'objet d'un accès, et, pour un groupe de noeuds de bits de degré d supérieur à deux, les valeurs d'arêtes étant obtenues à partir de d lignes de la RAM d'arêtes supérieure,
pour le traitement des noeuds de contrôle, à l'étape d'extraction, q lignes consécutives faisant l'objet d'un accès dans la RAM d'arêtes supérieure et deux lignes consécutives faisant l'objet d'un accès dans la RAM d'arêtes inférieure,
où $q=d_c-2$, d_c représentant le degré des noeuds de contrôle en fonction du schéma prédéfini, $d_c=7$ pour un taux de codage de 1/2, $d_c=10$ pour un taux de codage de 2/3, $d_c=16$ pour un taux de codage de 3/4 et

d_c=22 pour un taux de codage de 5/6,
les tables 1 à 4 s'établissant comme suit :

Table 1

Index de ligne/Index de colonne de départ (Taux 2/3)
0/0 433/323 242/150 91/117 323/112 147/93 35/105 227/232 196/311 292/180 52/244 180/250 20/335
8/0 121/326 178/109 299/157 195/338 99/232 251/107 411/263 364/199 28/218 276/370 108/80 84/130
16/0 281/359 18/112 83/180 115/264 163/149 355/321 11/206 268/100 436/79 252/316 420/280 380/335
24/0 345/122 146/365 107/40 283/363 123/368 379/340 3/156 124/15 220/187 356/127 188/71 156/82
32/0 425/177 234/46 267/219 67/224 171/175 219/306 387/87 372/56 140/31 36/339 116/36 316/288
40/0 417/214 122/188 339/58 235/72 187/26 75/302 19/362 164/285 132/109 148/189 60/65 412/303
48/0 89/312 362/214 43/11 419/119 427/378 395/10 347/167 68/221 260/310 396/54 308/268 388/176
56/0 73/69 434/266 155/277 435/360 363/183 51/165 331/181 12/232 404/193 172/175 324/349 348/98
64/0 177/354 34/172 243/141 139/362 259/151 179/166 307/56 76/367 244/121 100/299 428/12 284/133
72/0 145/164 194/335 131/362 403/326 313/180 275/137 203/86 204/303 4/5 228/360 300/76 92/17
80/0 377/382 394/243 27/109 59/237 371/175 211/358 291/353 340/161 212/94 332/333 44/117 236/200
88/0 65/365 378/142
96/0 57/285 226/108
104/0 97/161 250/133
112/0 129/184 114/44
120/0 337/130 50/178
128/0 401/389 170/258
136/0 25/330 82/372
144/0 321/309 162/170
152/0 185/38 386/128
160/0 49/376 90/331
168/0 265/293 314/166
176/0 297/86 282/193
184/0 217/117 42/210
192/0 201/124 306/86
200/0 313/377 138/97
208/0 193/247 202/163
216/0 209/377 186/212
224/0 233/238 26/22
232/0 329/152 410/271
240/0 9/245 106/170
248/0 409/190 58/289
256/0 113/375 154/44
264/0 33/232 274/268
272/0 153/339 218/145
280/0 289/319 98/4
288/0 41/209 130/23
296/0 385/42 210/267
304/0 17/7 258/227
312/0 169/166 290/330
320/0 241/107 66/111
328/0 137/39 418/182
336/0 249/137 354/218
344/0 161/73 2/79
352/0 105/280 266/282
360/0 257/69 298/51
368/0 81/185 338/118

(suite)

Index de ligne/Index de colonne de départ (Taux 2/3)
376/0 369/228 370/202
384/0 225/71 74/136
392/0 1/314 346/289
400/0 353/286 322/166
408/0 305/81 330/301
416/0 273/170 402/282
424/0 393/227 10/312
432/0 361/379 426/364
5/0 350/140 263/166
13/0 102/110 87/335
21/0 174/333 215/219
29/0 422/227 31/273
37/0 406/168 175/11
45/0 254/42 279/201
53/0 230/347 47/291
61/0 214/139 55/92
69/0 358/131 199/344
77/0 86/374 183/298
85/0 118/118 407/25
93/0 318/221 39/66
101/0 54/256 79/202
109/0 374/195 119/162
117/0 238/89 207/243
125/0 366/78 95/96
133/0 46/216 351/9
141/0 326/99 127/87
149/0 134/75 319/102
157/0 158/154 15/65
165/0 286/158 143/362
173/0 190/146 191/205
181/0 62/4 343/262
189/0 94/239 271/38
197/0 198/207 231/297
205/0 22/32 167/105
213/0 246/385 303/246
221/0 390/368 439/220
229/0 334/207 247/262
237/0 398/378 63/211
245/0 150/340 359/100
253/0 294/75 415/189
261/0 222/321 391/78
269/0 166/343 159/105
277/0 126/93 239/166
285/0 110/113 151/373
293/0 302/144 71/18
301/0 262/368 111/193
309/0 414/332 375/389
317/0 142/236 103/242
325/0 278/22 7/154

(suite)

Index de ligne/Index de colonne de départ (Taux 2/3)
333/0 342/192 423/330
341/0 14/181 431/16
349/0 38/367 383/16
357/0 270/91 223/195
365/0 182/211 287/313
373/0 310/170 135/230
381/0 78/15 295/220
389/0 430/353 335/91
397/0 30/141 367/216
405/0 382/36 311/98
413/0 206/377 255/372
421/0 438/225 399/148
429/0 70/182 327/105
437/0 6/277 23/94

Table 2

Index de ligne/Index de colonne de départ (Taux 5/6)
0/0 221/158 442/14 503/323 283/150 104/117 384/112 165/93 45/105 266/232 226/311 347/180 67/244
20/0 101/369 162/326 323/359 23/112 124/180 144/264 205/149 405/321 6/206 306/100 507/79 287/316
40/0 201/285 302/12 63/134 243/68 264/238 344/375 105/259 345/213 246/75 66/148 327/100 167/220
60/0 381/141 422/112 443/125 223/47 204/375 504/214 145/188 385/58 206/72 166/26 87/302 71362
80/0 461/383 82/80 143/61 463/106 284/196 4/94 85/104 295/235 386/3 426/218 27/38 107/161
100/0 41/310 482/66 343/376 403/166 324/265 404/236 245/230 445/63 186/343 486/88 427/202 267/362
120/0 61/31 502/317 123/25 163/139 424/269 164/309 25/56 505/260 406/279 346/148 367/315 47/382
140/0 421/362 462/206 263/297 83/384 244/287 184/132 225/140 125/14 506/216 106/311 447/87 487/264
160/0 441/191 382/360 423/282 203/2 84/58 64/347 425/249 5/267 466/232 46/275 127/385 187/26
180/0 501/296 222/324 3/73 43/6 364/319 444/204 185/82 65/159 26/90 286/155 307/181 147/366
200/0 301/325 102/119 383/285 103/84 304/121 484/352 365/102 485/107 86/9 366/76 387/229 467/52
220/0 341/331 322/242 483/275 303/293 464/166 44/283 305/232 465/86 126/193 146/184 207/38 407/117
240/0 21/314 362/289 363/211 183/120 24/286 224/166 325/186 265/144 446/81 326/301 227/4 247/199
260/0 161/91 142/78
280/0 241/209 2/119
300/0 141/87 342/147
320/0 281/55 42/46
340/0 261/213 182/145
360/0 181/264 62/88
380/0 1/96 262/184
400/0 361/30 282/126
420/0 81/202 202/206
440/0 481/156 242/263
460/0 401/170 22/126
480/0 321/42 402/21
500/0 121/272 122/337
8/0 289/369 190/223
28/0 369/313 130/127
48/0 189/92 290/241
68/0 509/124 210/56
88/0 489/23 430/101

(suite)

Index de ligne/Index de colonne de départ (Taux 5/6)
108/0 309/208 510/162
128/0 349/147 330/242
148/0 29/263 490/54
168/0 69/312 250/377
188/0 249/315 270/116
208/0 49/176 170/58
228/0 109/337 10/55
248/0 469/65 110/187
268/0 209/105 470/362
288/0 229/164 150/80
308/0 9/293 410/374
328/0 329/122 310/152
348/0 149/124 390/382
368/0 389/160 230/92
388/0 169/357 370/368
408/0 449/296 90/377
428/0 269/32 70/212
448/0 409/59 450/257
468/0 89/291 30/234
488/0 429/130 350/95
508/0 129/276 50/38
11/0 292/349 133/372
31/0 492/271 253/248
51/0 192/149 273/378
71/0 352/265 153/37
91/0 332/244 293/199
111/0 152/354 393/243
131/0 312/144 213/184
151/0 92/219 173/11
171/0 392/182 473/325
191/0 232/219 193/30
211/0 372/157 13/63
231/0 12/108 333/359
251/0 112/33 513/88
271/0 72/207 413/9
291/0 272/100 93/357
311/0 432/166 233/272
331/0 412/265 33/210
351/0 132/155 493/50
371/0 312/292 453/214
391/0 172/387 53/114
411/0 32/233 433/177
431/0 252/113 373/52
451/0 212/347 353/90
471/0 52/89 73/198
491/0 452/285 313/233
511/0 472/103 113/84
14/0 55/43 36/361
34/0 355/70 116/287

