IEEE P802.11  
Wireless LANs

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| **Proposed Draft Text: EHT LTF Sequence** | | | | |
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Abstract

This submission proposes the draft text on EHT-LTF for 802.11be D0.3.

Revisions:

* Rev 0: update the GI and math description
* Rev 1: Track changes from 11be draft 0.2
* Rev 2: some typos fixed
* Rev 3: include extra LTF

References:

[1] 802.11-20/1935r4 Compendium of Stras Polls and Potential Changes to the Specification Framework Document

36.3.11.10 EHT-LTF

The EHT-LTF field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs and the receive chains. In an EHT MU PPDU, the transmitter provides training for *NSS, r, total* spatial streams used for the transmission of the PSDU(s) in the r-th RU/MRU. In an EHT TB PPDU, the transmitter of user *u* in the *r*-th RU/MRU provides training for *NSS, r, u* spatial streams used for the transmission of the PSDU. For each subcarrier in the r-th RU/MRU, the MIMO channel that can be estimated is an *NRX × NSS, r, total* matrix. An EHT transmission has a preamble that contains EHT-LTF symbols, where the data tones of each EHT-LTF symbol are multiplied by entries belonging to a matrix *PEHT-LTF*, to enable channel estimation at the receiver. When single stream pilot is used in EHT-LTF, the pilot subcarriers of each EHT-LTF symbol are multiplied by the entries of a matrix *REHT-LTF* to allow receivers to track phase and/or frequency offset during MIMO channel estimation using the EHT-LTF. Single stream pilots shall be used for all spatial multiplexing modes (both UL and DL) defined in EHT except when 1x LTF is used. *PEHT-LTF* is defined such that each modulated spatial stream in an RU/MRU is active on all sub-carriers in that RU/MRU for which the EHT-LTF sequence takes a non-zero value. This is applicable to multi-AP transmission modes as well

In an EHT MU PPDU with a single RU/MRU (the RU/MRU having an MU-MIMO allocation or an SU allocation), the minimum number of EHT-LTF symbols, *NEHT-LTF*, is a function of the total number ofspatial streams *NSS* as shown in Table 36-xx (Minimum Number of EHT-LTFs required for different numbers of spatial streams).

Table 36-xx—Minimum Number of EHT-LTFs required for different numbers of spatial streams

|  |  |
| --- | --- |
| ***NSS*** | **Minimum *NEHT-LTF*** |
| 1 | 1 |
| 2 | 2 |
| 3-4 | 4 |
| 5-6 | 6 |
| 7-8 | 8 |
| … | … |

In an EHT MU PPDU, *NEHT-LTF* is indicated in the U-SIG field. In an EHT MU PPDU with more than one RU/MRU, *NEHT-LTF* may take a value that is greater than or equal to the maximum value of the initial number of EHT-LTF symbols for each RU/MRU, where the initial number of EHT-LTF symbols is calculated as a function of *NSS, r, total* (where *r* is the index of the RU/MRU) based on Table 36-xx (Minimum Number of EHT-LTFs required for different numbers of spatial streams).

In an EHT TB PPDU, *NEHT-LTF* is indicated in the Trigger frame that triggers the transmission of the PPDU. In a non-OFDMA EHT TB PPDU, the minimum number of EHT-LTF symbols, *NEHT-LTF*, is a function of the total number of spatial streams, *NSS*, as shown in Table 36-xx (Minimum Number of EHT-LTFs required for different numbers of spatial streams). For an OFDMA EHT TB PPDU, *NEHT\_LTF* may be greater than or equal to the maximum value of the initial number of EHT-LTF symbols for each RU/MRU *r*, which is calculated as a function of *NSS, r, total*, separately based on Table 36-xx (Minimum Number of EHT-LTFs required for different numbers of spatial streams).

In order to improve the MIMO channel estimation for non-OFDMA transmisssions, the number of EHT-LTFs may be larger than the initial number of EHT-LTFs determined by the total number of spatial streams. If additional EHT-LTFs are used, then the total number of EHT-LTFs (which is signaled separately from Nss) should be no more than twice the initial number of EHT-LTFs determined by the number of spatial streams, and chosen from the set [2 4 8]. Supporting additional EHT-LTFs is optional for the receiver, which is indicated by EHT PHY capability fields.

