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Abstract

This submission shows

* Coding for Data field

Revisions:

* Rev 0: Initial version of the document.
* Rev 1: TBD topics are highlighted in yellow
* Rev 2: Updated MCS values, and editorial changes based on comments
* Rev 3: Added $N\_{SD,short}$values for BPSK+DCM+DUP mode
* Rev 4: Editorial changes

**34.3.11.5 coding**

The Data field shall be encoded using either the binary convolutional code (BCC) defined in 34.3.11.5.1

(BCC coding and puncturing) or the low density parity check (LDPC) code defined in 34.3.11.5.2 (LDPC

coding). For an EHT MU PPDU, the coding type is selected by the Coding subfield in EHT-SIG User field, as defined in 34.3.10.7 (EHT-SIG). For an EHT TB PPDU, the coding type is selected by the UL FEC Coding Type subfield in User Info field in the soliciting Trigger frame, or the RU size indicated in RU allocation subfield in the soliciting frame carrying a TRS Control subfield, as defined in 9.3.1.22 (Trigger frame format) and 26.5.2.3.4 (TXVECTOR parameters for HE TB PPDU response to TRS Control subfield), respectively.

When conducting FEC encoding for multi-link operation, one FEC encoder is applied to one PSDU per STA for each link.

**34.3.11.5.1 BCC coding**

Support for BCC coding is limited to less than or equal to four spatial streams, EHT-MCSs 0 to 9, and EHT-MCS x (BPSK+DCM with $N\_{SS}=1$) (per user in the case of MU-MIMO), and is mandatory (for both transmit and receive) for RU or MRU sizes less than or equal to a 242-tone RU.

BCC encoding process is described in 27.3.12.5.1 (BCC coding and puncturing).

If EHT-MCSx (MCS0+DCM with $N\_{SS}=1$) is used in a 106-tone, 242-tone RU, or 106-tone + 26-tone MRU with BCC coding, then after every $2×N\_{DBPS}$ coded bits, one padding bit is added. The padding bit may be set to any value.

**34.3.11.5.2 LDPC coding**

LDPC is the only FEC coding scheme in the EHT PPDU Data field for RUs or MRUs with RU sizes greater than a 242-tone RU. LDPC is the only FEC coding scheme in the EHT PPDU Data field for EHT-MCSs 10 to 13. The LDPC Coding In Payload subfield of the EHT Capabilities element indicates support for the transmission and reception of the LDPC encoded PPDUs. Support for LDPC coding (for both transmit and receive) is mandatory for EHT STAs declaring support for at least one of EHT 40/80/160/80+80/320/160+160 MHz PPDU bandwidths for SU transmission, for EHT STAs declaring support for more than 4 spatial streams, or for EHT STAs declaring support for EHT-MCSs 10 and 11, according to the LDPC Coding In Payload subfield of the EHT Capabilities element as defined in 9.4.2.x (EHT Capabilities element). Otherwise, support of LDPC coding for either transmit or receive is optional.

**34.3.11.5.3 EHT PPDU padding process**

A two-step padding process is applied to an EHT PPDU. A pre-FEC padding process including both pre-FEC MAC and pre-FEC PHY padding is applied before conducting FEC coding, and a post-FEC PHY padding process is applied on the FEC encoded bits.

Four pre-FEC padding boundaries partition the last OFDM symbol of an EHT PPDU into four symbol segments. The pre-FEC padding may pad toward one of the four possible boundaries. The four pre-FEC padding boundaries are represented by a pre-FEC padding factor parameter.

Figure 34-3.11.5-1 (EHT PPDU padding process in the last OFDM symbol if a = 1 for the *u*-th user) illustrates these four possible symbol segments in the last OFDM symbol, and the general padding process assuming the desired pre-FEC padding boundary, represented by the pre-FEC padding factor, is 1.



**Figure 34-3.11.5-1 ⎯ EHT PPDU padding process in the last OFDM symbol if *a* = 1 for the *u*-th user**

**34.3.11.5.4 Encoding process for an EHT MU PPDU**

For an EHT MU PPDU, all the users shall use a common pre-FEC padding factor *a* value and a common $N\_{SYM}$ value. The padding process is described as follows.