(suite)

Index de ligne/Index de colonne de départ (Taux 5/6)
54/0 115/137 196/57
74/0 95/161 416/206
94/0 295/273 336/209
114/0 255/184 296/287
134/0 435/11 376/38
154/0 155/356 16/379
174/0 135/251 76/10
194/0 235/314 256/293
214/0 75/296 216/326
234/0 275/314 356/116
254/0 455/133 156/165
274/0 375/292 436/283
294/0 515/227 456/337
314/0 315/111 176/155
334/0 175/98 276/334
354/0 335/7 476/87
374/0 415/161 136/15
394/0 395/338 496/98
414/0 495/82 396/269
434/0 195/312 516/187
454/0 475/100 56/356
474/0 15/163 316/195
494/0 35/197 96/145
514/0 215/301 236/381
17/0 18/321 459/4
37/0 398/236 139/8
57/0 338/117 439/84
77/0 438/97 499/93
97/0 298/292 19/215
117/0 218/224 419/275
137/0 98/229 299/27
157/0 378/133 339/232
177/0 118/191 359/271
197/0 478/272 159/386
217/0 498/262 119/219
237/0 418/282 519/297
257/0 238/33 379/339
277/0 258/230 179/350
297/0 158/27 59/188
317/0 318/249 399/229
337/0 278/333 279/330
357/0 138/276 239/49
377/0 178/34 219/304
397/0 458/344 199/181
417/0 58/312 479/158
437/0 358/377 259/364
457/0 78/157 319/380
477/0 318/75 99/57
497/0 38/296 79/26

(suite)

Index de ligne/Index de colonne de départ (Taux 5/6)
517/0 198/115 39/342

Table 3

Index de ligne/Index de colonne de départ (Taux 1/2)
240/0 306/249 387/194 98/132 268/80 219/33 64/252 108/54
245/0 146/169 37/233 183/243 233/207 9/336 54/91 363/391
250/0 196/123 242/31 63/103 118/277 344/177 339/46 173/219
255/0 216/36 287/288 318/43 83/327 34/28 354/114 53/84
260/0 316/69 377/8 323/110 308/250 314/209 214/101 298/134
265/0 256/186 257/166 23/196 68/68 234/41 144/249 333/11
270/0 201/192 32/38 213/255 203/124 84/285 264/12 263/134
275/0 36/100 247/220 388/286 273/339 89/334 154/192 223/148
280/0 396/141 132/112 283/125 163/47 79/375 14/214 138/188
285/0 31/189 82/65 18/303 313/92 299/317 129/18 373/356
290/0 381/332 332/312 258/214 43/21 364/219 274/378 198/10
295/0 121/66 217/124 338/346 48/380 189/155 199/79 278/224
300/0 71/260 22/248 193/240 288/248 284/237 224/268 38/263
305/0 46/232 282/193 293/175 3781349 169/98 184/165 168/31
310/0 156/116 87/62 208/390 113/287 69/354 269/172 343/141
315/0 311/12 192/133 143/43 58/75 124/176 324/24 383/346
320/0 16/118 372/259 368/265 133/59 309/321 289/272 104/80
325/0 336/114 7/90 123/190 228/181 114/324 319/240 244/246
330/0 226/71 112/218 358/348 398/83 179/121 119/366 394/197
335/0 21/383 142/80 158/61 218/106 329/196 4/94 49/104
340/0 221/97 2/252 178/174 13/190 164/166 99/130 204/9
345/0 126/76 67/120 78/183 243/53 134/140 149/197 359/239
350/0 96/221 392/290 28/163 353/297 279/147 294/343 374/314
355/0 176/230 367/63 73/343 393/88 174/202 259/362 249/256
360/0 241/60 202/21 348/66 328/351 139/144 94/258 384/41
365/0 26/374 262/54 303/391 153/132 254/145 209/307 74/126
370/0 91/25 382/139 238/269 128/309 239/56 24/260 369/279
375/0 151/213 317/133 253/161 188/92 399/371 194/116 39/302
380/0 296/140 307/14 93/216 148/311 389/87 334/264 109/335
385/0 286/76 222/17 33/116 8/191 304/360 19/282 379/2
390/0 106/217 212/188 103/68 248/264 29/48 44/174 349/274
395/0 281/269 162/333 3/243 88/320 159/75 59/300 229/136
0/0 346/176 157/302
5/0 171/47 42/1
10/0 86/124 267/2
15/0 321/291 197/8
20/0 236/149 147/50
25/0 1/168 347/191
30/0 386/257 252/12
35/0 301/64 397/176
40/0 341/340 272/97
45/0 101/201 122/134
50/0 136/201 57/343
55/0 131/169 292/299

(suite)

Index de ligne/Index de colonne de départ (Taux 1/2)
60/0 166/389 352/216
65/0 76/132 297/33
70/0 211/261 167/45
75/0 161/323 12/150
80/0 116/93 107/105
85/0 246/180 322/244
90/0 261/190 342/297
95/0 366/385 177/103
100/0 391/240 77/328
105/0 266/327 182/182
110/0 181/73 47/322
115/0 191/126 72/135
120/0 251/115 227/161
125/0 276/85 172/213
130/0 371/17 327/236
135/0 66/326 62/109
140/0 141/232 357/107
145/0 271/218 207/370
150/0 56/252 127/20
155/0 61/143 97/305
160/0 11/383 237/214
165/0 376/359 337/112
170/0 186/149 277/321
175/0 206/79 92/316
180/0 291/315 362/135
185/0 51/93 232/326
190/0 6/197 102/103
195/0 331/142 187/122
200/0 361/363 27/368
205/0 326/15 152/187
210/0 111/82 52/214
215/0 41/385 312/150
220/0 356/387 137/254
225/0 81/175 302/84
230/0 351/11 17/303
235/0 231/55 117/265

Table 4

Index de ligne/Index de colonne de départ (Taux 3/4)
0/0 113/334 100/308 423/175 493/163 32/370 116/20 467/48 243/275 370/284 356/114 77/201 7/214
14/0 29/350 44/366 185/335 3/40 494/155 144/324 383/185 229/96 230/376 188/182 427/304 385/269
28/0 435/215 366/165 101/329 17/221 46/276 74/130 341/4 313/169 314/11 272/267 21/376 273/122
42/0 155/306 240/253 353/325 451/355 312/33 88/27 47/23 327/90 286/87 34/201 483/221 175/39
56/0 197/263 492/185 283/223 367/316 60/241 228/91 145/175 439/3 454/168 202/98 133/214 203/82
70/0 463/384 352/298 269/9 129/294 256/303 214/387 5/316 285/257 90/282 48/376 399/317 329/102
84/0 1/159 170/317 409/245 255/173 270/11 438/179 271/224 89/131 300/144 328/199 343/321 231/338
98/0 211/266 450/256 199/279 171/358 242/192 466/378 187/100 19/70 62/98 384/313 35/382 245/164

(suite)

Index de ligne/Index de colonne de départ (Taux 3/4)
112/0 141/386 128/357 87/172 465/64 424/35 354/238 117/300 257/174 146/154 496/182 161/232 91/355
126/0 15/196 296/183 395/218 73/356 452/367 158/342 173/70 131/251 258/268 76/176 455/172 119/109
140/0 57/265 58/45 437/175 59/369 284/357 102/53 103/286 33/318 412/49 160/25 105/120 371/188
154/0 323/272 198/11 31/140 227/330 410/150 298/113 61/249 495/207 244/190 426/233 63/30 189/283
168/0 477/41 408/85 311/63 45/301 326/13 200/292 159/218 481/99 20/171 174/192 217/102 315/178
182/0 43/340 212/289 381/152 115/273 172/111 36812 75/34 369/291 132/92 482/375 413/195 301/219
196/0 225/338 436/232 479/161 339/50 340/372 396/293 355/218 397/80 468/212 342/375 497/351 259/314
210/0 253/84 30/254 297/89 241/165 382/65 18/60 299/186 425/104 440/255 398/62 441/191 469/14
224/0 449/109 478/333 325/82 143/94 186/39 130/44 453/22 411/329 6/168 118/357 287/119 357/258
238/0 169/152 310/308 213/159 157/365 480/361 4/64 201/245 215/92 104/185 216/189 147/125 49/310
252/0 267/180 380/44
266/0 71/132 184/228
280/0 281/48 268/91
294/0 393/59 254/241
308/0 379/129 86/21
322/0 127/319 114/57
336/0 85/227 282/298
350/0 491/101 324/74
364/0 309/378 226/317
378/0 239/220 2/201
392/0 407/135 156/221
406/0 365/360 394/114
420/0 183/335 422/129
434/0 421/105 464/120
448/0 295/245 142/160
462/0 351/37 338/29
476/0 337/16 72/305
490/0 99/220 16/347
8/0 23/384 346/305
22/0 415/118 444/373
36/0 65/28 24/211
50/0 261/130 80/113
64/0 275/316 220/366
78/0 205/109 206/255
92/0 51/110 38/74
106/0 373/262 304/363
120/0 345/250 472/134
134/0 37/173 388/301
148/0 359/272 430/234
162/0 429/71 150/189
176/0 93/332 94/299
190/0 163/385 416/307
204/0 289/144 164/50
218/0 457/140 290/145
232/0 79/42 360/26
246/0 387/59 262/196
260/0 233/93 66/21
274/0 303/116 136/28
288/0 121/176 276/279

