IEEE P802.11
Wireless LANs

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| HE-LTF –26.3.10.3 |
| Date: 2016-04-17 |
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Abstract

This submission proposes resolutions for multiple comments related to TGax D0.1 with the following CIDs (**18 CIDs**):

* 1865 323 481 517 537 920 319 1059 2559 2551 2552 2553 2554 2555 2556 2557 2558 923

Revisions:

* Rev1: Initial version of the document.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGax Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGax Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

***TGax Editor: Editing instructions preceded by “TGax Editor” are instructions to the TGax editor to modify existing material in the TGax draft. As a result of adopting the changes, the TGax editor will execute the instructions rather than copy them to the TGax Draft.***

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 319 | Bin | 122.43 | Add a new optional combiniation 2x LTF+ 3.2usCP to support outdoor channel. Since 2x LTF is the only mode suppoted in sounding NDP, this new 2x LTF+3.2up CP is useful for outdoor channel sounding | as in comment | RejectedThe reason is that 2x LTF+ 1.6usCP already can support ourdoor channel |
| 2552 | Youhan | 122.33 | Make (1xHE-LTF, TGI2,Data) and (1xHE-LTF, TGI4,Data) mandatory for non-OFDMA, MU-MIMO HE\_TRIG PPDU. | Make (1xHE-LTF, TGI2,Data) and (1xHE-LTF, TGI4,Data) mandatory for non-OFDMA, MU-MIMO HE\_TRIG PPDU. | RejectedThe reason is that the commenter failed to provide sufficient reason  |

**Discussion: *…***

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID):***

CID 481

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 481 | Daewon | 132.02 | when beam change is set to 0, the spatial mapping between pre-HE modulated symbols and HE-LTF1 must be same. However, the pre-HE modulated symbols are multiplied with gamma, while HE-STF, HE-LTF, and HE-Data are not, therefore, spatial mapping is not strictly identical for all 20Mhz segments of the transmission. | clarify the beam change description to state that pre-HE and HE-LTF 1 has the idential spatial mapping with the exception of the gamma factor or include the gamma factor to HE portions of the PPDU when beam change is set to 0. | RevisedThe description for beam change bit between table 25-16 and table 26-1 do not match.Instruction to editor:Please modify the text **in TGax D0.1 P72, Line 55** (**TGax D0.4 P124, Line 49**) according to the changes indicated under CID 1865 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 920):***

##### 26.3.9.7.2 Content

The HE-SIG-A field for an HE SU PPDU or an HE extended range SU PPDU contains the fields listed in Table 26-15 (HE-SIG-A field of an HE SU PPDU and HE extended range SU PPDU(#Ed)).

**Table 26-15—HE-SIG-A field of an HE SU PPDU and HE extended range SU PPDU(#Ed) Two Parts of HE-SIG-A Bit Field Number of bits Description**

The HE-SIG-A field for an HE SU PPDU or an HE extended range SU PPDU contains the fields listed in .