In an EHT MU PPDU transmission, the transmitter first computes the number of bits left in the last OFDM symbol for user *u* as in Equation (34-3.12.5-1).

 $N\_{Excess,u}=mod\left(8∙APEP\\_LENGTH\_{u}+N\_{Tail}+N\_{service},N\_{DBPS,u}\right)$ (34-3.12.5-1)

where

 $APEP\\_LENGTH\_{u}$ is the TXVECTOR parameter $APEP\\_LENGTH$ for the *u-*th user.

 $N\_{Tail}$ is the number of tails bits per encoder as defined in Table 34-3.8-x (Timing-related constants)

 $N\_{service} $is the number of bits in the SERVICE field as defined in Table 34-3.8-x (Timing-related constants)

 $N\_{DBPS,u}$ is the number of data bits per OFDM symbol for the *u-*th user.

Based on $N\_{Excess,u}$, the transmitter then computes the initial number of symbol segments in the last OFDM symbol, i.e., initial pre-FEC padding factor value $a\_{init,u}$ as shown Equation (34-3.12.5-2), and the initial number of OFDM symbols, $N\_{SYM,init,u}$, for each user *u* using Equation (34-3.11.2-3).

 $a\_{init,u}=\left\{\begin{matrix}4, if N\_{Excess,u}=0\\min\left(\left⌈\frac{N\_{Excess,u}}{N\_{DBPS,short,u}}\right⌉,4\right), otherwise\end{matrix}\right.$ (34-3.12.5-2)

 $N\_{SYM,init,u}=\left⌈\frac{8∙APEP\\_LENGTH\_{u}+N\_{Tail}+N\_{service}}{N\_{DBPS,u}}\right⌉$ (34-3.11.5-3)

where

 $N\_{DBPS,short,u}=N\_{CBPS,short,u}∙R\_{u}$, in which $R\_{u}$ is the coding rate for the *u-*th user.

 $N\_{CBPS,short,u}=N\_{SD,short,u}∙N\_{SS,u}∙N\_{BPSCS,u}$, in which $N\_{SD,short,u}$ is the $N\_{SD,short}$ value corresponding to the
 occupied RU or MRU size of the *u-*th user, $N\_{SS,u}$ and $N\_{BPSCS,u}$ are defined in Table 34-3.8-x (Frequently used
 parameters).

The parameter $N\_{SD,short}$ values for different RU and MRU sizes are shown in Table 34-3.12.5-1 ($N\_{SD,short}$ values).

**Table 34-3.12.5-1 (**$N\_{SD,short}$ **values)**

|  |  |
| --- | --- |
| **RU/MRU size** | $$N\_{SD,short}$$ |
| **DCM=0** | **DCM=1** | **DCM=1, DUP** |
| 26-tone | 6 | 2 | − |
| 52-tone | 12 | 6 | − |
| 52+26-tone | 18 | 8 | − |
| 106-tone | 24 | 12 | − |
| 106+26-tone | 30 (TBD) | 14 (TBD) | − |
| 242-tone | 60 | 30 | − |
| 484-tone | 120 | 60 | − |
| 484+242-tone | 180 (TBD) | 90 (TBD) | − |
| 996-tone | 240 | 120 | 60 (TBD) |
| 996+484-tone | 360 (TBD) | 180 (TBD) | − |
| 996+484+242-tone | 420 (TBD) | 210 (TBD) | − |
| 2x996-tone | 492 | 246 | 120 (TBD) |
| 2x996+484-tone | 612 (TBD) | 306 (TBD) | − |
| 3x996-tone | 732 (TBD) | 366 (TBD) | − |
| 3x996+484-tone | 852 (TBD) | 426 (TBD) | − |
| 4x996-tone | 984 (TBD) | 492 (TBD) | 246 (TBD) |

Among all the users, derive the user index with the longest encoded packet duration as in Equation (34-3.12.5-4).