(suite)

Index de ligne/Index de colonne de départ (Taux 3/4)
302/0 485/235 332/69
316/0 443/336 178/353
330/0 499/298 458/45
344/0 191/240 234/244
358/0 9/13 248/94
372/0 219/36 402/112
386/0 331/192 52/58
400/0 471/294 500/144
414/0 317/186 318/150
428/0 107/69 108/346
442/0 149/139 486/346
456/0 135/170 192/65
470/0 401/2 10/281
484/0 177/326 374/2
498/0 247/143 122/242
11/0 474/49 433/281
25/0 292/134 335/294
39/0 404/29 265/296
53/0 320/345 111/194
67/0 208/221 13/94
81/0 264/133 419/95
95/0 54/157 83/51
109/0 166/363 195/303
123/0 194/389 377/15
137/0 460/36 447/169
151/0 306/23 279/311
165/0 40/133 153/233
179/0 236/53 27/257
193/0 446/121 293/259
207/0 250/350 167/310
221/0 68/104 209/119
235/0 334/224 251/323
249/0 432/83 503/117
263/0 180/192 125/201
277/0 362/183 391/267
291/0 110/347 405/288
305/0 222/22 223/10
319/0 502/80 489/249
333/0 12/100 139/370
347/0 390/229 321/44
361/0 376/295 97/70
375/0 124/166 69/108
389/0 418/73 349/223
403/0 96/321 237/242
417/0 26/23 181/237
431/0 82/7 55/264
445/0 348/347 461/381
459/0 138/244 41/239
473/0 488/356 475/320

(suite)

Index de ligne/Index de colonne de départ (Taux 3/4)
487/0 278/80 307/248 501/0 152/153 363/334

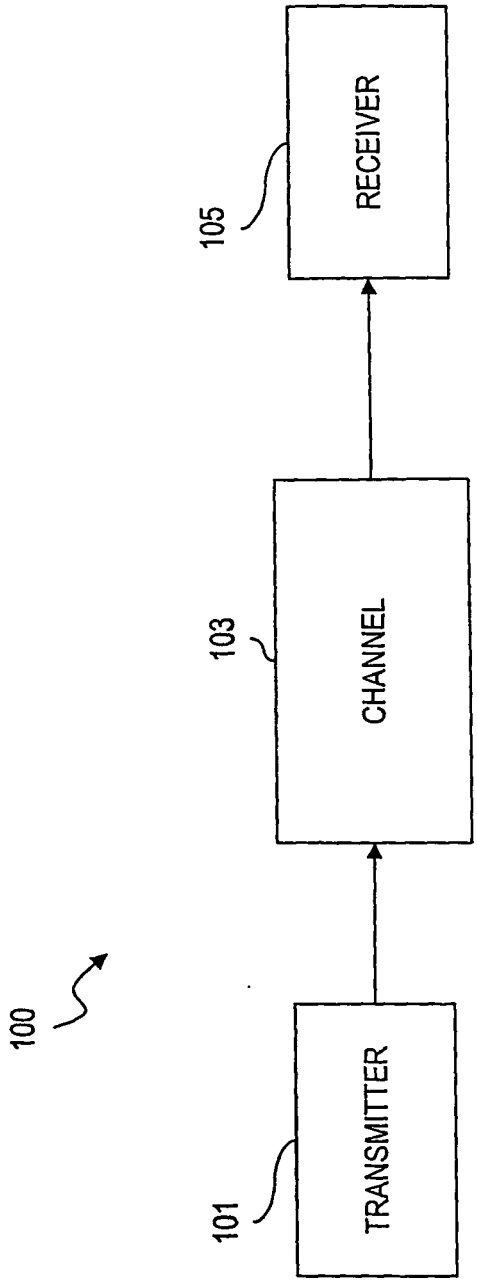


FIG. 1

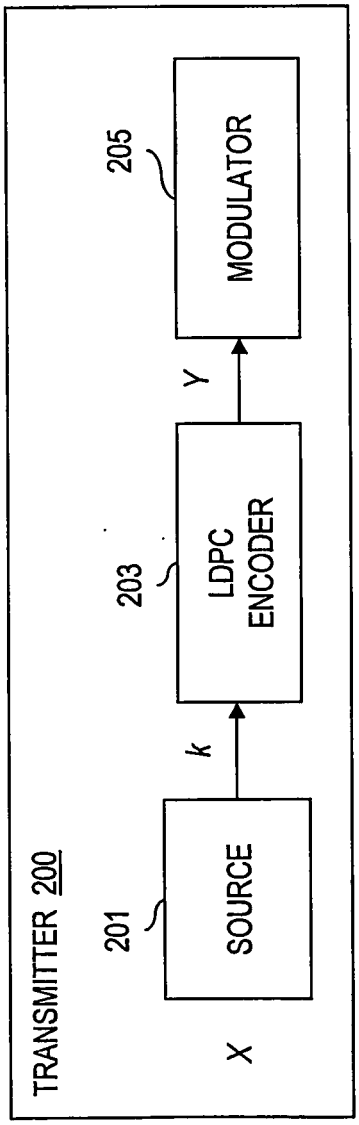

TRANSMITTER 200
201
SOURCE
X
k
203
LDPC ENCODER
Y
205
MODULATOR
207

FIG. 2

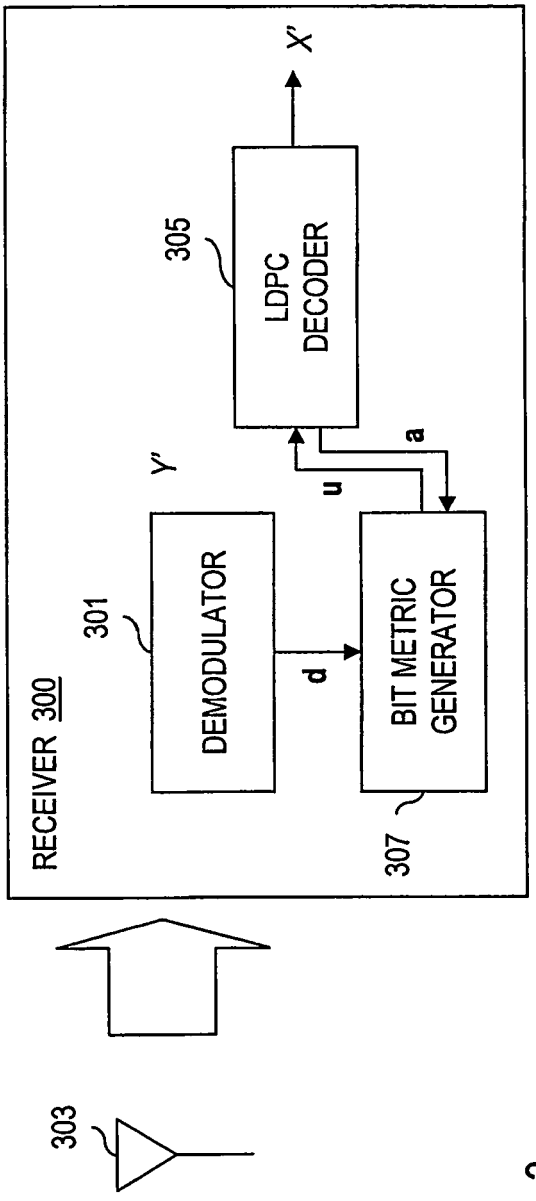

RECEIVER 300
301
DEMODULATOR
Y'
d
BIT METRIC GENERATOR
307
u
a
305
LDPC DECODER
X'
303

FIG. 3

FIG. 4

$$H = \begin{array}{c} \begin{matrix} n_1 & n_2 & n_3 & n_4 & n_5 & n_6 & n_7 & n_8 \end{matrix} \\ \left[\begin{array}{cccccccc} 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 1 & 0 \end{array}\right] \end{array} \begin{matrix} m_1 \\ m_2 \\ m_3 \\ m_4 \end{matrix}$$