Table ‑ - Fields in the HE-SIG-A for an HE SU PPDU and HE extended range SU PPDU

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two Parts of HE-SIG-A** | **Bit** | **Field** | **Number of bits** | **Description** |
| TBD | TBD | DL/UL | 1 | Indicates whether the PPDU is sent UL or DL. This field indicates DL for TDLS.NOTE—The TDLS peer can identify the TDLS frame by To DS and From DS fields in the MAC header of the MPDU. |
| TBD | Format | 1 | Differentiate between an HE SU PPDU and an HE trigger-based PPDU or between an HE extended range SU PPDU and an HE trigger-based PPDU |
| TBD | BSS Color | 6 | The BSS Color field is an identifier of the BSS |
| TBD | Spatial Reuse | TBD | TBD |
| TBD | TXOP Duration | TBD | Indicates the remaining time in the current TXOP. Details TBD. |
| TBD | Bandwidth | 2 | Set to 0 for 20 MHz, 1 for 40 MHz, 2 for 80 MHz, 3 for 160 MHz and 80+80 MHz |
| TBD | MCS | 4 | HE-MCS index |
| TBD | CP+LTF Size | 3 | To indicate the CP length and HE-LTF size, the current combinations are 1x HE-LTF + 0.8 µs, 2x HE-LTF + 0.8 µs, 2x HE-LTF + 1.6 µs and 4x HE-LTF + 3.2 µs. Other combinations are TBD. |
| TBD | Coding | 2 | Indication of BCC/LDPC and presence of the extra OFDM symbol for LDPC. Detailed indication is TBD.  |
| TBD | Nsts | 3 | Indicates the number of spatial streams: Set to 0 for 1 space time streamSet to 1 for 2 space time streamsSet to 2 for 3 space time streamsSet to 3 for 4 space time streamsSet to 4 for 5 space time streamsSet to 5 for 6 space time streamsSet to 6 for 7 space time streamsSet to 7 for 8 space time streams |
| TBD | STBC | 1 | Set to 1 if space time block coding is used and set to 0 otherwise. |
| TBD | TxBF | 1 | Set to 1 if a Beamforming steering matrix is applied to the waveform in an SU transmission, set to 0 otherwise. |
| TBD | DCM | 1 | Set to 1 indicates that the payload of the SU PPDU is modulated with dual sub-carrier modulation for the MCS. Set to 0 indicates that the payload of the PPDU is not modulated with dual sub-carrier modulation for the MCS.  |
| TBD | Packet Extension | 3 | The first two bits indicate the “*a-factor*” and the third bit indicates the PE-Disambiguity. |
| TBD | Beam Change | 1 | Set to 1 indicates that the pre-HE-STF portion of the SU PPDU is spatially mapped differently from HE-LTF1.Set to 0 indicates that the pre-HE-STF portion of the SU PPDU is spatially mapped the same way as HE-LTF1 on each tone. |
| TBD | CRC | 4 | CRC of bits 0–41 in HT-SIG-A. See 22.3.9.7.1 (CRC calculation for HE-SIG-A). The first bit to be transmitted is bit C3 as explained in 20.3.9.7.1 (CRC calculation for HE-SIG). |
| TBD | Tail | 6 | Used to terminate the trellis of the convolutional decoder.Set to 0. |

NOTE—The HE-SIG-A field contents for the HE extended range SU PPDU may be subject to change.

### 26.2.2 TXVECTOR and RXVECTOR parameters

The parameters in Table 26‑1 (TXVECTOR and RXVECTOR parameters) are defined as part of the TXVECTOR parameter list in the PHY-TXSTART.request primitive and/or as part of the RXVECTOR parameter list in the PHY-RXSTART.indication primitive.