 $u\_{max}=arg max\_{u=0}^{N\_{user,total}-1}\left(N\_{SYM,init,u}-1+\frac{a\_{init,u}}{4}\right)$ (34-3.12.5-4)

where

 $arg max f\left(x\right)≔\{x|x\in \left[0,N\_{user,total}-1\right] ⋀ ∀y\in \left[0,N\_{user,total}-1\right];f\left(y\right)\leq f(x)$

Then the common $a\_{init}$ and $N\_{SYM,init}$ values among all the users are derived by Equation (34-3.12.5-5).

 $\begin{matrix}N\_{SYM,init}=N\_{SYM,init,u\_{max}}\\a\_{init}=a\_{init,u\_{max}}\end{matrix}$ (34-3.11.5-5)

Next calculate each user’s initial number of data bits and initial number of coded bits in its last OFDM symbol as in Equations (34-3.12.5-6) and (34-3.12.5-7).

 $N\_{DBPS,last,init,u}=\left\{\begin{matrix}a\_{init}∙N\_{DBPS,short,u}, if a\_{init}<4\\N\_{DBPS,u}, if a\_{init}=4\end{matrix}\right.$ (34-3.11.5-6)

 $N\_{CBPS,last,init,u}=\left\{\begin{matrix}a\_{init}∙N\_{CBPS,short,u}, if a\_{init}<4\\N\_{CBPS,u}, if a\_{init}=4\end{matrix}\right.$ (34-3.11.5-7)

For each user with LDPC encoding, the number of pre-FEC padding bits for the *u*-th user is computed as in Equation (34-3.11.5-8).

 $N\_{PAD,Pre-FEC,u}=(N\_{SYM,init}-1)N\_{DBPS,u}+N\_{DBPS,last,init,u}-8∙APEP\\_LENGTH\_{u}-N\_{service}$ (34-3.11.5-8)

For each user with LDPC encoding, the parameters $N\_{pld,u}$ and $N\_{avbits,u}$ are computed using Equations (34-3.11.5-9) and (34-3.11.5-10), respectively.

 $N\_{pld,u}=\left(N\_{SYM,init}-1\right)N\_{DBPS,u}+N\_{DBPS,last,init,u}$ (34-3.11.5-9)

 $N\_{avbits,u}=\left(N\_{SYM,init}-1\right)N\_{CBPS,u}+N\_{CBPS,last,init,u}$ (34-3.11.5-10)

For each user with LDPC encoding continue LDPC encoding process as in 19.3.11.7.5 (LDPC PPDU encoding

process) starting with the parameters $N\_{pld,u}$ and $N\_{avbits,u}$. If there is at least one user with LDPC encoding for which the following condition in step d) of LDPC encoding process as described in 19.3.11.7.5 (LDPC PPDU encoding process) is met:

 $\left(N\_{punc,u}>0.1×N\_{CW,u}×L\_{LDPC,u}×\left(1-R\_{u}\right)\right) AND \left(N\_{shrt,u}<1.2×N\_{punc,u}×\frac{R\_{u}}{1-R\_{u}}\right) is true OR if $

 $N\_{punc,u}>0.1×N\_{CW,u}×L\_{LDPC,u}×\left(1-R\_{u}\right) is true,$

where $N\_{punc,u}$, $N\_{CW,u}$, $L\_{LDPC,u}$, $N\_{shrt,u}$ are the LDPC encoding parameters for user *u*, as defined in 19.3.11.7.5 (LDPC PPDU encoding process), and $R\_{u}$ is the coding rate of user *u*, then the LDPC Extra Symbol Segment field of U-SIG shall be set to 1, and all users with LDPC encoding shall increment $N\_{avbits}$ and recompute $N\_{punc}$, using Equations (34-3.11.5-11) and (34-3.11.5-12)

 $N\_{avbits,u}=\left\{\begin{matrix}N\_{avbits,u}+N\_{CBPS,u}-3N\_{CBPS,short,u}, if a\_{init}=3\\N\_{avbits,u}+N\_{CBPS,short,u}, otherwise\end{matrix}\right.$ (34-3.11.5-11)

 $N\_{punc,u}=max\left(0,\left(N\_{CW,u}×L\_{LDPC,u}\right)-N\_{avbits,u}-N\_{shrt,u}\right)$ (34-3.11.5-12)

Then update the common pre-FEC padding factor *a* and $N\_{SYM}$ values for all users by Equation (34-3.11.5-13).

