IEEE P802.11
Wireless LANs

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| TGah D1.0 LB200 Comment Resolutions on Section 24.3.8 S1G Preamble |
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Abstract: This document contains proposed resolutions for the following CIDs from LB200 of TGah D1.0:

***Clause 24.3.8:***

* 1318
* 1319
* 1320
* 1321
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* 2074
* 2092
* 2171
* 2281
* 2694
* 2695

##### CIDs for Clause 24.3.8

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| --- | --- | --- | --- | --- | --- | --- |
| CID | Commenter | Section | Page.Line | Comment | Proposed Change | Resolution |
| 1318 | Adrian Stephens | 24.3.8.2 | 283.28 | "Greater than or equal to 2MHz PHY"I don't think Clause 24 defines multiple PHYs. It defines a single PHY with multiple formats. | Change title to relate to PPDU format. | Accept. See reproduced text below for applied changes. |
| 1319 | Adrian Stephens | 24.3.8.2.1.4 | 287.53 | "NOTE--Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position."This should not be a note, because this information is necessary for interoperability. | Promote to body text. | Accept. See reproduced text below for applied changes. |
| 1320 | Adrian Stephens | 24.3.8.2.1.4 | 289.05 | "(AMPDU)" - terminology | Replace all "AMPDU" with "A-MPDU" | Accept. See reproduced text below for applied changes. |
| 1321 | Adrian Stephens | 24.3.8.2.1.4 | 291.19 | The "0" dots in figure 24-28 have drooped. | Raise them up.Ditto at 300.57 on the left. | Accept. See reproduced text below for applied changes. |
| 1322 | Adrian Stephens | 24.3.8.2.2.1 | 292.38 | " long preamble is always single user modulated" -- the 'reassurance' given by "always" is unnecessary. | " long preamble is single user modulated. | Accept. See reproduced text below for applied changes. |
| 1323 | Adrian Stephens | 24.3.8.2.2.1.4 | 295.65 | More red text | make it black | Accept. See reproduced text below for applied changes. |
| 1324 | Adrian Stephens | 24.3.8.3.3 | 309.01 | Notes within a subclause are numbered consecutively. | Change previous note to "NOTE 1<em-dash>", and this one to "NOTE 2<em-dash>".Review all NOTEs in the draft and ensure any multiples within the same subclause are numbered. | Accept. See reproduced text below for applied changes. |
| 1567 | Bo Sun | 24.3.8.2.1.2 | 284.32 | the expain of NSR is missing | chang to NSR is defined Table 24-4 (Timing-related constants) | Accept. See reproduced text below for applied changes. |
| 1568 | Bo Sun | 24.3.8.2.1.2 | 284.32 | the parameter of Qk is not defined in equation (24-13), also missing in the time domain representation of other signal of preamble. | add the definition of Qk under formula that uses Qk throughout the spec | Accept. See reproduced text below for applied changes. |
| 1572 | Bo Sun | 24.3.8.3.4 | 311.35 | For 1MHz PPDU, the roatation of SIG field symbols makes no sense. For example, in 11ac, the rotation is used to distinguish VHT format from HT format. In S1G 2MHz PPDU, the rotation is used to distinguish short preamble from long preamble. | Delete the term "rotated" in this section | Accept. See reproduced text below for applied changes. |
| 1610 | Brian Hart | 24.3.8.2.1.4 | 287.56 | "The SIG field is composed of two OFDM symbols, SIG-1 and SIG-2, each containing 24 data bits, as shown in Table 24-11" | Due to BCC encoding the end data bits in SIG1 are spread into SIG2, so not correct to say "each containing 24 data bits" Instead talk about first part and second part containing 48 bits total ... (see 11ac for the template) | Accept. See reproduced text below for applied changes. |
| 1611 | Brian Hart | 24.3.8.2.1.4 | 287.31 | "reserved" is lowercase | Reserved | Accept. See reproduced text below for applied changes. |
| 1612 | Brian Hart | 24.3.8.2.1.4 | 288.26 | UPLINK - is the is the TXVECTOR parameter or the SIG field? | Be specific. Better still, lowercase the field name | Revise. Rename SIG field entry as Uplink Indication, which will have same value as UPLINK of TXVECTOR |
| 1613 | Brian Hart | 24.3.8.2.1.4 | 288.31 | "If UPLINK is set to 0, B7-B9 are set to thevalue of the TXVECTOR parameter COLOR and B10-B15 are set to the value of the TXVECTOR parameter PARTIAL\_AID." is SIG structure not reflected in the SIG diagram | Need to reflect this explosion in Fig 24-26/27 | Reject. The field ID is properly described in Table 24-11. Description clearly indicates how the bits of the “ID” field in the SIG should be populated. |