An EHT PPDU supports 3 EHT-LTF types: 1x EHT-LTF, 2x EHT-LTF and 4x EHT-LTF. Table 36-xx (EHT-LTF type and GI duration combinations for various EHT PPDU formats) defines whether a particular EHT-LTF type and GI duration combination is mandatory, conditional mandatory or optional for each EHT PPDU format.

Table 36-xx—EHT-LTF type and GI duration combinations for various EHT PPDU formats

|  |  |  |  |
| --- | --- | --- | --- |
| **EHT-LTF type and GI duration combination** | **EHT MU PPDU** | **EHT sounding NDP** | **EHT TB PPDU** |
| 1x EHT-LTF  1.6 GI | N/A | N/A | M |
| 2x EHT-LTF  0.8 GI | M | M | N/A |
| 2x EHT-LTF  1.6 GI | M | M | M |
| 4x EHT-LTF  0.8 GI | O | N/A | N/A |
| 4x EHT-LTF  3.2 GI | M | O | M |
| M=mandatory  O = optional  N/A = not supported by the PPDU format  NOTE – 1× LTF + 1.6 μs GI only for non-OFDMA transmission.  If a STA does not support transmission or reception of a particular PPDU format, then the M/O designation is not applicable for the transmission or reception, respectively, of that PPDU format. | | | |

In an EHT MU PPDU, the combination of EHT-LTF type and GI duration is indicated in U-SIG field. In an EHT TB PPDU, the combination of EHT-LTF type and GI duration is indicated in the Trigger frame that triggers the transmission of the PPDU. If an EHT PPDU is an EHT sounding NDP, the combinations of EHT-LTF types and GI durations are listed in 36.3.17 (EHT sounding NDP).

The duration of each EHT-LTF symbol excluding GI is *TEHT-LTF*, defined in Equation (36-42).

where ,, are defined in Table 36-9 (Timing-related constants).

In a 20 MHz transmission, the 1x EHT-LTF sequence transmitted on subcarriers [–122: 122] is given by Equation (27-41) with *HELTF*-122,122replaced by *EHTLTF*-122,122.

In a 20 MHz transmission, the 2x EHT-LTF sequence transmitted on subcarriers [–122: 122] is given by Equation (27-42) with *HELTF*-122,122replaced by *EHTLTF*-122,122.

In a 20 MHz transmission, the 4x EHT-LTF sequence transmitted on subcarriers [–122: 122] is given by Equation (27-43) with *HELTF*-122,122replaced by *EHTLTF*-122,122.

In a 40 MHz transmission, the 1x EHT-LTF sequence transmitted on subcarriers [–244: 244] is given by Equation (27-44) with *HELTF*-244,244replaced by *EHTLTF*-244,244. .

In a 40 MHz transmission, the 2x EHT-LTF sequence transmitted on subcarriers [–244: 244] is given by Equation (27-45) with *HELTF*-244,244replaced by *EHTLTF*-244,244.

In a 40 MHz transmission, the 4x EHT-LTF sequence transmitted on subcarriers [–244: 244] is given by Equation (27-46) with *HELTF*-244,244replaced by *EHTLTF*-244,244.

In an 80 MHz transmission, the 1x EHT-LTF sequence transmitted on subcarriers [–500: 500] is given by Equation (27-47) with *HELTF*-500,500replaced by *EHTLTF*-500,500.

In an 80 MHz transmission, the 2x EHT-LTF sequence transmitted on subcarriers [–500: 500] is given by Equation Equation (27-48) with *HELTF*-500,500replaced by *EHTLTF*-500,500.

In an 80 MHz transmission, the 4x EHT-LTF sequence transmitted on subcarriers [–500: 500] is given by Equation Equation (27-49) with *HELTF*-500,500replaced by *EHTLTF*-500,500.

In a 160 MHz transmission using a 1x EHT-LTF, the 1x EHT-LTF sequence is given by Equation (27-50) with *HELTF*-1012,1012replaced by *EHTLTF*-1012, 1012.

In a 160 MHz transmission using a 2x EHT-LTF, the 2x EHT-LTF sequence is given by Equation (27-51) with *HELTF*-1012,1012replaced by *EHTLTF*-1012, 1012.

In a 160 MHz transmission using a 4x EHT-LTF, the 4x EHT-LTF sequence is given by Equation (27-52) with *HELTF*-1012,1012replaced by *EHTLTF*-1012, 1012.