 $\left\{\begin{matrix}N\_{SYM}=N\_{SYM,init}+1 and a=1, if a\_{init}=4\\N\_{SYM}=N\_{SYM,init} and a=a\_{init}+1, otherwise\end{matrix}\right.$ (34-3.11.5-13)

If none of the users with LDPC encoding for which the condition mentioned above in step d) of LDPC encoding process as described in 19.3.11.7.5 (LDPC PPDU encoding process) is met, or if all the users scheduled in the EHT MU PPDU are BCC encoded, then the LDPC Extra Symbol Segment field of U-SIG shall be set to 0, and the common pre-FEC padding factor *a* and $N\_{SYM}$ values for all users shall be updated by Equation (34-3.11.5-14).

 $\begin{matrix}N\_{SYM}=N\_{SYM,init}\\a=a\_{init}\end{matrix}$ (34-3.11.5-14)

For the users with LDPC encoding,

 $N\_{DBPS,last,u}=N\_{DBPS,last,init,u}$ (34-3.11.5-15)

For the users with BCC encoding, update the $N\_{DBPS}$ of the last OFDM symbol as

 $N\_{DBPS,last,u}=\left\{\begin{matrix}a∙N\_{DBPS,short,u}, if a<4\\N\_{DBPS,u}, if a=4\end{matrix}\right.$ (34-3.11.5-16)

For each user with either LDPC or BCC encoding, update the $N\_{CBPS}$ of the last OFDM symbol as

 $N\_{CBPS,last,u}=\left\{\begin{matrix}a∙N\_{CBPS,short,u}, if a<4\\N\_{CBPS,u}, if a=4\end{matrix}\right.$ (34-3.11.5-17)

For the users with BCC encoding, the number of pre-FEC padding bits is shown in Equation (34-3.11.5-18).

 $N\_{PAD,Pre-FEC,u}=(N\_{SYM}-1)N\_{DBPS,u}+N\_{DBPS,last,u}-8∙APEP\\_LENGTH\_{u}-N\_{Tail}-N\_{service}$ (34-3.11.5-18)

For each user with either LDPC or BCC encoding, the number of post-FEC padding bits in the last

symbol is computed as in Equation (34-3.11.5-16).

 $N\_{PAD,Post-FEC,u}=N\_{CBPS,u}-N\_{CBPS,last,u}$ (34-3.11.5-19)

Among the pre-FEC padding bits, the MAC delivers a PSDU that fills the available octets in the Data field

of the EHT PPDU, toward the desired initial pre-FEC padding boundary represented by $a\_{init}$ for users encoded

by LDPC, and toward the desired pre-FEC padding boundary represented by *a* for users encoded by BCC, in the last OFDM symbol. The PHY then determines the number of padding bits to add and appends them to the PSDU. The

number of pre-FEC padding bits added by PHY will always be 0 to 7. The procedure is defined in Equation (34-3.11.5-20) and Equation (34-3.11.5-21).

 $N\_{PAD,Pre-FEC,MAC,u}=8∙\left⌊\frac{N\_{PAD,Pre-FEC,u}}{8}\right⌋$ (34-3.11.5-20)

 $N\_{PAD,Pre-FEC,PHY,u}=N\_{PAD,Pre-FEC,u} mod 8$ (34-3.11.5-21)

**34.3.11.5.5 Encoding process for an EHT TB PPDU**

For an EHT TB PPDU sent in response to a Trigger frame, the AP indicates the UL Length, GI And EHT-LTF

Type, Number Of EHT-LTF Symbols And Midamble Periodicity, Pre-FEC Padding Factor, LDPC Extra Symbol Segment, PE Disambiguity and Doppler fields in the Trigger frame. The common values $T\_{PE}$ and $N\_{SYM}$ are derived by non-AP STAs as shown in Equation (34-3.12-x) and Equation (34-3.12-x). The AP shall set the LDPC Extra Symbol Segment field in the Common Info field of the Trigger frame to 1 if the calculations described in the EHT MU PPDU encoding process indicate the need for an LDPC extra symbol segment for any LDPC encoded user solicited by the AP for an EHT TB PPDU transmission.