| 1614 | Brian Hart | 24.3.8.2.1.4 | 288.33 | "B10-B15 are set to the value of the TXVECTOR parameter PARTIAL\_AID" but the TXVECTOR table indicates PARTIAL\_AID ranges from 0-511 | Need to define a restriction on PARTIAL\_AID in the TXVECTOR table OR how to crop 9 bits down to 6 bits (or a ref) | Reject. The Partial AID field in TXVECTOR can either be 9-bits or 6 bits. The definitions are in Section 9.17b Group ID, partial AID, UPLINK, and Color in S1G PPDUs. When a >=2MHz PPDU is sent by an AP and is addressed to a STA associated with that AP, the formula is: (dec(AID[0:8])+dec(BSSID[44:47]*xor* BSSID[40:43])×2^5 ) mod 2^6. |
| 1761 | Edward Reuss | 24.3.8.2.1.4 | 291.20 | Figure 24-28 indicates that the QBPSK constellation is either +1j or something less than -1j. Shouldn't this be +1j and -1j? | Modify Figure 24-28 to indicate the constellation contains +1j and -1j. | Accept. See reproduced text below for applied changes. |
| 1762 | Edward Reuss | 24.3.8.2.2.1.3 | 300.58 | Figure 24-34 indicates that the constellation for SIG-A-1 can be either +1j or something less than -1j. I assume that this is a diagram error.Also, are they "SIG-A-1" and "SIG-A-2", or should they be labeled "SIG-A1" and SIG-A2"? | Fix Figure 24-34. | Accept. See reproduced text below for applied changes. |
| 1765 | Eugene Baik | 24.3.8.3.3 | 308.13 | Equation 24-37 for LTF1 is incorrect. The P-matrix factor [A^{k}\_{LTF}]\_{m,n} should be [A^{k}\_{LTF}]\_{m,1} as all symbols for LTF1 receive same mapping (n=1, first column) | In equation 24-37, change [A^{k}\_{LTF}]\_{m,n} to [A^{k}\_{LTF}]\_{m,1} | Accept. See reproduced text below for applied changes. |
| 1766 | Eugene Baik | 24.3.8.3.3 | 308.20 | Equation 24-38 for LTF1 is incorrect. The P-matrix factor [A^{k}\_{LTF}]\_{m,n} should be [A^{k}\_{LTF}]\_{m,1} as all symbols for LTF1 receive same mapping (n=1, first column) | In equation 24-38, change [A^{k}\_{LTF}]\_{m,n} to [A^{k}\_{LTF}]\_{m,1} | Accept. See reproduced text below for applied changes. |
| 1767 | Eugene Baik | 24.3.8.2.1.4 | 288.40 | Coding bits in Table 24-11 defines how LDPC codeword lengths are calculated, and reference Section 22.3.10.5.4 of the 11ac spec and Section 20.3.11.6.5 of the 11n spec. These specs assume the Service field length is 16 bits when it is now 8 bits for 11ah. Need to define 11ah-specific LDPC length calculations for 11ah | Need to create new section in 11ah spec to specify LDPC length calculations. Coding bit definition should reference this section | Reject. Length, Number of symbol (N\_sym), and available bits (N\_pld) equations in Section 22.3.10.5.5 LDPC coding of 11ac spec are still applicable because number of service bits (N\_service) are treated as variable. |
| 1768 | Eugene Baik | 24.3.8.2.2.1.4 | 296.37 | Coding bits in Table 24-14 define how LDPC codeword lengths are calculated, and reference Section 22.3.10.5.4 of the 11ac spec and Section 20.3.11.6.5 of the 11n spec. These specs assume the Service field length is 16 bits when it is now 8 bits for 11ah. Need to define 11ah-specific LDPC length calculations for 11ah | Need to create new section in 11ah spec to specify LDPC length calculations. Coding bit definition should reference this section | Reject. Length, Number of symbol (N\_sym), and available bits (N\_pld) equations in Section 22.3.10.5.5 LDPC coding of 11ac spec are still applicable because number of service bits (N\_service) are treated as variable. |
| 1769 | Eugene Baik | 24.3.8.2.2.1.4 | 299.04 | Coding bits in Table 24-15 define how LDPC codeword lengths are calculated, and reference Section 22.3.10.5.4 of the 11ac spec and Section 20.3.11.6.5 of the 11n spec. These specs assume the Service field length is 16 bits when it is now 8 bits for 11ah. Need to define 11ah-specific LDPC length calculations for 11ah | Need to create new section in 11ah spec to specify LDPC length calculations. Coding bit definition should reference this section | Reject. Length, Number of symbol (N\_sym), and available bits (N\_pld) equations in Section 22.3.10.5.5 LDPC coding of 11ac spec are still applicable because number of service bits (N\_service) are treated as variable. |
| 1770 | Eugene Baik | 24.3.8.3.4 | 310.18 | Coding bits in Table 24-18 define how LDPC codeword lengths are calculated, and reference Section 22.3.10.5.4 of the 11ac spec and Section 20.3.11.6.5 of the 11n spec. These specs assume the Service field length is 16 bits when it is now 8 bits for 11ah. Need to define 11ah-specific LDPC length calculations for 11ah | Need to create new section in 11ah spec to specify LDPC length calculations. Coding bit definition should reference this section | Reject. Length, Number of symbol (N\_sym), and available bits (N\_pld) equations in Section 22.3.10.5.5 LDPC coding of 11ac spec are still applicable because number of service bits (N\_service) are treated as variable. |