In a 320 MHz transmission using a 1x EHT-LTF, the 1x EHT-LTF sequence is given by Equation (36-43).

(36-43)

where

means number of 23 consecutive 0s

*LTF*80MHz\_1st\_1x = {*LTF*80MHz\_left\_1x, 0, *LTF*80MHz\_right\_1x}

*LTF*80MHz\_2nd\_1x = {*LTF*80MHz\_left\_1x, 0, *LTF*80MHz\_right\_1x}

*LTF*80MHz\_3rd\_1x = {-*LTF*80MHz\_left\_1x, 0, -*LTF*80MHz\_right\_1x}

*LTF*80MHz\_4th\_1x = {-*LTF*80MHz\_left\_1x, 0, -*LTF*80MHz\_right\_1x}

*LTF*80MHz\_left\_1x and *LTF*80MHz\_right\_1x is in the section 27.3.11.10 HE-LTF

In a 320 MHz transmission using a 2x EHT-LTF, the 2x EHT-LTF sequence is given by Equation (36-44).

(36-44)

Where,

LTF80MHz\_2x = [ +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 0 0 0 0 0 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 +1 0 +1 0 -1 0 -1 0 +1 0 +1 0 +1 0 -1 0 -1 0 -1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 -1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 -1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 -1 0 -1 0 -1 0 +1 0 +1 0 -1 0 +1 0 +1 0 +1 0 +1 0 +1 0 -1 0 +1 0 +1];

Means number of 23 consecutive 0s.

In a 320 MHz transmission using a 4x EHT-LTF, the 4x EHT-LTF sequence is given by Equation (36-45).

(36-45)

, , , , , , , ,

, , , , , ,

where,

=[+1 -1 -1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 -1 +1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 -1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 +1 -1 -1 -1 -1 -1 -1 -1 -1 +1 -1 -1 +1 -1 -1 +1 +1 +1 -1 +1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 +1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 -1 +1 -1 +1 -1 -1 +1 +1 +1 +1 +1 -1 +1 +1 -1 -1 +1 +1 +1 -1 +1 +1 -1 +1 +1 -1 -1 +1 +1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 +1 -1 -1 +1 +1 -1 -1 -1 +1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 -1 +1 -1 +1 +1 -1 -1 -1 +1 +1 -1 -1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 +1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 +1 +1 -1 -1 +1 +1 +1 -1 -1 -1 +1 -1 -1 +1 +1 -1 -1 -1 +1 -1 +1 -1 -1 +1 +1 +1 +1 +1 -1 -1 -1 -1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 -1 -1 -1 +1 -1 +1 +1 -1 -1 -1 +1 -1 -1];

=[ -1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 -1 +1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 +1 +1 +1 +1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 -1 -1 +1 +1 +1 +1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 -1 -1 +1 +1 -1 -1 -1 +1 +1 -1 +1 -1 -1 +1 -1 -1 -1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 -1 +1 +1 +1 -1 -1 -1 +1 -1 -1 +1 +1 -1 +1 +1 +1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 -1 +1 -1 +1 +1 -1 +1 -1 +1 +1 -1 -1 -1 -1 -1 +1 -1 -1 +1 +1 -1 -1 -1 +1 -1 -1 +1 -1 -1 +1 +1 -1 -1 +1 +1 +1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 +1 -1 +1 -1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 +1 +1 -1 -1 +1 -1 +1 -1 +1 +1 +1 +1 +1 -1 -1 -1 +1 +1 -1 -1 -1 -1 -1 -1 -1 -1 +1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 +1 +1 +1 -1 +1 +1 +1 +1 +1 -1 +1 +1 -1 +1 -1 +1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 -1 +1 +1 -1 -1 +1 -1 -1 +1 -1 -1 -1 +1 +1 -1 -1 +1 -1 -1 -1 -1 -1 +1 +1 -1 +1 -1 +1 +1 -1 +1 -1 -1 -1 -1 -1 -1 +1 -1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 -1 -1 -1 +1 +1 +1 -1 +1 -1 -1 -1 +1 +1 -1 +1 +1 -1 +1 +1 +1 +1 +1 +1 +1 +1 -1 -1 -1 -1 +1 +1 -1 +1 -1 +1 -1 +1 -1 +1 -1 -1 +1 -1 +1 -1 -1 -1 -1 -1 -1 +1 +1 -1 +1 +1 +1 -1 +1 -1 +1 +1 +1 -1 -1 -1 -1 -1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 -1 -1 +1 -1 +1 +1 -1 -1 +1 +1 -1 -1 -1 +1 +1 +1 -1 +1 +1 -1 -1 +1 +1 +1 -1 +1 -1 +1 +1 -1 -1 -1 -1 -1 +1 +1 +1 +1 -1 +1 -1 +1 -1 -1 -1 +1 -1 +1 +1 -1 +1 +1 +1 -1 -1 +1 +1 +1 -1 +1 +1 -1 +1 +1 +1 +1 -1 ];