Table ‑ - TXVECTOR and RXVECTOR parameters

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| --- | --- | --- | --- | --- |
| Parameter | Condition | Value | TXVECTOR | RXVECTOR |
| FORMAT |  | Determines the format of the PPDU.Enumerated type:NON\_HT indicates Clause 18 (Orthogonal frequency division multiplexing (OFDM) PHY specification) or non-HT duplicate PPDU format. In this case, the modulation is determined by the NON\_HT\_MODULATION parameter.HT\_MF indicates HT-mixed format.HT\_GF indicates HT-greenfield format.VHT indicates VHT format.HE\_SU indicates HE SU PPDU format.HE\_MU indicates HE MU PPDU formatHE\_EXT\_SU indicates HE extended range SU PPDU formatHE\_TRIG indicates HE trigger-based PPDU format | Y | Y |
| PE\_DURATION | FORMAT is HE\_SU or HE\_MU or HE\_EXT\_SU or HE\_TRIG. | Determines the duration of PE field in an HE PPDU.Possible values are 0 µs, 4 µs, 8 µs, 12 µs and 16 µs. |  |  |
| BEAM\_CHANGE | FORMAT is HE\_SU or HE\_EXT\_SU |  Set to 1 indicates that the pre-HE-STF portion of the SU PPDU is spatially mapped differently from HE-LTF1.Set to 0 indicates that the pre-HE-STF portion of the SU PPDU is spatially mapped the same way as HE-LTF1 on each tone. |  |  |
| Otherwise | Set to 1 |  |  |
|  | (To be added) |  |  |  |
| BSS\_COLOR | FORMAT is HE\_SU or HE\_MU or HE\_EXT\_SU or HE\_TRIG. | Set to a value of the AP’s choosing within the range 0 to *TBD* (see 25.11 (STA ID, Uplink Flag and BSS Color in HE PPDUs)). | Y | Y |
| Otherwise | Not present | N | N |
| UPLINK\_FLAG | FORMAT is HE\_SU or HE\_MU or HE\_EXT\_SU | Set to 1 if the HE PPDU is addressed to an APSet to 0 otherwise (see 25.11 (STA ID, Uplink Flag and BSS Color in HE PPDUs)). | Y | Y |
| Otherwise | Not present | N | N |
| STA\_ID\_LIST | FORMAT is HE\_MU | Indicates the list of STA IDs for an HE MU PPDU (see 25.11 (STA ID, Uplink Flag and BSS Color in HE PPDUs)). | MU | Y |
| Otherwise | Not present | N | N |
| NOTE 1—In the “TXVECTOR” and “RXVECTOR” columns, the following apply:Y = Present;N = Not present;O = Optional;MU indicates that the parameter is present once for an HE SU PPDU, HE extended range SU PPDU and HE trigger-based PPDU and present per user for an HE MU PPDU. Parameters specified to be present per user are conceptually supplied as an array of values indexed by *u*, where *u* takes values 0 to NUM\_USERS-1. |
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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 1865 | Sameer | 129.38 | Clarify the mapping of channels, is 80MHz\_primary sequence mapped to primary channel even it is the "higher" frequency? | as in comment | Revised-A clarification for channels mapping has been provided.Instruction to editor:Please modify the text **in TGax D0.1 P 128, Line 62** (**TGax D0.4 P 192, Line 62**) according to the changes indicated under CID 1865 in IEEE 802.11-16/1202r2 |
| 2554 | Youhan | 128.62 | Is the LTF\_{80MHz\_primary} always used in the lower 80 MHz regardless of whether the Primary80 is located in HE160? If so, change the name "LTF\_{80MHz\_primary}" as it can be misleading to mean that the lower 80 MHz is the Primary80. | Change the name "LTF\_{80MHz\_primary}" and "LTF\_{80MHz\_secondar}" as it can be misleading to mean that the lower 80 MHz is the Primary80. |  RevisedThe same text change as in CID 1865 in IEEE 802.11-16/1202r2 |
| 2558 | Youhan | 129.32 | If an 80+80 MHz BSS has the Primary80 segment at higher frequency than the Secondary80 segment, would the "LTF\_{80MHz\_primary}" be used in the Primary80 segment, or the segment which is lower in frequency? | Clarify if "LTF\_{80MHz\_primary}" would be used in the Primary80 segment, or the segment which is lower in frequency. | RevisedThe same text change as in CID 1865 in IEEE 802.11-16/1202r2 |

**Discussion: *…***

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 1865):***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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| In a 160 MHz transmission, the 1x HE-LTF sequence transmitted is given by Equation (26‑47).

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| --- | --- | --- |
| *HELTF-1012,1012* = { 1x LTF80MHz\_primary, zeros(1,23), 1x LTF80MHz\_secondary } |  | (26‑47) |

where 1x LTF80MHz\_primary = {L-LTF80MHz\_1x, 0, R-LTF80MHz\_1x} and shall be used in the primary 80 MHz frequency segment, 1x LTF80MHz\_ secondary = {L-LTF80MHz\_1x, 0, (-1)\*R-LTF80MHz\_1x} and shall be used in the secondary 80 MHz frequency segment.In a 160 MHz transmission, the 2x HE-LTF sequence transmitted is given by Equation (26‑48).