FIG. 5

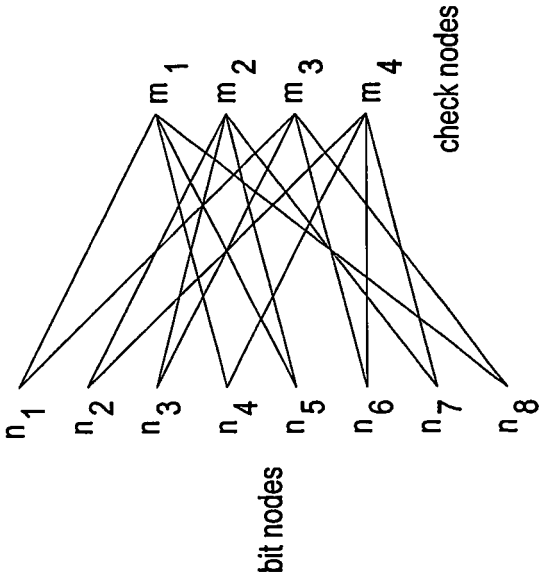
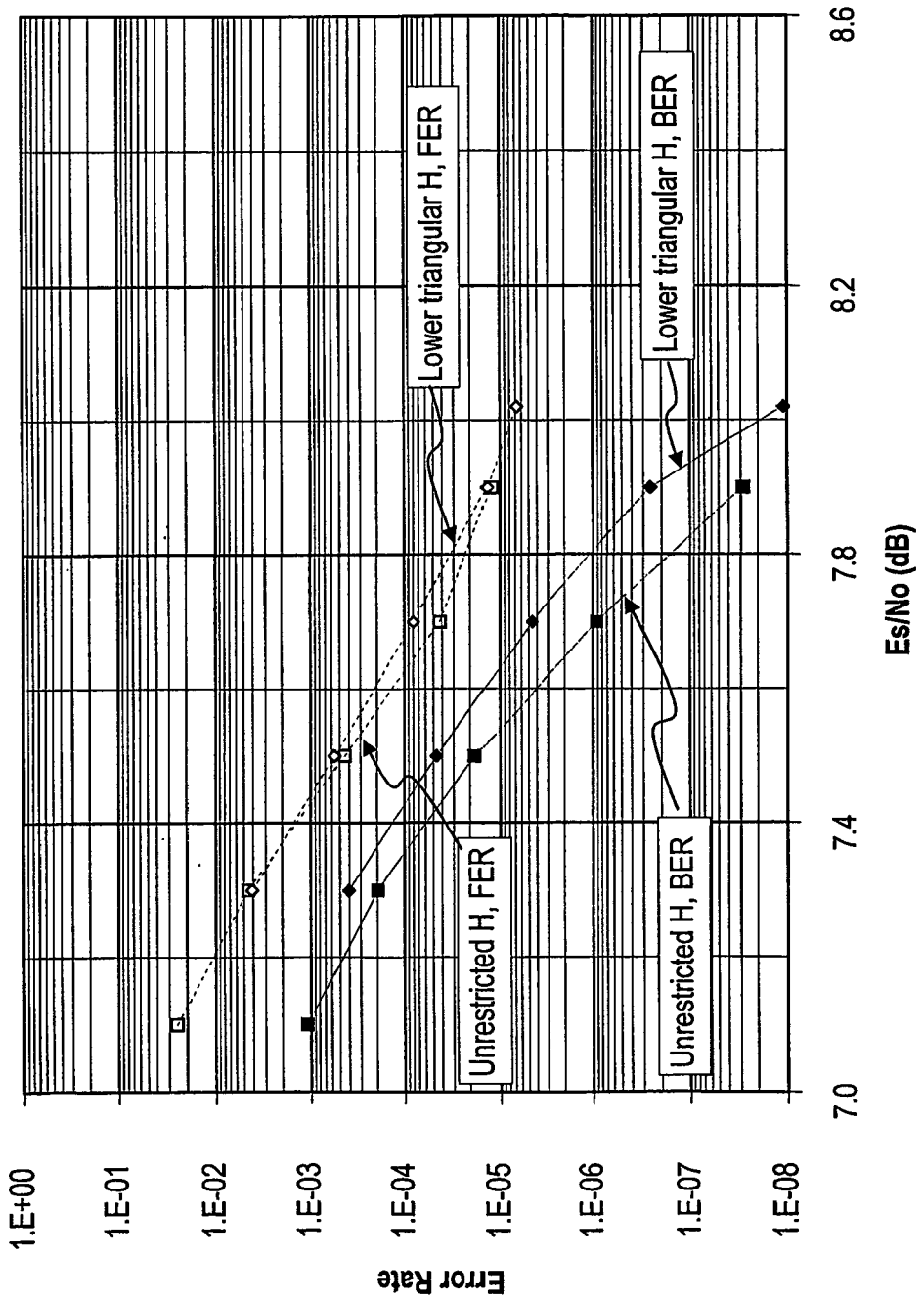


FIG. 6

$$B = \left[\begin{array}{cccccccc} 1 & x & x & x & x & x & x & x \\ x & 1 & x & x & x & x & x & x \\ x & x & 1 & x & x & x & x & x \\ x & x & x & 1 & x & x & x & x \\ x & x & x & x & 1 & x & x & x \\ x & x & x & x & x & 1 & x & x \\ x & x & x & x & x & x & 1 & x \\ x & x & x & x & x & x & x & 1 \end{array}\right]$$

FIG. 7


Error Rate
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
7.0
7.4
7.8
8.2
8.6
Es/No (dB)
Lower triangular H, FER
Lower triangular H, BER
Unrestricted H, FER
Unrestricted H, BER

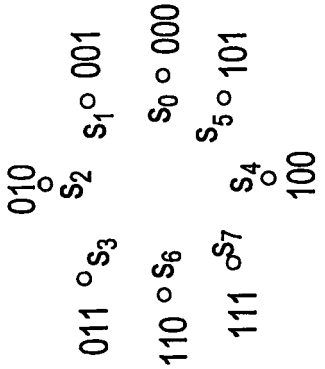

010
s2
s1 001
011
s3
s0 000
110
s6
s5 101
111
s7
s4
100

FIG. 8A

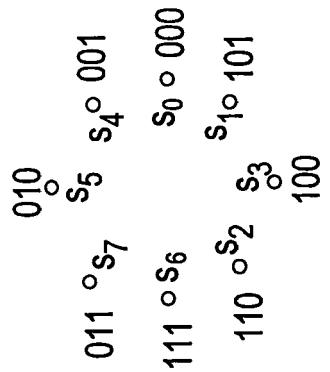

010
s5
s4 001
011
s7
s0 000
111
s6
s1 101
110
s2
s3
100

FIG. 8B

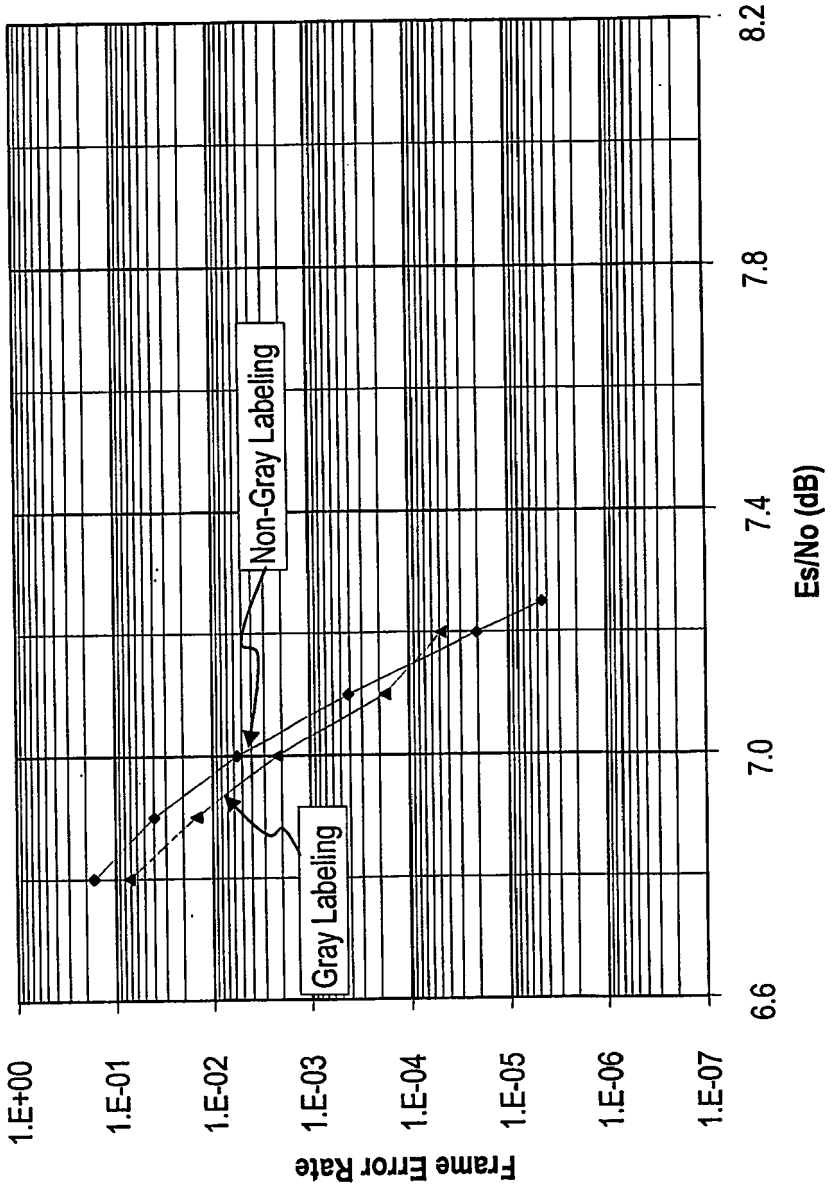

Frame Error Rate
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
6.6
7.0
7.4
7.8
8.2
Es/No (dB)
Non-Gray Labeling
Gray Labeling