| 1782 | Eugene Baik | 24.3.8.2.1.4 | 287.17 | The 2MHz short frame SIG definition needs an Uplink indication bit | Add a field in the SIG bit map and definitions table for Uplink indication | Reject. As of Draft 1.1, the Uplink indication definition has been added. |
| 1783 | Eugene Baik | 24.3.8.2.2.1.4 | 295.01 | The 2MHz long frame SU SIG definition needs an Uplink indication bit | Add a field in the SU SIG bit map and definitions table for Uplink indication | Reject. As of Draft 1.1, the Uplink indication definition has been added. |
| 2073 | Jens Tingleff | 24.3.8.2.1.3 | 285.31 | LTF fields in clause 22 are not defined in equations 22-32 and friends. (Those equations are still in the STF part of clause 22.) | Figure out correct reference | Accept. See reproduced text below for applied changes. |
| 2074 | Jens Tingleff | 243.8.2.1.3 | 285.42 | (Equation 24-14) The dot before the second open square bracket looks like it should be an implied multiplication. Where the baseline (well, clause 22 and 23, specifically - although clause 23 has 'x' a few times) uses dot (not consistent, BTW), it is centered vertically. In clause 24 the dots that there are appear vertically aligned with the base. (also in 24-15, 24-16, 24-17 and others). Suggest you align with clause 22 and 23 (or eliminate explicit multiplication dots and xs). | Decide how to write mutiplication in equations | Accept. See reproduced text below for applied changes. |
| 2092 | John Coffey | 24.3.8.2.1.5 | 291.28 | It makes little sense to have a 4-bit CRC. The overall packet is already protected by a true CRC, so the S1G SIGA CRC amounts to a waste of 4 bits that could be put to some other purpose. If there's nothing useful at present, the bits should be reserved for future use. | Delete Subcluase 24.3.8.2.1.5 in its entirety, along with all references thereto. Make appropriate other changes,e.g., in Table 24-11 (P289 LL30-32), change the entry for B14-B17 to "Reserved / 4 / Set to 0" | Reject. SIG CRC essential for ensuring integrity of decoded SIG bits, and preventing false alarms and incorrect deferral behaviour for unintended recipients of any S1G PPDU. 4-bit CRC calculation has Hamming distance of 2, as described in document 11-12/1092r0.  |
| 2171 | Kenichi Mori | 24.3.8.2.2.1.3 | 297.24 | Bit location of "Doppler" and "Reserved" should be swapped to align with 2MHz and above short preamble format. By doing this, it should be easier to implement because decoded data can be stored without considering short and long format. | Bit location of "Doppler" and "Reserved" should be swapped to align with 2MHz and above short preamble format. | Reject. Separate Bitmaps for SIG fields have to be used anyways. Not useful to optimize individual bit locations, since Rx will know SIG type by this point and parse each time separately. No hardware shared during parsing, most likely.  |
| 2281 | Li Chia Choo | 24.3.8.2.2.2.4 | 302.00 | It is not clear how the SIG-B bits are repeated as a function of CH\_BANDWIDTH as defined in24.3.8.2.2.2.4 (SIG-B definition). | Please clarify how SIG-B bits are repeated as a function of CH\_BANDWIDTH. | Revise. The SIG-B bits are repeated for 4, 8, and 16MHz in a way similar to 40, 80, and 160MHz for VHT SIG-B.See reproduced text below for applied changes. |
| 2694 | Ronald Murias | 24.3.8.2.2.1.4 | 295.01 | Because the SGI is signalled in the SIG-A field, the short GI may not be applied until the data field. If the channel supports a short GI, it is more efficient to apply to all symbols.Known methods exist to signal this bit before the SIG field. | Indicate short GI before the SIG field. | Reject.Overhead savings from Short GI shows up for longer Data packets. Delta from rate benefit of SGI on SIG would be minimal with high overhead.Would not want to use SGI on SIG, since all devices in network would then need to support SGI to decode SIG (for deferral purposes, e.g.). Additionally not all devices in BSS or network may see the same short-delay spread channel. |
| 2695 | Ronald Murias | 24.3.8.3.2 | 307.17 | The new STF sequence for 1 MHz is sub-optimal, resulting in poor (by comparison to the 2+MHz) autocorrelation for timing sync. | Generate a 1 MHz STF with autocorrelation performance that rivals the 2 MHz mode. | Reject. See contribution 11-12/0115r0 for selection criteria and process for 1MHz STF and LTF sequences. Autocorrelation drop between 1MHz STF and LTF sequence shown in Slide 12. |
|  |  |  |  |  |  |  |