NOTE—The AP might set the LDPC Extra Symbol Segment field to 1 regardless of the value derived from the calculations. The AP might select a value for the Pre-FEC Padding Factor field that differs from that derived from the calculations described in the EHT MU encoding process.

For an EHT TB PPDU sent in response to a frame containing a TRS Control subfield, the parameters used to

derive the common values $T\_{PE}$ and $N\_{SYM}$are described in 26.5.2.3.4 (TXVECTOR parameters for HE TB PPDU response to TRS Control subfield).

For an EHT TB PPDU with BCC encoding, follow the EHT MU padding and encoding process as described in 34.3.11.5.4 (EHT MU PPDU encoding process) with initial parameters as follows:

 ⎯ If the TXVECTOR parameter TRIGGER\_METHOD is TRIGGER\_FRAME, the initial parameters are $N\_{SYM,init}= N\_{SYM}$ and $a\_{init}=a$, where *a* is the pre-FEC padding factor indicated in the Pre-FEC Padding Factor subfield of the Common info field in the Trigger frame, and $N\_{SYM}$ is the common number of data OFDM symbols derived from the UL Length, Number Of EHT-LTF Symbols And Midamble Periodicity, and Doppler subfields of the Common Info field in the Trigger frame.

 ⎯ If the TXVECTOR parameter TRIGGER\_METHOD is TRS, the initial parameters are set to $N\_{SYM,init}= F\_{VAL}+1$ and $a\_{init}=4$, where $F\_{VAL}$ is the value of the UL Data Symbol subfield of the TRS Control subfield.

For an EHT TB PPDU with LDPC encoding, follow the EHT MU padding and encoding process as described in 34.3.11.5.4 (EHT MU PPDU encoding process) with initial parameters as follows

 ⎯ If the TXVECTOR parameter TRIGGER\_METHOD is TRIGGER\_FRAME and the LDPC Extra Symbol Segment field in the Trigger frame is 1, set the initial parameter using Equation (34-3.11.5-22).

 $\left\{\begin{matrix}a\_{init}=4 and N\_{SYM,init}= N\_{SYM}-1, if a=1\\a\_{init}=a-1 and N\_{SYM,init}=N\_{SYM}, otherwise\end{matrix}\right.$ (34-3.11.5-22)

 Then continue with the LDPC encoding process as in 34.3.11.5.4 (EHT MU PPDU encoding process), during which $N\_{avbits,u}$ is always incremented as in Equation (34-3.11.5-11), and $N\_{punc,u}$ is always recomputed as in Equation (34-3.11.5-12).

 ⎯ If the TXVECTOR parameter TRIGGER\_METHOD is TRIGGER\_FRAME and the LDPC Extra Symbol Segment field in the Trigger frame is 0, set initial parameters to $N\_{SYM,init}= N\_{SYM}$ and $a\_{init}=a$. Then continue with the LDPC encoding process as in 34.3.11.5.4 (EHT MU PPDU encoding process), during which $N\_{avbits,u}$ and $N\_{punc,u}$ are not changed.

 ⎯ If the TXVECTOR parameter TRIGGER\_METHOD is TRS, then the parameter LDPC\_EXTRA\_SYMBOL is 1, and initial parameters are set to $N\_{SYM,init}= F\_{VAL}+1$ and $a\_{init}=3$, where $F\_{VAL}$ is the value of the UL Data Symbols subfield of the TRS Control subfield. Then continue with the LDPC encoding process as in 34.3.11.5.4 (EHT MU PPDU encoding process), during which $N\_{avbits,u}$ is always incremented as in Equation (34-3.11.5-11), and $N\_{punc,u}$ is always recomputed as in Equation (34-3.11.5-12).