DRAFT

Low Density Parity Check Coding

The bit sequence input for a given code block to channel coding is denoted by $u_1 \quad u_2 \quad \dots \quad u_K$, where K is the number of bits to be encoded. The parity check bit sequence produced by FEC Encoder is denoted by $p_1 \quad p_2 \quad \dots \quad p_M$, where M is the number of parity check bits. The output of FEC Encoder is denoted by $\mathbf{c} = [c_1 \quad c_2 \quad \dots \quad c_N] = [u_1 \quad u_2 \quad \dots \quad u_K | p_1 \quad p_2 \quad \dots \quad p_M]$, where $N = K + M$ is length of encoder output sequence.

The FEC encoding scheme is shown in Figure x1. The scheme consists of a systematic QC-LDPC encoder and a shortening and puncturing mechanism. The parameters of the FEC encoding scheme are:

– the LDPC parity check matrix is a 1~~2~~3-by-~~69~~75 quasi-cyclic matrix, with circulant size $Z = 256$; LDPC user bit length before shortening is 5~~7~~62 $\times$ 256 = 14,592~~15,872~~, the parity bit length before puncturing is 1~~2~~3 $\times$ 256 = 3,072~~328~~; the codeword length before any shortening and puncturing is 17,664~~19,200~~;
– the number of transmitted information bits, K (with maximum user length $K_{\max}$ = 14,328~~5,677~~);
– the number of shortened information bits, S ($S_{\min}$ = 264~~195~~);
– the number of punctured parity check bits, P ($P = 512$);
– the number of parity-check bits after puncturing, M (M = 3,072~~328~~ − 512 = 2,560~~816~~);
– the number of output bits, N ($N = K + M$, FEC codeword, whose size depends on the burst length pattern to determine shortening length); $N_{max} = K_{max} + M$ = 16,888~~8,493~~;
– the code rate, $R = K/N$, defined as the code rate after puncturing and after shortening.

The encoder supports highest code rate $R_{\max} = \frac{K_{\max}}{N_{max}} = 0.848477$. Codes with lower code rates/shorter block length shall be obtained through shortening. The puncturing length and location are fixed for all scenarios.

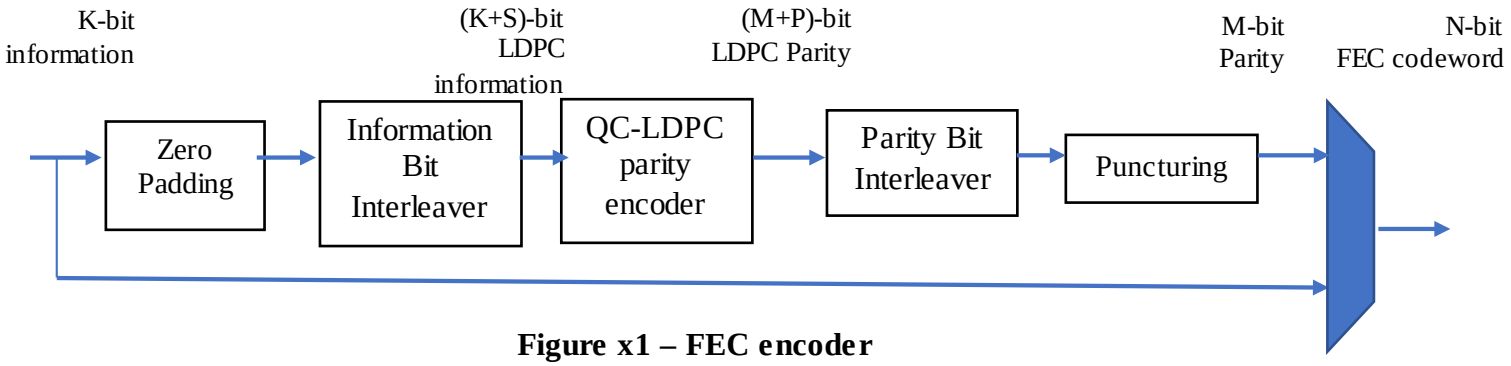

Figure x1 – FEC encoder

LDPC Encoder

The full LDPC code is defined by a (M+P)×(K+S+M+P) = 3,072328 ×17,6649200 size parity-check matrix H composed by a 123×6975 array of 256×256 sub-matrices $\mathbf{A}_{i,j}$,:

$$\mathbf{H} = \begin{bmatrix} \mathbf{A}_{1,1} & \cdots & \mathbf{A}_{1,6975} \\ \vdots & \ddots & \vdots \\ \mathbf{A}_{123,1} & \cdots & \mathbf{A}_{123,6975} \end{bmatrix}$$

The sub-matrices $\mathbf{A}_{i,j}$ are either a cyclic shifted version of identity matrix or a zero matrix, and have a size of 256×256. The parity-check matrix can be described in its compact form:

$$\mathbf{H}_c = \begin{bmatrix} a_{1,1} & \cdots & a_{1,6975} \\ \vdots & \ddots & \vdots \\ a_{123,1} & \cdots & a_{123,6975} \end{bmatrix}$$

where $a_{i,j} = -1$ for a zero sub-matrix in position (i, j), and a positive integer number $a_{i,j}$ defines the number of right column shifts of the identity matrix.

Note to Editor (to be removed prior to publication): If the parity matrix font size is too small for publication, suggest following what Clause 55/55A did by having a zip file made downloadable from http://standards.ieee.org/downloads/802.3/ containing han_3ca_1_031-18.txt. Hopefully, will be cleaner and easier than creating larger tables like as was done in Clause 101.