FIG. 9

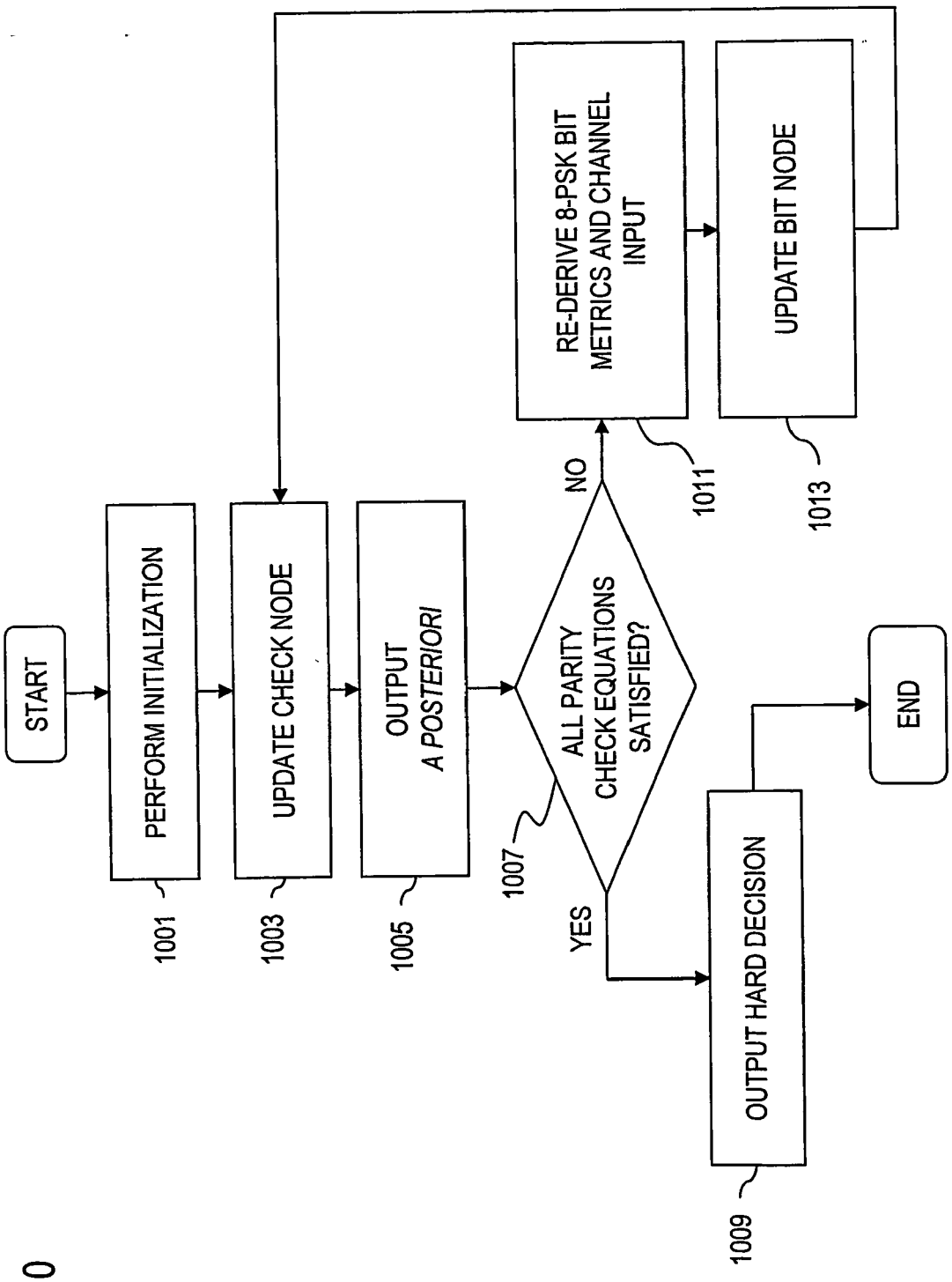

START
PERFORM INITIALIZATION
1001
UPDATE CHECK NODE
1003
OUTPUT
A POSTERIORI
1005
ALL PARITY
CHECK EQUATIONS
SATISFIED?
1007
NO
YES
RE-DERIVE 8-PSK BIT
METRICS AND CHANNEL
INPUT
1011
UPDATE BIT NODE
1013
OUTPUT HARD DECISION
1009
END

FIG. 10

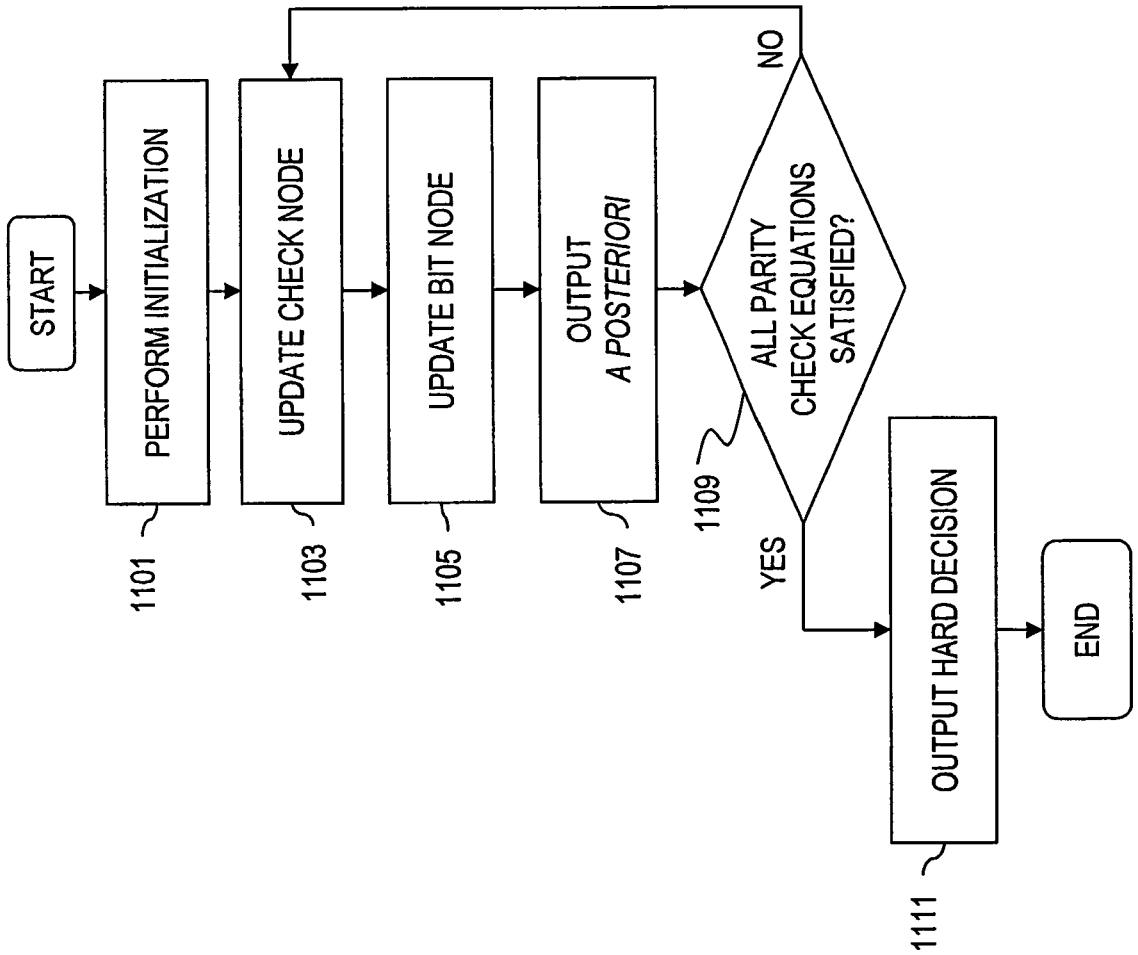

START
PERFORM INITIALIZATION
UPDATE CHECK NODE
UPDATE BIT NODE
OUTPUT
A POSTERIORI
ALL PARITY
CHECK EQUATIONS
SATISFIED?
NO
YES
OUTPUT HARD DECISION
END
1101
1103
1105
1107
1109
1111

FIG. 11

FIG. 12A

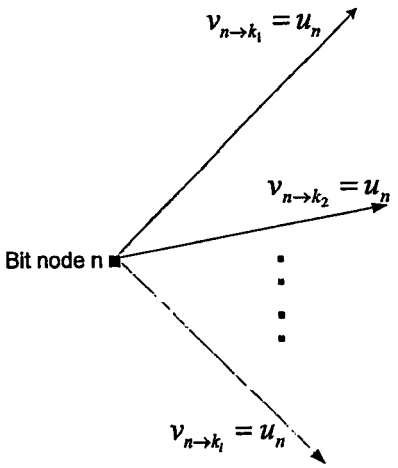
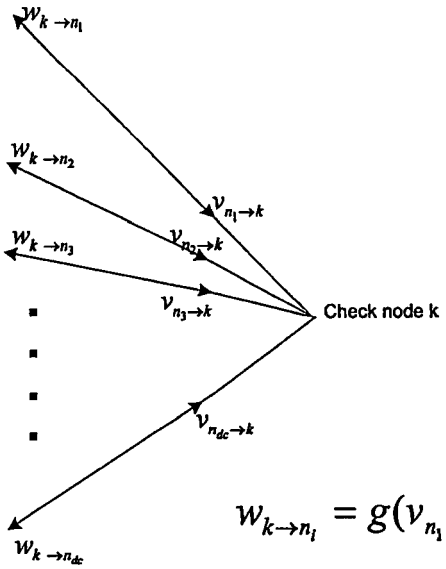
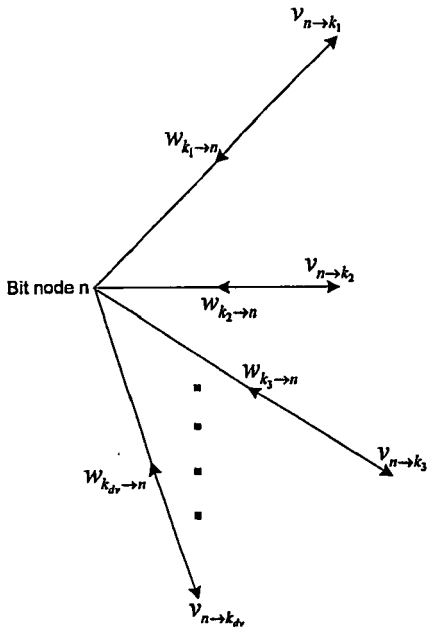