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| *HELTF-1012,1012* = { 2x LTF80MHz\_primary, zeros(1,23), 2x LTF80MHz\_secondary } |  | (26‑48) |

where

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| 2x LTF80MHz\_primary = { {1st 242-RU}, {2nd 242-RU}, {central 26-RU}, {3rd 242-RU}, {4th 242-RU} |  |  | (26‑49) |
| 2x LTF80MHz\_secondary = { {1st 242-RU}, (-1)\*{2nd 242-RU}, {central 26-RU}, {3rd 242-RU}, (-1)\*{4th 242-RU} } |  |  | (26‑50) |

In a 160 MHz transmission, the 4x HE-LTF sequence transmitted is given by Equation (26‑51).

|  |  |  |
| --- | --- | --- |
| *HELTF-1012,1012* = { 4x LTF80MHz\_primary, zeros(1,23), 4x LTF80MHz\_secondary } |  | (26‑51) |

where

|  |  |  |
| --- | --- | --- |
| 4x LTF80MHz\_primary = {L-LTF80MHz\_4x, 0, R-LTF80MHz\_4x}  |  | (26‑52) |
| 4x LTF80MHz\_ secondary = {L-LTF80MHz\_4x, 0, (-1)\*R-LTF80MHz\_4x}  |  | (26‑53) |

For a noncontiguous 80+80 MHz transmission, the 1x HE-LTF sequence is given by Equation (26‑54).

|  |  |  |
| --- | --- | --- |
| *HELTF80+80MHz* = { 1x LTF80MHz\_primary, 1x LTF80MHz\_secondary } |   | (26‑54) |

For a noncontiguous 80+80 MHz transmission, the 2x HE-LTF sequence is given by Equation (26‑55).

|  |  |  |
| --- | --- | --- |
| *HELTF80+80MHz* = { 2x LTF80MHz\_primary, 2x LTF80MHz\_secondary } |  | (26‑55) |

For a noncontiguous 80+80 MHz transmission, the 4x HE-LTF sequence is given by Equation (26‑56).

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| *HELTF80+80MHz* = { 4x LTF80MHz\_primary, 4x LTF80MHz\_secondary } |  | (26‑56) |

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CID 323

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 323 | Bin | 129.33 | Eqns (26-54)(26-55)(26-56) for 80+80MHz using same expression as for 160MHz seems inappropriate, as center 23 zeros do not make sense for non-contiguous 80+80 | suggest to change to " LTF for 80+80 is two 80MHz LTFs (1024 tones each including nulls) are combined together, for example, 1x HE-LTF80+80MHz= [1x LTF80MHz\_primary , 1x LTF80MHz\_secondary]" | AcceptInstruction to editor:Please modify the text **in TGax D0.1 P 129, Line 33, Line 38, Line 43** (**TGax D0.4 P 193, Line 33, Line 38, Line 43**) according to the changes indicated under CID 323 in IEEE 802.11-16/1202r2 |
| 2557 | Youhan | 129.32 | 80+80 transmissions can have large frequency gap in between the two 80 MHz segments. So, putting 23 zeros in between the two 80 MHz segments is incorrect. | Sequences for 80+80 should be defined per 80 MHz, not over 160 MHz. | RevisedThe same text change as in CID 323 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 323):***

For a noncontiguous 80+80 MHz transmission, the 1x HE-LTF sequence is given by Equation (26‑54).

|  |  |  |
| --- | --- | --- |
| *HELTF80+80MHz* = { 1x LTF80MHz\_primary, 1x LTF80MHz\_secondary } |   | (‑) |

For a noncontiguous 80+80 MHz transmission, the 2x HE-LTF sequence is given by Equation (26‑55).

|  |  |  |
| --- | --- | --- |
| *HELTF80+80MHz* = { 2x LTF80MHz\_primary, 2x LTF80MHz\_secondary } |  | (‑) |

For a noncontiguous 80+80 MHz transmission, the 4x HE-LTF sequence is given by Equation (26‑56).

|  |  |  |
| --- | --- | --- |
| *HELTF80+80MHz* = { 4x LTF80MHz\_primary, 4x LTF80MHz\_secondary } |  | (‑) |