*TGah Editor: Please make the following changes to the Section 24.3.8 text, changes below highlighted in yellow. Also please pay attention to ~~old text striked out in red~~, and also red text as special notes to editor:*

* S1G preamble
* Introduction

Three preamble formats are defined for S1G PPDUs corresponding to the three PPDU formats: 1MHz preamble, greater than or equal to 2MHz short preamble, and greater than or equal to 2MHz long preamble. The first two preamble formats are defined solely for single user, and the third preamble may be used in either single user or multiuser mode.

* Greater than or equal to 2MHz ~~PHY~~ PPDU Format
* Short preamble

The greater than or equal to 2MHz short preamble is used only for SU transmissions.

* Cyclic shift for S1G modulated fields

The cyclic shift values defined in this subclause apply to the STF, LTF, SIG and Data fields of the S1G short preamble PPDU, for >=2MHz Tx bandwidths. Throughout the S1G short preamble, cyclic shifts are applied to prevent beamforming when similar signals are transmitted in different space-time streams. The same cyclic shift is applied to these streams during the transmission of the Data field of the S1G short preamble PPDU. The cyclic shift value  for space-time stream *n* out of *NSTS,total* total space-time streams is shown in Table 24-9 (Cyclic shift values for the S1G short preamble PPDU).

|  |
| --- |
| * Cyclic shift values for the S1G short preamble PPDU (continued)
 |
|   for >=2MHz, Short Preamble PPDU  |
| Total number of space-time streams (*NSTS,total* ) | Cyclic shift for space-time stream *n* (μs) |
| 1 | 2 | 3 | 4 |
| 1 | 0 | - | - | - |
| 2 | 0 | -4 | - | - |
| 3 | 0 | -4 | -2 | - |
| 4 | 0 | -4 | -2 | -6 |

* STF definition

The STF field for a 2 MHz or 4 MHz transmissions is defined by Equation (20-8) and Equation (20-9) respectively in 20.3.9.3.3 (L-STF definition). For a 8 MHz or 16 MHz transmissions, the STF field is defined by Equation (22-14) and Equation (22-15) respectively in 22.3.8.1.2 (L-STF definition). Note that these equations do not include the phase rotation per 2 MHz subchannel.