The compact form of parity-check matrix $\mathbf{H}_c$ shown below:

80 -1 -1 60 169 -1 11 -1 143 -1 -1 222 -1 59 -1 218 -1 -1 178 -1 -1 -1 -1 -1 105 -1 -1 19 -1 -1 126 -1 -1 -1 211 -1 -1 -1 -1 -1 247 -1 255 -1 -1 85 -1 -1 -1 -1 -1 246 94 -1 -1 -1 -1 -1 242 -1 -1 -1 -1 129 -1 19 58 27
-1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 0 -1 0 -1 -1 -1 0 -1 0 -1 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 -1 0 -1 -1 0 -1 -1 -1 -1 -1 -1 0 -1
-1 91 -1 74 -1 237 202 -1 -1 201 136 -1 178 -1 239 -1 183 -1 -1 217 -1 232 -1 -1 -1 169 -1 -1 -1 -1 -1 -1 129 60 -1 -1 -1 -1 -1 19 76 -1 -1 -1 -1 -1 77 -1 -1 -1 2 -1 -1 -1 101 -1 -1 217 -1 -1 -1 48 -1 -1 -1 -1 -1 172 42
105 -1 -1 87 -1 43 -1 165 -1 180 -1 80 227 -1 221 -1 77 -1 -1 0 -1 -1 -1 -1 16 -1 -1 -1 -1 252 -1 96 -1 0 -1 -1 -1 -1 17 -1 -1 -1 -1 -1 219 -1 -1 198 165 -1 -1 -1 -1 36 -1 -1 -1 -1 171 -1 -1 -1 -1 228 -1 -1 -1 39 234
-1 170 250 -1 -1 195 139 -1 -1 135 -1 92 -1 147 -1 1 -1 -1 -1 -1 13 -1 -1 98 -1 -1 142 -1 -1 -1 225 -1 -1 -1 -1 -1 23 108 -1 -1 -1 -1 -1 -1 0 -1 0 -1 -1 -1 -1 135 -1 -1 -1 -1 121 0 -1 -1 -1 -1 -1 0 -1 -1 46 242 228
-1 46 -1 37 -1 49 150 -1 65 -1 -1 177 144 -1 70 -1 95 -1 -1 221 -1 -1 -1 192 -1 128 -1 -1 214 -1 -1 -1 -1 -1 51 -1 -1 -1 100 -1 -1 19 -1 -1 235 -1 -1 -1 -1 -1 -1 4 -1 -1 251 -1 -1 109 -1 -1 -1 -1 -1 -1 140 -1 -1 193 241
137 -1 104 -1 238 -1 -1 228 -1 225 247 -1 -1 191 -1 177 -1 255 -1 -1 -1 -1 192 -1 -1 -1 -1 51 -1 -1 -1 -1 195 -1 0 -1 -1 172 -1 -1 -1 -1 -1 219 -1 -1 236 -1 -1 136 -1 -1 -1 0 -1 -1 -1 159 -1 -1 10 -1 -1 -1 -1 -1 5 -1 25 94
-1 118 15 -1 93 -1 -1 228 -1 78 -1 16 0 -1 48 -1 0 -1 -1 -1 62 -1 0 -1 -1 0 -1 -1 -1 -1 0 0 -1 -1 -1 -1 -1 -1 112 -1 0 -1 -1 -1 -1 -1 -1 0 -1 -1 -1 0 0 -1 -1 -1 -1 22 -1 -1 -1 -1 -1 0 0 -1 -1 -1 -1 120 192
-1 208 0 -1 0 -1 0 -1 0 -1 0 -1 -1 251 0 -1 -1 44 123 -1 -1 -1 -1 0 -1 -1 0 -1 -1 -1 -1 0 0 -1 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 153 -1 -1 -1 -1 0 -1 -1 0 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 0 0 16 0
0 -1 -1 123 -1 41 191 -1 211 -1 217 -1 243 -1 97 -1 252 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 -1 0 -1 -1 41 -1 -1 -1 29 -1 0 -1 -1 -1 -1 0 -1 -1 -1 -1 193 -1 145 -1 -1 -1 -1 0 -1 -1 -1 -1 -1 140 46 -1 -1 58 -1 202 215
209 -1 252 -1 39 -1 -1 159 69 -1 37 -1 134 -1 -1 201 49 -1 -1 -1 -1 104 -1 -1 -1 -1 129 -1 -1 157 -1 -1 -1 222 -1 -1 -1 -1 -1 -1 -1 139 39 -1 -1 -1 -1 -1 203 -1 94 -1 -1 -1 -1 -1 194 -1 -1 3 -1 -1 43 153 -1 -1 -1 207 109
53 -1 93 -1 216 -1 -1 57 9 -1 130 -1 -1 130 -1 238 -1 -1 -1 -1 -1 144 -1 -1 -1 -1 -1 162 0 -1 -1 -1 -1 -1 175 -1 -1 -1 145 -1 0 -1 -1 -1 36 -1 -1 -1 -1 -1 91 -1 -1 22 -1 -1 -1 0 0 212 -1 -1 -1 0 -1 -1 69 88

A fixed amount (512 bits) and locations of the parities are punctured on the full LDPC matrix; a minimum amount (264195 bits) and locations of the user bits are shortened on the full LDPC matrix. The effective maximum code rate 0.848477.

Figure x3 – Codeword Information/Parity Location assignments