CID 517

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 517 | Dong | 122.14 | <reference> does not defined.It would need to be clarified the function of number of HE-LTF symbol by considering the total number of space time stream | define the number of HE-LTF symbol for different number of space time like as 11ac | RevisedA clarification has been provided.Instruction to editor:Please modify the text **in TGax D0.1 P 122, Line 14** (**TGax D0.4 P 186, Line 39**) according to the changes indicated under CID 517 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 517):***

#### 26.3.9.10 HE-LTF

The HE Long Training field (HE-LTF) field provides a means for the receiver to estimate the MIMO channel between the set of constellation mapper outputs (or, if STBC is applied, the STBC encoder outputs) and the receive chains. In an HE SU PPDU, HE MU PPDU or HE extended range SU PPDU, the transmitter provides training for *NSTS,r,total* space-time streams (spatial mapper inputs) used for the transmission of the PSDU(s) in the *r-*th RU; in an HE trigger-based PPDU, the transmitter of user-*u* in the *r*-th RU provides training for *NSTS,r,u* space-time streams used for the transmission of the PSDU. For each tone in the *r*-th RU,(#5930) the MIMO channel that can be estimated is an *NRX*  *NSTS,r,total* matrix. A HE transmission has a preamble that contains HE-LTF symbols, where the data tones of each HE-LTF symbol are multiplied by entries belonging to a matrix *PHE-LTF*(#6556), to enable channel estimation at the receiver. The pilot tones of each HE-LTF symbol are multiplied by the entries of a matrix *RHE-LTF*(#6556) defined in the following text. The multiplication of the pilot tones in the HE-LTF symbol by the *RHE-LTF*(#6556) matrix instead of the *PHE-LTF*(#6556) matrix allows receivers to track phase and frequency offset during MIMO channel estimation using the HE-LTF. In an HE SU PPDU and HE extended range SU PPDU, the number of HE-LTF symbols, *NHE-LTF*(#6556), is a function of the total number of space-time streams *NSTS* as shown in in Table 26-6. In an HE trigger-based PPDU, *NHE-LTF*(#6556) is indicated in the Trigger frame that triggers the transmission of the PPDU. In an HE MU PPDU, *NHE-LTF*(#6556) is indicated in the HE-SIG-A field. In an HE MU PPDU and HE trigger-based PPDU, *NHE-LTF*(#6556) is selected to be not smaller than the maximum value of the functions for each *NSTS*,*r,total*. As a result the HE-LTF field consists of one, two, four, six or eight symbols.

CID 920

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 920 | JUNG | 122.18 | Insert the text for more accurate description | Change to the following; N\_HE-LTF is selected to be no smaller than the maximum value of the functions for each N\_STS,r,total, so HE-LTF symbols shall be aligned across the entire band. | RejectedThe reason is that PHY Motion #159 already resolved this issue |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 920):***

CID 2551

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 2551 | Youhan | 122.29 | TGI,Data2 and TGI,Data4 are not defined. Also, TGI,Data seems to be used in error. | Change TGI,Data to TGI1,Data, TGI,Data2 to TGI2,Data, and TGI,Data4 to TGI4,Data. | AcceptedInstruction to editor:Please modify the text **in TGax D0.1 P 122, Line 29, Line 37** (**TGax D0.4 P 186, Line 61, P 187, Line 3**) according to the changes indicated under CID 2551 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 2551):***

A HE PPDU supports 3 HE-LTF modes, which are 1x HE-LTF, 2x HE-LTF, and 4x HE-LTF. It is optional to support 1x HE-LTF in an HE SU PPDU, HE extended range SU PPDU and HE MU PPDU. In an HE SU PPDU, HE MU PPDU or HE extended range SU PPDU, the combination of HE-LTF modes and GI duration is indicated in HE-SIG-A field. In an HE trigger-based PPDU, the combination of HE-LTF modes and GI duration is indicated in the Trigger frame that triggers the transmission of the PPDU. The mandatory combinations of HE-LTF modes and GI duration are:

—2x HE-LTF, TGI1,Data

—2x HE-LTF, TGI2,Data

—4x HE-LTF, TGI4,Data

The optional combinations of HE-LTF mode and GI duration are:

—1x HE-LTF, TGI1,Data in a HE SU PPDU or HE extended SU PPDU

—1x HE-LTF, TGI1,Data in a non-OFDMA, MU-MIMO HE MU PPDU

—1x HE-LTF, TGI2,Data in a non-OFDMA, MU-MIMO HE trigger-based PPDU

CID 2553

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| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 2553 | Youhan | 123.03 | What does "-122,122" mean in "HELTF\_{-122,122}"? Similar comment on other equations on the HE-LTF and HE-STF sequences. | Clarify what "-122,122" means. | RevisedA clarification has been provided.Instruction to editor:Please modify the text **in TGax D0.1 P 123, Line 1, Line 16, Line 33, P 124, Line 1, Line26,**  **P 125, Line 1, P 126, Line 1,**  **P 127, Line 1,**  **P 128, Line 1** (**TGax D0.4 P 187, Line 27 P 188, Line 1, Line20,**  **P 189, Line 1, Line 28, P 190, Line 1,**  **P 191, Line 1,**  **P 192, Line 1**) according to the changes indicated under CID 2553 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 2553):***

In a 20 MHz transmission, the 1x HE-LTF sequence transmitted and located on subcarrier [-122:122] is given by Equation **(26‑38)**.

|  |  |
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| *HELTF-122,122* = {0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0} | **(26‑38)** |

In a 20 MHz transmission, the 2x HE-LTF sequence transmitted and located on subcarrier [-122:122] is given by Equation (26‑39).

|  |  |
| --- | --- |
| *HELTF-122,122* = {-1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -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, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1} | (‑) |

In a 20 MHz transmission, the 4x HE-LTF sequence transmitted and located on subcarrier [-122:122] is given by Equation (26‑40).

|  |  |
| --- | --- |
| *HELTF-122, 122* = {-1, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, +1, +1, -1,  +1, -1, +1, +1, +1, +1, -1, +1, -1, -1, +1, +1, -1, +1, +1, +1, +1, -1, -1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, +1,  -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, +1, -1, +1, -1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1,  -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, +1, -1, +1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, -1, -1, -1, +1, -1, +1, +1,  +1, 0, 0, 0, -1, +1, -1, +1, -1, +1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1,  +1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, +1, -1, +1, -1, -1, -1, -1, +1, -1, +1, +1, -1, -1,  +1, -1, -1, -1, -1, +1, +1, -1, +1, +1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1,  -1, -1, -1, +1, -1, +1, -1, -1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, -1, -1, +1, -1, +1, -1, +1, +1} | (‑) |

In a 40 MHz transmission, the 1x HE-LTF sequence transmitted and located on subcarrier [-244:244] is given by Equation **(26‑41)**.

|  |  |
| --- | --- |
| *HELTF-244,244* = { +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1} | **(26‑41)** |

In a 40 MHz transmission, the 2x HE-LTF sequence transmitted and located on subcarrier [-244:244] is given by Equation (26‑42).

|  |  |
| --- | --- |
| *HELTF-244,244* = {+1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +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} | (‑) |

In a 40 MHz transmission, the 4x HE-LTF sequence transmitted and located on subcarrier [-244:244] is given by Equation (26‑43).

|  |  |
| --- | --- |
| *HELTF−244,244* ={+1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, -1, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, +1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, -1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, 0, 0, 0, 0, 0, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, +1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, -1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1} | (‑) |

In an 80 MHz transmission, the 1x HE-LTF sequence transmitted and located on subcarrier [-500:500] is given by Equation Equation (26‑44).

|  |  |
| --- | --- |
| *HELTF-500,500* = { -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, 0, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, -1, 0, 0, 0, +1, 0, 0, 0, +1} | (‑) |

In an 80 MHz transmission, the 2x HE-LTF sequence transmitted and located on subcarrier [-500:500] is given by Equation (26‑45).

|  |  |
| --- | --- |
| *HELTF-500,500* = {+1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, +1, 0, +1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, +1, 0, +1, 0, +1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -1, 0, +1, 0, -1, 0, -1, 0, -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} | (‑) |

In an 80 MHz transmission, the 4x HE-LTF sequence transmitted and located on subcarrier [-500:500] is given by Equation (26‑46).