The time domain representation of the STF signal at transmit chain  shall be as specified in Equation (24-13).

*

where

is defined in Table 24-4 (Timing-related constants)

represents the cyclic shift for space-time stream *m* with a value given in Table 24-9 (Cyclic shift values for the S1G short preamble PPDU)

 is defined by Equation (24-5)~ Equation (24-8).

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-6 (Frequently used parameters)

 is defined in in 20.3.9.4.6. (HT-LTF definition)

  has the value given in Table 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

* LTF definition

The 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. The transmitter provides training for *NSTS* space time streams (spatial mapper inputs) used for the transmission of the PSDU. For each tone, the MIMO channel that can be estimated is an *NRX*  *NSTS* matrix. All S1G transmissions have a preamble that contains LTF symbols, where the data tones of each LTF symbol are multiplied by entries belonging to a matrix *PHTLTF*, to enable channel estimation at the receiver.

The pilot tones of each LTF symbol are multiplied by the first column of the *PHTLTF* matrix. The multiplication of the pilot tones in the LTF symbols by the first column of the *PHTLTF* matrix instead of the whole *PHTLTF* matrix is to allow receivers to track phase and frequency offset during MIMO channel estimation using the LTF. The number of LTF symbols, *NLTF*, is a function of the total number of space-time streams *NSTS* as shown in Table 24-10 (Number of LTFs required for different numbers of space time streams). As a result, the LTF field consists of one, two, or four symbols that are necessary for the demodulation of the Data field in the PPDU or for channel estimation in an NDP.

|  |
| --- |
| * Number of LTFs required for different numbers of space time streams
 |
| *NSTS* | *NTLTF* |
| 1 | 1 |
| 2 | 2 |
| 3 | 4 |
| 4 | 4 |

The LTF field for a 2 MHz, 4 MHz, 8 MHz, are 16 MHz transmissions are defined by ~~Equation (22-32), Equation (22-33), Equation (22-34) and Equation (22-35) respectively in~~ ~~22.3.8.2.5 (VHT-LTF definition)~~ Equation (22-36), Equation (22-37), Equation (22-38) and Equation (22-39) respectively in 22.3.8.3.5 (VHT-LTF definition). Note that these equations do not include the phase rotation per 2 MHz subchannel.

The generation of the time domain LTF symbols is shown in Figure 24-25 (Generation of LTF symbols) where  is given in Equation (24-14).

$$A\_{LTF}^{k}=\left\{\begin{array}{c}\left[P\_{HTLTF}\right]\_{\*,1}∙\left[1 1 1 1\right], if k\in K\_{Pilot\\_Fix}\\P\_{HTLTF}, otherwise\end{array}\right.$$

* 

where

 is the subcarrier indices for the fixed pilot tones.
For a 2 MHz transmission, .
For a 4 MHz transmission, .
For an 8 MHz transmission, .
For a 16 MHz transmission, 

is the first column of the *PHTLTF* matrix.

|  |
| --- |
|  |
| * Generation of LTF symbols
 |

The time domain representation of the LTF1, and LTF2~LTFNLTF signals at transmit chain shall be as specified in Equation (24-15) and Equation (24-16), respectively.

* 
* 

where

 and  are defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-9 (Cyclic shift values for the S1G short preamble PPDU)

 is defined by Equation (24-5) ~ Equation (24-8).

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-6 (Frequently used parameters)

 is defined in by Equation (24-14)

 has the value given in Table 24-7 (Tone scaling factor and guard interval duration values for PHY fields)

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

The first LTF (LTF1) consists of two periods of the long training symbol, preceded by a double length (16 s) cyclic prefix. The placement of the first and subsequent LTFs in a greater than or equal to 2MHz short format PPDU is shown in Figure 24-20 (S1G greater than or equal to 2 MHz short format).