FIG. 12B



$$w_{k\to n_i}=g(v_{n_1\to k},v_{n_2\to k},\ldots,v_{n_{i-1}\to k},v_{n_{i+1}\to k},\ldots,v_{n_{dc}\to k})$$

FIG. 12C



$$v_{n\to k_i}=u_n+\sum_{j\neq i}w_{k_j\to n}$$

FIG. 13A

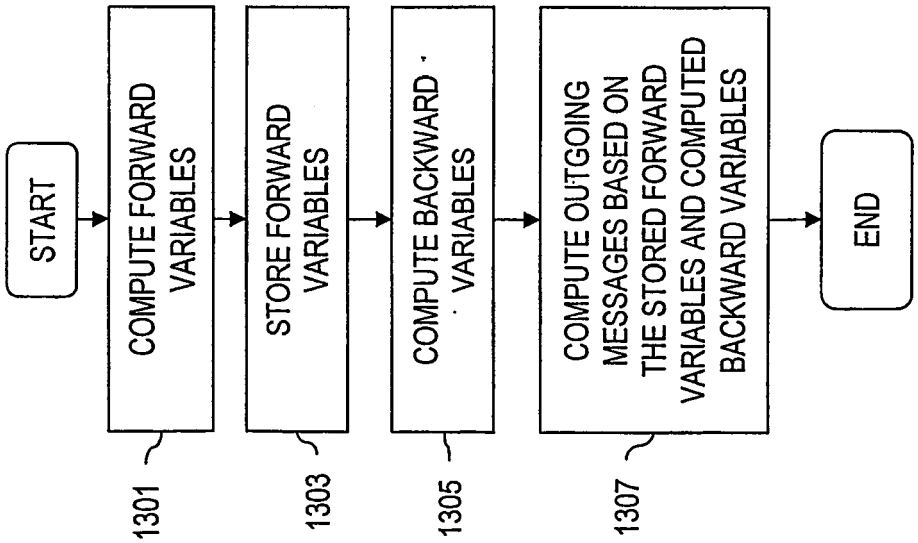
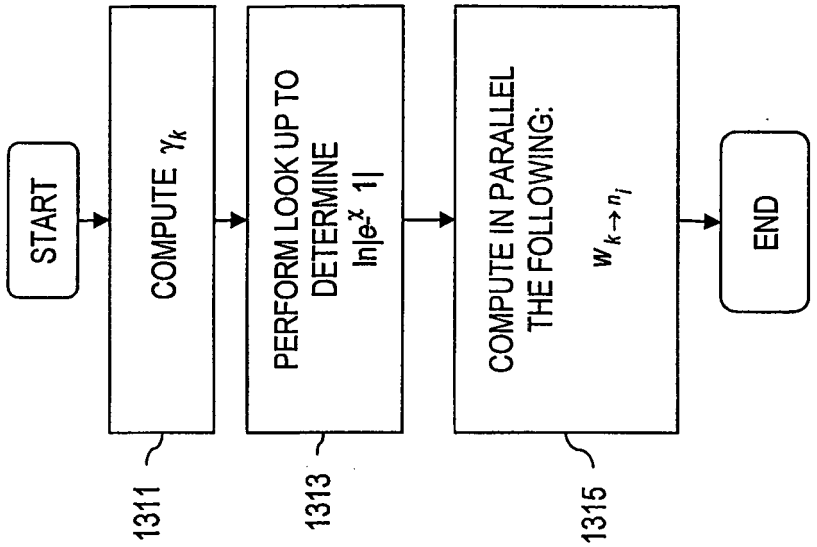


FIG. 13B



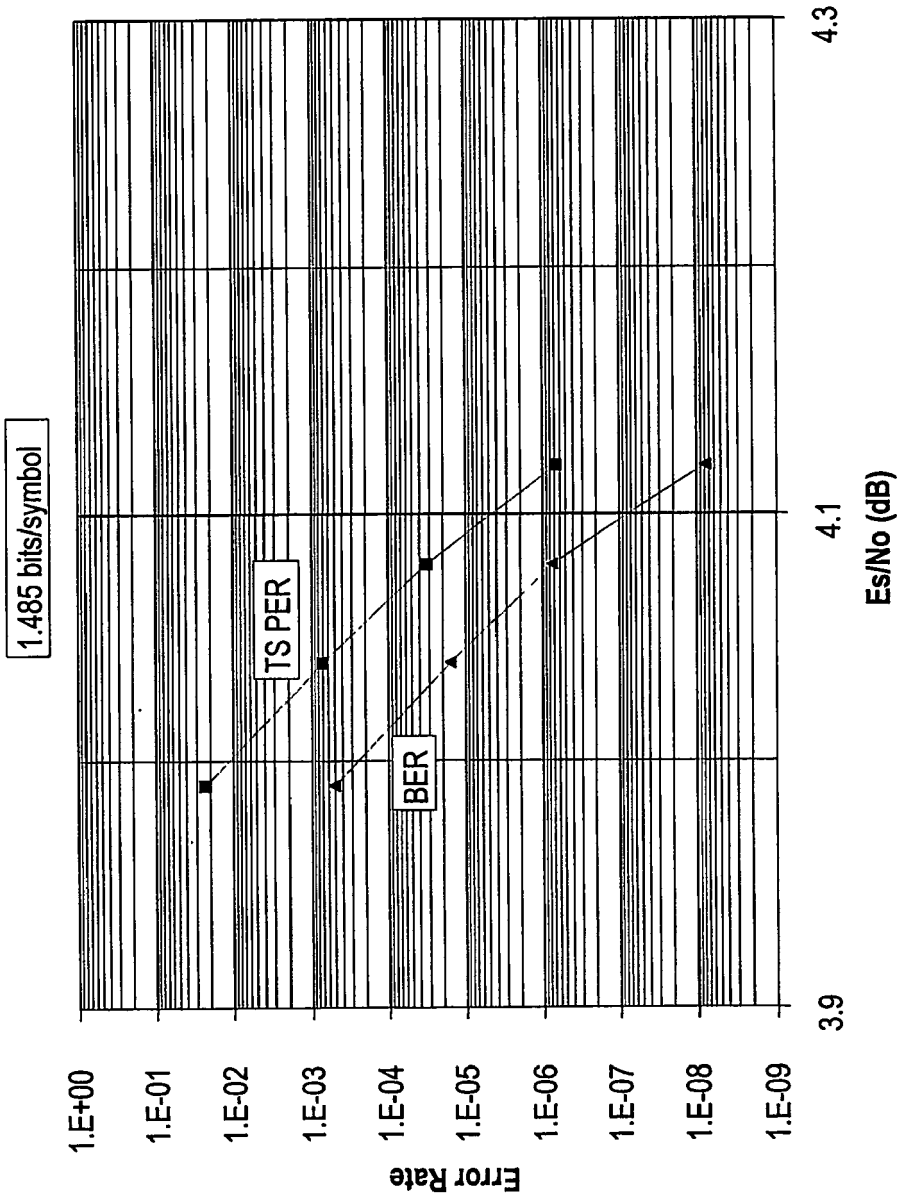

1.485 bits/symbol
TS PER
BER
Error Rate
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
3.9
4.1
4.3
Es/No (dB)