|  |  |
| --- | --- |
| *HELTF-500,500* = {+1, +1, -1, +1, -1, +1, -1, -1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, -1, +1, +1, +1, -1, -1, -1, -1, -1, -1, +1, +1, +1, +1, +1, +1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1, -1, -1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, -1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, +1, -1, +1, -1, +1, +1, -1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, +1, +1, +1, +1, +1, +1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1, -1, -1, +1, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, +1, -1, +1, -1, +1, +1, -1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, -1, -1, -1, -1, -1, -1, +1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1, -1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, -1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, +1, -1, +1, -1, +1, +1, -1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, +1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, -1, +1, -1, -1, -1, -1, +1, +1, +1, -1, -1, +1, 0, 0, 0, 0, 0, +1, -1, -1, -1, -1, -1, -1, +1, -1, +1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, -1, +1, +1, +1, +1, +1, +1, +1, -1, +1, -1, -1, +1, -1, -1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, +1, -1, +1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, -1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1, -1, +1, -1, -1, +1, -1, +1, +1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, +1, -1, +1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, -1, -1, +1, -1, +1, -1, +1, +1, +1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, -1, -1, -1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1, -1, +1, -1, -1, +1, -1, +1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, +1, +1, +1, -1, -1, +1, -1, -1, -1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, +1, -1, +1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, +1, -1, +1} | (‑) |

CID 2555

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 2555 | Youhan | 128.62 | What is "zeros(1,23)"? | Clarify what "zeros(1,23)" means (what we are writing is not Matlab code). | RevisedA clarification has been provided.Instruction to editor:Please modify the text **in TGax D0.1 P129, Line 3** (**TGax D0.4 P193, Line 3**) according to the changes indicated under CID 2555 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 2555):***

In a 160 MHz transmission, the 1x HE-LTF sequence transmitted is given by Equation (26‑47).

|  |  |  |
| --- | --- | --- |
| *HELTF-1012,1012* = { 1x LTF80MHz\_primary, zeros(1,23), 1x LTF80MHz\_secondary } |  | (‑) |

where 1x LTF80MHz\_primary = {L-LTF80MHz\_1x, 0, R-LTF80MHz\_1x}, 1x LTF80MHz\_ secondary = {L-LTF80MHz\_1x, 0, (-1)\*R-LTF80MHz\_1x}, and zeros(1,23) means 23 zeros.

CID 2556

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 2556 | Youhan | 129.12 | What are "{n-th 242-RU}" and "{central 26-RU}"? | Add missing sequence definition. | RevisedA definition has been provided.Instruction to editor:Please modify the text **in TGax D0.1 P129, Line 13** (**TGax D0.4 P193, Line 13**) according to the changes indicated under CID 2556 in IEEE 802.11-16/1202r2 |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 2556):***

In a 160 MHz transmission, the 2x HE-LTF sequence transmitted is given by Equation (26‑48).

|  |  |  |
| --- | --- | --- |
| *HELTF-1012,1012* = { 2x LTF80MHz\_primary, zeros(1,23), 2x LTF80MHz\_secondary } |  | (‑) |

where

|  |  |  |  |
| --- | --- | --- | --- |
| 2x LTF80MHz\_primary = { {1st 242-RU}, {2nd 242-RU}, {central 26-RU}, {3rd 242-RU}, {4th 242-RU} |  |  | (‑) |
| and nth 242 –RU is defined in table 26-10 in 26.3.7 and the central 26-RU refers to the 19th 26-RU in the table 26-10.2x LTF80MHz\_secondary = { {1st 242-RU}, (-1)\*{2nd 242-RU}, {central 26-RU}, {3rd 242-RU}, (-1)\*{4th 242-RU} } |  |  | (‑) |

CID 923

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 923 | JUNG | 122.49 | Insert the text for clarification | "the transmission of the PPDU." can be changed to "the transmission of the PPDU for the UL transmission." | RejectedIn the original text, it already refers to “HE trigger-based PPDU”  |