means number of 5 consecutive 0s;

means number of 23 consecutive 0s

For an OFDMA transmission, the values of EHT-LTF sequence (defined in Equation (27-41) to Equation (27-52) and Equation (36-43) to Equation (36-45)) are set to zero if they are assigned to subcarriers within RUs that are not allocated to any user (see 36.3.10 (Mathematical description of signals)).

The generation of the time domain EHT-LTF symbols in an EHT MU PPDU and EHT TB PPDU is shown in Figure 36-xx (Generation of EHT-LTF symbols in an EHT MU PPDU and EHT TB PPDU) where  is given by Equation (36-46).



Figure 36-xx—Generation of EHT-LTF symbols in an EHT MU PPDU and EHT TB PPDU

The generation of the time domain symbol of a 1x EHT-LTF is equivalent to modulating every 4 subcarriers in an OFDM symbol of 12.8 μs excluding GI, and then transmitting only the first ¼ of the OFDM symbol in the time domain, as shown in Figure 36-xx (Generation of 1x EHT-LTF symbols).



Figure 36-xx—Generation of 1x EHT-LTF symbols

The generation of the time domain symbol of a 2x EHT-LTF is equivalent to modulating every 2 subcarriers in an OFDM symbol of 12.8 μs excluding GI, and then transmitting only the first half of the OFDM symbol in the time domain, as shown in Figure 36-xx (Generation of 2x EHT-LTF symbols).



Figure 36-xx— Generation of 2x EHT-LTF symbols

 (36-46)

Where

is the set of subcarrier indices for the pilot subcarriers as defined in 36.3.2.4 (Pilot subcarriers).

is a  matrix whose elements are defined in Equation (36-47).

 (36-47)

is defined in Equation (36-48).



Where  is defined in Equation (19-27), is defined in Equation (21-44), and  is defined in Equation (21-45).

If the 1x EHT-LTF is used for non-OFDMA UL MU-MIMO, the EHT no pilot EHT-LTF mode is used.

In an EHT MU PPDU, the time domain representation of the waveform transmitted on transmit chain  shall be as described by Equation (36-48).

 （36-48）

In an EHT TB PPDU, the time domain representation of the waveform of user *u* in the *r*-th RU, transmitted on transmit chain  shall be as described by Equation (36-49).

 （36-49）

In Equation (36-48) and Equation (36-49) the following notations are used:

 is the number of EHT MU PPDU recipients (see Table 36-14 (Frequently used parameters)) in RU *r*

 is the EHT-LTF sequence applied on subcarrier *k* for spatial stream *m* of user *u*



 is defined in 36.3.10 (Mathematical description of signals)

 is the number of OFDM symbols in the EHT-LTF field

 represents the cyclic shift for spatial stream *Mr,u* + *m* as defined in 36.3.11.2.2(Cyclic shift for EHT modulated fields)

 and  are defined in 36.3.10 (Mathematical description of signals)

 is defined in Equation (36-46)

 is given in Table 36-14 (Frequently used parameters) for EHT SU PPDU and EHT MU PPDU. For an EHT TB PPDU it is given by the TXVECTOR parameter STARTING\_STS\_NUM.

 is the set of subcarrier indices for the tones in the RU r as defined in 36.3.10 (Mathematical description of signals)

and are defined below Equation (36-12)

is the cardinality of the set of modulated subcarriers within *Kr* for EHT-LTF field, as defined in 27.3.10 (Mathematical description of signals)

Other variables are defined below Equation (36-8), Equation (36-10), Equation (36-11), Equation (36-16),

Equation (36-19) and Equation (36-42)