FIG. 14A

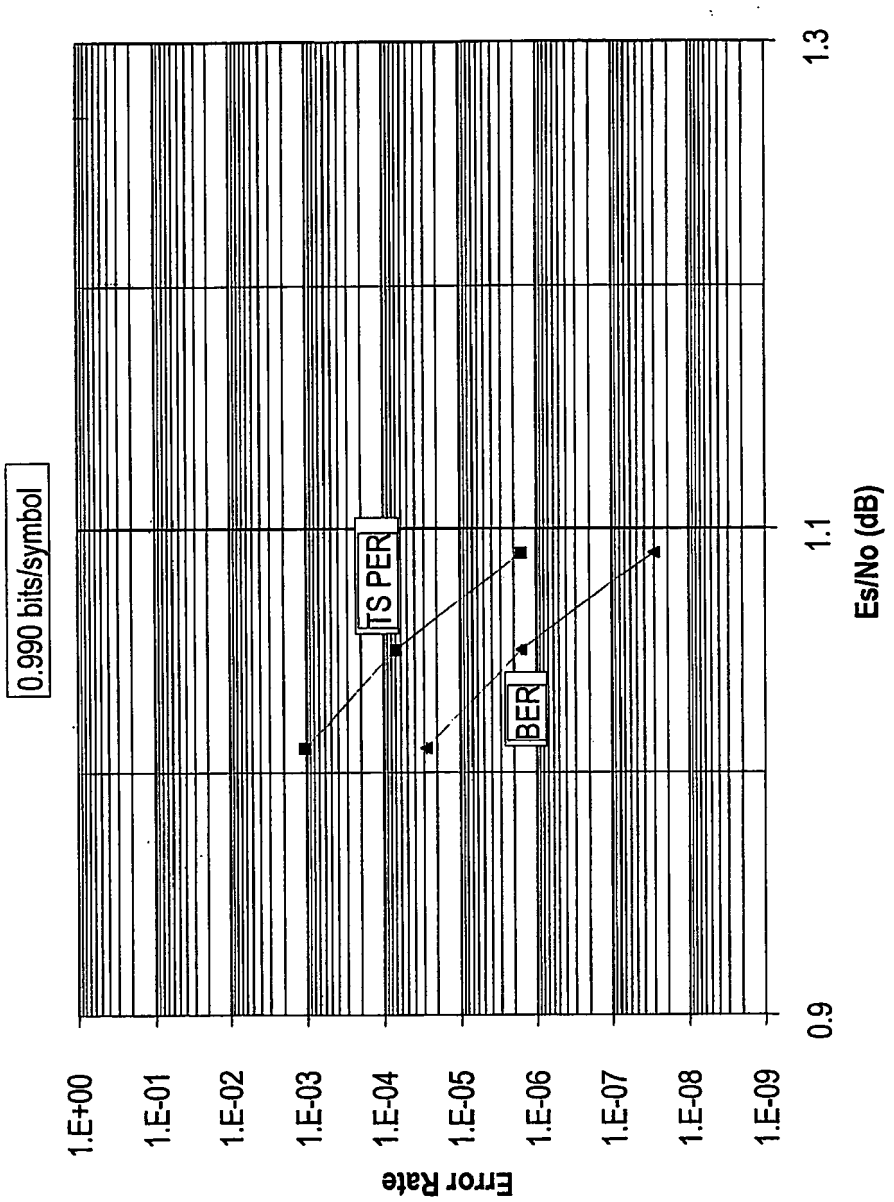
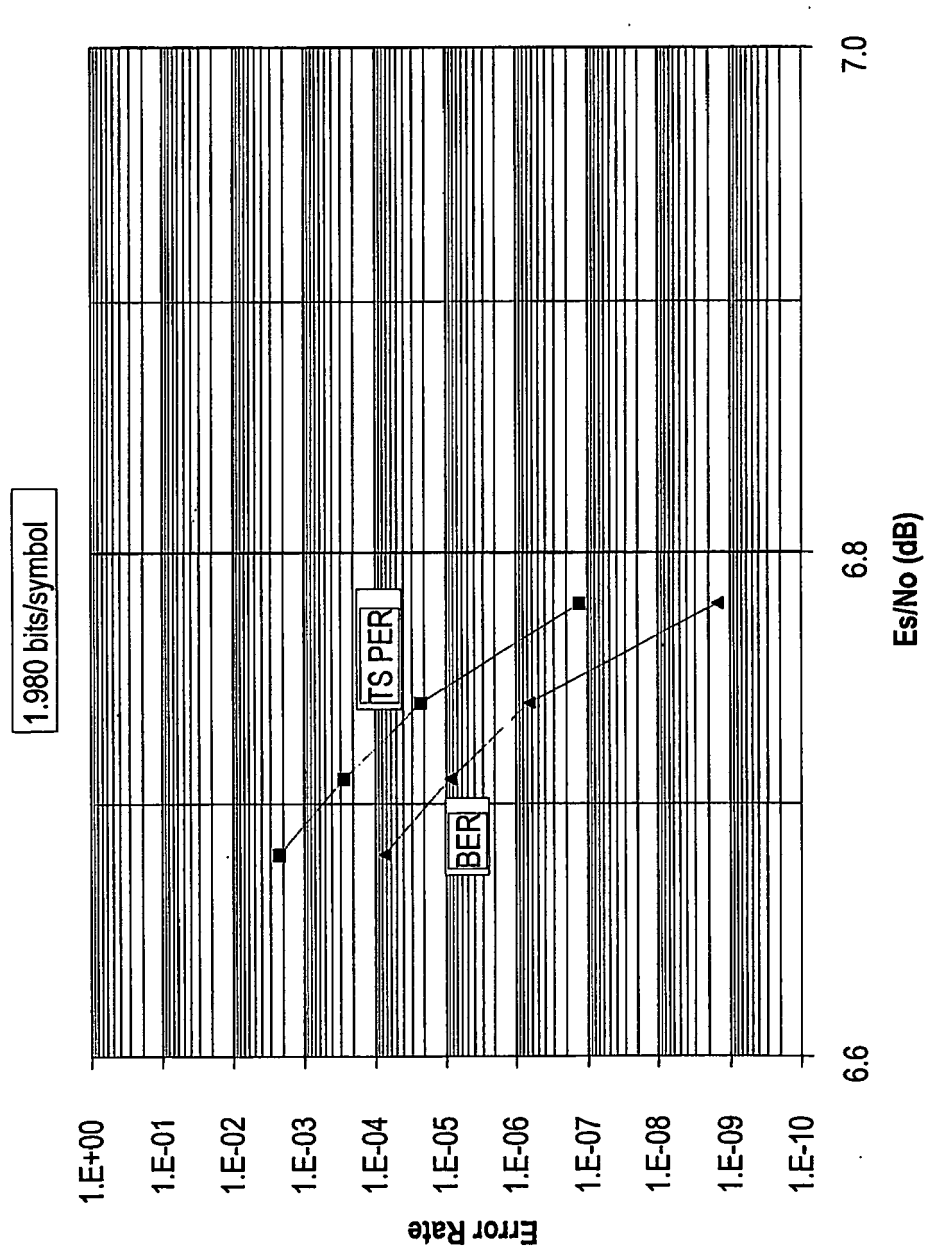

0.990 bits/symbol
TS PER
BER
Error Rate
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
0.9
1.1
1.3
Es/No (dB)

FIG. 14B

FIG. 14C


1.980 bits/symbol
TS PER
BER
1.E+00
1.E-01
1.E-02
1.E-03
1.E-04
1.E-05
1.E-06
1.E-07
1.E-08
1.E-09
1.E-10
Error Rate
6.6
6.8
7.0
Es/No (dB)