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 923):***

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **CID** | **Commenter** | **P.L** | **Comment** | **Proposed Change** | **Resolution** |
| 1059 | KE | 131.28 | for the equation (26-57), it has been agreed that HE-LTF for UL MU-MIMO has 2 different schemes, one is SSC which is depicted here but the other one is not mentioned | add the content of " the masking the LTF sequence of each spatial stream by a distinct orthogonal code" in this subclause. | RevisedA technical solution has been provided.Instruction to editor:Please modify the text **TGax D0.4 P193, Line 46** according to the changes indicated under CID 1059 in IEEE 802.11-16/1202r2 |
| 537 | Eunsung | 130.01 | We agreed that the HE-LTF sequence for UL MU MIMO is masked repeatedly using an orthogonal matrix but no corresponding text is in the draft. | Add the HE-LTF sequence generation using an orthogonal matrix for UL MU MIMO as in PHY motion 56 [11-15/0987r6]. | RevisedThe same text change as in CID 1059 in IEEE 802.11-16/1202r2 |
| 2559 | Youhan | 131.53 | What is the waveform equation for HE\_TRIG PPDU not using the single stream pilot? | What is the waveform equation for HE\_TRIG PPDU not using the single stream pilot? | RevisedThe same text change as in CID 1059 in IEEE 802.11-16/1202r2 |

**Discussion: *…***

**TGax Editor: *Change the paragraphs below of this subclause as follows (#CID 1059):***

**Note to editor – change the following paragraphs in 26.3.9.10 HE-LTF**

In the UL MUMIMO transmission not using single stream pilots, the generation of the HE-LTF sequence per frequency segment is to mask the non-zero elements in the common HE-LTF sequence repeatedly by a distinct orthogonal code as defined by equation 26-xx.

 (26-xx)

Where is the *k*-th element of the common HE-LTF sequence generated by the one of the equations from (26-39) to (26-57) depends on the bandwidth and the HE-LTF mode. For user *u* of any UL MU-MIMO frequency allocation, the orthogonal code  is defined by (26-yy).

 (26-yy)

Where is the *i*-th repetition of the *u*-th row of the P8which is defined in Equation (22-46).  is the number of non-zero elements in the common HE-LTF. is the first *M* elements of the *u*-th row of the P8. It means if  is not a multiple of 8, the remaining *M* non-zero elements of the common HE-LTF sequence are masked by the first *M* elements of the orthogonal code.

The generation of the time domain HE-LTF symbols per frequency segment in an HE SU PPDU, HE MU PPDU, HE extended range SU PPDU, HE trigger-based PPDU is shown in where  (#6556) is given by Equation .



Figure ‑26– Generation of HE-LTF symbols per frequency segment in an HE SU PPDU, HE MU PPDU, HE extended range SU PPDU, and HE trigger-based PPDU

(Here omit the description for the generation of time domain symbol of 1x HE-LTF and 2x HE-LTF in TGax D 0.4)

is given by Equation (26‑58).

|  |  |
| --- | --- |
| $$A\_{HELTF}^{k}=\left\{\begin{matrix}R\_{HELTF},if k\in K\_{Pilot} \\P\_{HELTF}, otherwise\end{matrix}\right.$$ | (‑58) |

where *K*Pilot is the set of subcarrier indices for the pilot tones as defined in 26.3.7.3 (Pilot tones).

 is a  matrix whose elements are defined in Equation (26-59).(#6556)

|  |  |
| --- | --- |
|  | (‑59) |

 is defined in (26-60).

|  |  |
| --- | --- |
|  | (‑60) |

where P4is defined in Equation (19-17), P6is defined in Equation 21-45), and P8is defined in Equation (22-46).

In an HE SU PPDU, HE MU PPDU, HE extended range SU PPDU and HE trigger-based PPDU, the time domain representation of the waveform transmitted on frequency segment *iSeg* of transmit chain *iTX* shall be as described by Equation (26‑61).

|  |  |
| --- | --- |
|  | (26‑61) |

Where

if single stream pilot is used and if single stream pilot is not used.

 (Here omit the description for other parameters in TGax D 0.4)