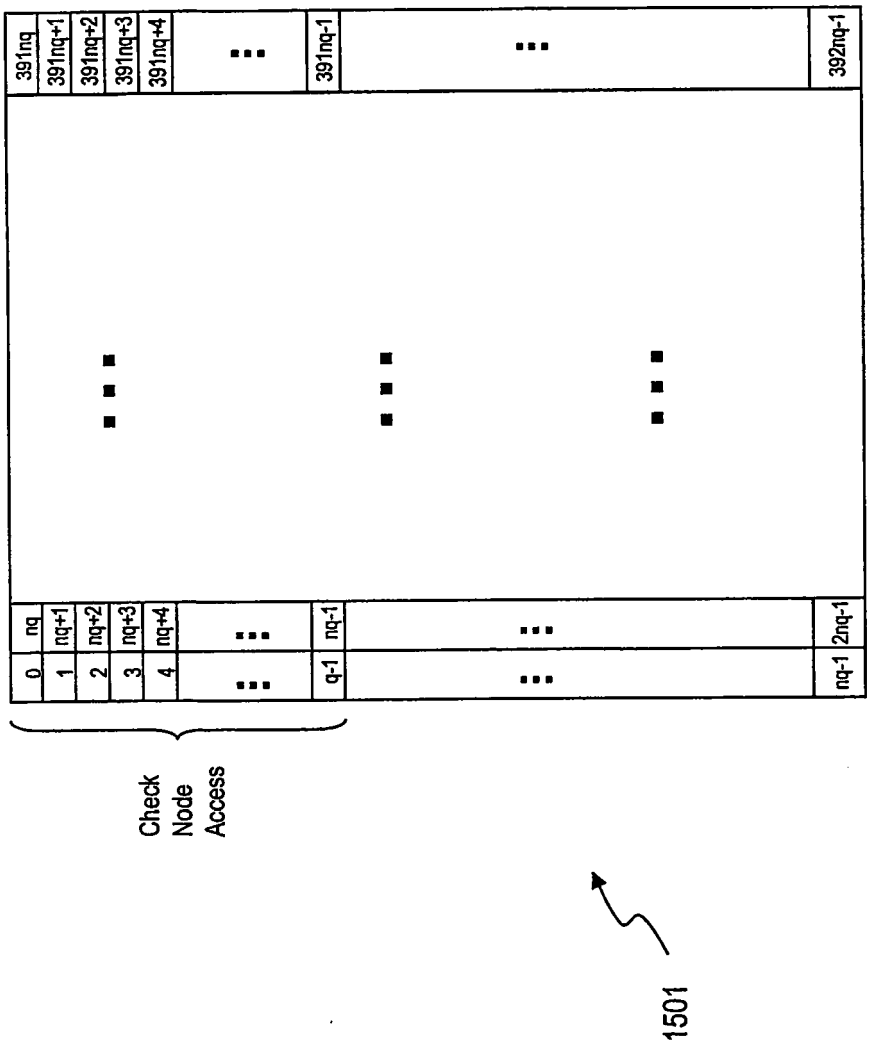
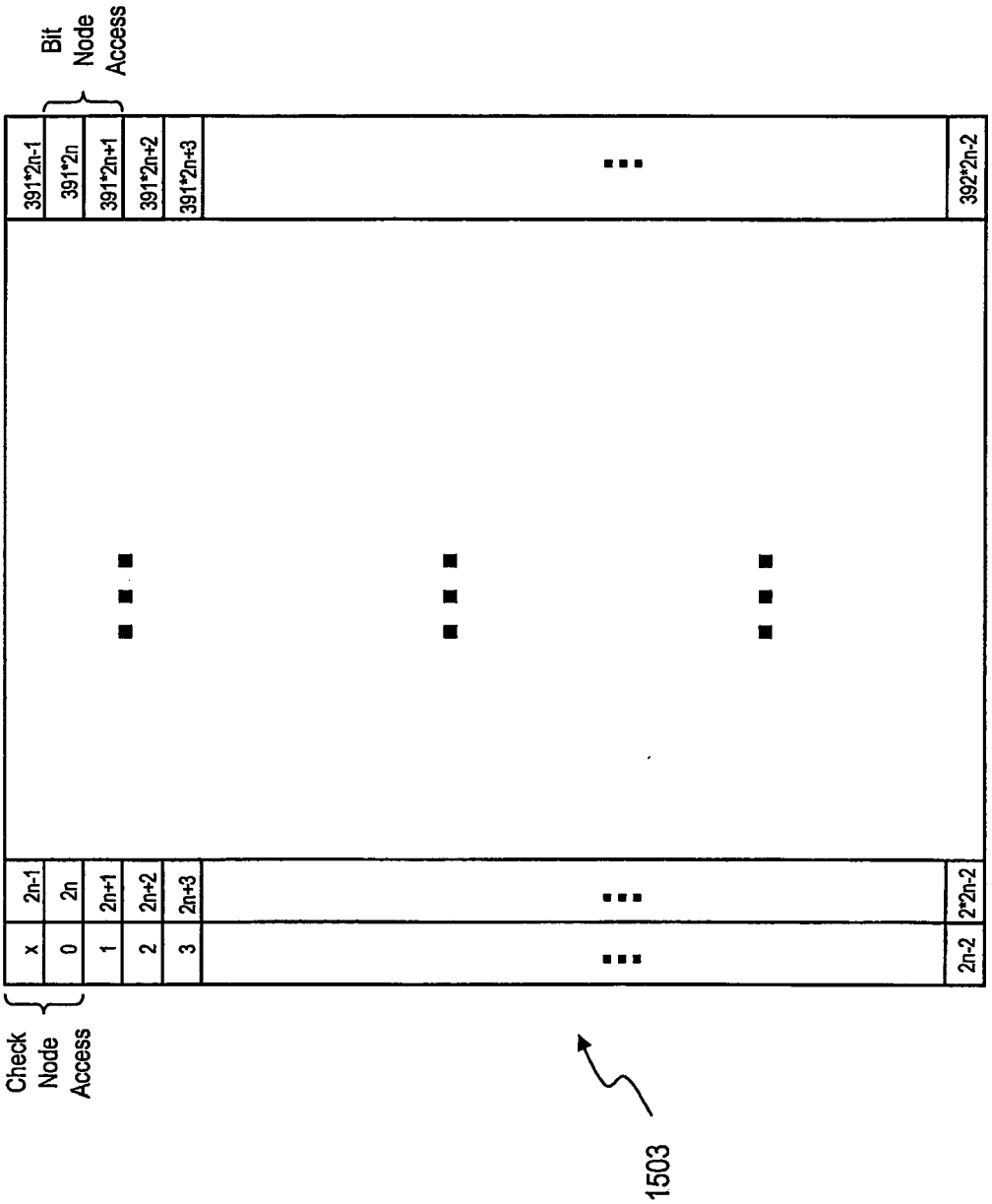

391nq
391nq+1
391nq+2
391nq+3
391nq+4
391nq-1
392nq-1
nq
nq+1
nq+2
nq+3
nq+4
nq-1
2nq-1
0
1
2
3
4
q-1
nq-1
Check Node Access
1501

FIG. 15A

FIG. 15B


Bit Node Access
391*2n-1
391*2n
391*2n+1
391*2n+2
391*2n+3
392*2n-2
2n-1
2n
2n+1
2n+2
2n+3
2*2n-2
x
0
1
2
3
2n-2
Check Node Access
1503

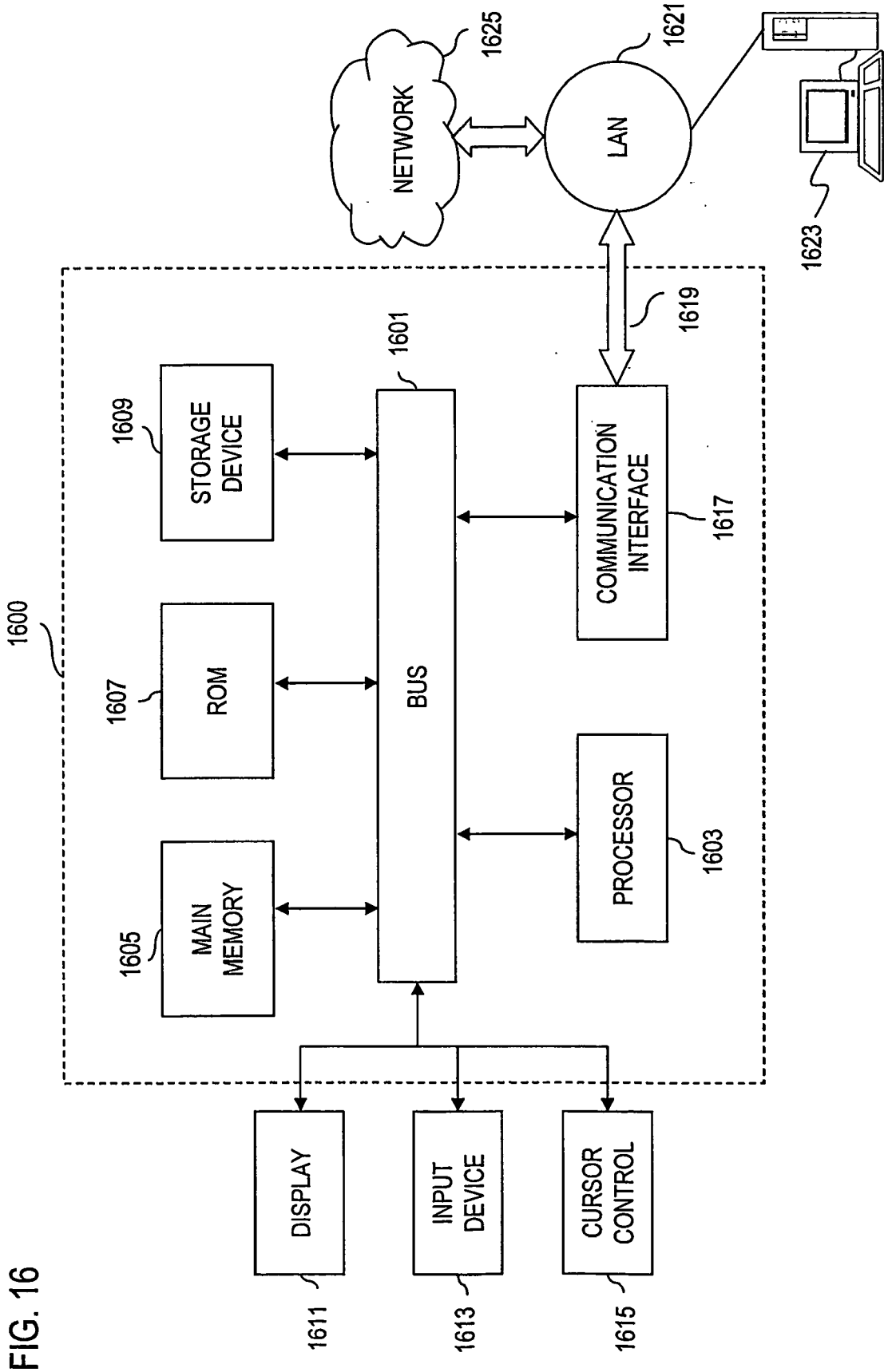

NETWORK
1625
LAN
1621
1623
1619
1601
1600
STORAGE DEVICE
1609
ROM
1607
MAIN MEMORY
1605
BUS
COMMUNICATION INTERFACE
1617
PROCESSOR
1603
DISPLAY
1611
INPUT DEVICE
1613
CURSOR CONTROL
1615

FIG. 16

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- WO 02103631 A **[0004]**