* SIG definition

The SIG field carries information required to interpret S1G format PPDUs sent with a short preamble. The structure of the SIG field for the fist symbol (SIG-1) is shown in Figure 24-26 (SIG-1 structure) and for the second symbol (SIG-2) is shown in Figure 24-27 (SIG-2 structure).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 | B2 | B3 B4 | B5 B6 | B7 B15 | B16 | B17 B18 | B19 B22 | B23 |
| ~~reserved~~Reserved | STBC | ~~UPLINK~~Uplink Indication | BW | Nsts | ID | SGI | Coding | MCS | Smoothing |
| * SIG-1 structure
 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 B9 | B10 B11 | B12  | B13 | B14 B17 | B18 B23 |
| Aggregation | Length | Response Indication | Doppler | NDP Indication | CRC | Tail |
| * SIG-2 structure
 |

The SIG field of S1G format PPDUs sent with a short preamble contains the fields listed in Figure 24-26 (SIG-1 structure) and Figure 24-27 (SIG-2 structure).(#872)

|  |
| --- |
| * Fields in the SIG field of short preamble (continued)
 |
| Symbol | Bit | Field | Number of bits | Description |
| SIG-1 | B0 | Reserved | 1 | Reserved. Set to 1. |
| B1 | STBC | 1 | Set to 1 if all spatial streams have space time block coding and set to 0 if no spatial streams has space time block coding. |
| B2 | ~~UPLINK~~Uplink Indication | 1 | Set to the value of the TXVECTOR parameter UPLINK. |
| B3-B4 | BW | 2 | Set to 0 for 2 MHz, 1 for 4 MHz, 2 for 8 MHz, 3 for 16 MHz  |
| B5-B6 | Nsts | 2 | 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 streams |
| B7-B15 | ID | 9 | If UPLINK is not present or set to 1, set to the value of the TXVECTOR parameter PARTIAL\_AID. PARTIAL\_AID provides an abbreviated indication of the intended recipient(s) of the PSDU(see Table 9.17b (Group ID, partial AID, UPLINK and Color in S1G PPDUs))). If UPLINK is set to 0, B7-B9 are set to the value of the TXVECTOR parameter COLOR and B10-B15 are set to the value of the TXVECTOR parameter PARTIAL\_AID. |
| B16 | Short GI | 1 | Set to 0 if short guard interval is not used in the Data field.Set to 1 if short guard interval is used in the Data field. |
| B17-B18 | Coding | 2 | B17 set to 0 for BCC and 1 for LDPCIf B17 is 1, B18 is set to 1 if the LDPC PPDU encoding process (of an SU PPDU), results in an extraOFDM symbol (or symbols) as described in 22.3.10.5.4 (LDPC coding), otherwise set to 0.If B17 is 0, B18 is reserved and set to 1. |
| B19-B22 | MCS | 4 | MCS Index |
| B23 | Smoothing | 1 | A value of 1 indicates that channel smoothing is recommended.A value of 0 indicates that channel smoothing is not recommended. |
| SIG-2 | B0 | Aggregation | 1 | Set to 1 when aggregation is ON (~~AMPDU~~ A-MPDU), and 0 otherwise.Note: S1G PPDUs shall be transmitted with aggregation ON whenever PHY payload size is greater than 511 bytes  |
| B1-B9 | Length | 9 | Denotes the length of PPDU in number of symbols when aggregation bit is set to 1, and in number of bytes when aggregation bit is set to 0.  |
| B10-B11 | Response Indication | 2 | This field indicates the presence and type of frame a SIFS time after the current frame transmission.Set to 0 if No Response.Set to 1 if NDP Response.Set to 2 if Normal Response.Set to 3 if Long Response. |
| B12 | Doppler | 1 | Set to 1 to indicate traveling pilots usage in packet. Otherwise 0 to indicate regular pilot tone locations. |
| B13 | NDP Indication | 1 | Used to indicate that frame is a Control NDP frame. If set to 1, then the SIG field contents follow the description in 8.3.5 (NDP MAC frames) |
| B14-B17 | CRC | 4 | CRC calculated as in 24.3.8.2.1.5 (CRC calculation for S1G SIGA fields).  |
| B18-B23 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.Set to 0. |

~~NOTE—Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position.~~

Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position.

The SIG field is composed of two OFDM symbols, SIG-1 and SIG-2, each ~~containing~~ providing 24 data bits, as shown in Table 24-11 (Fields in the SIG field of short preamble). SIG-1 is transmitted before SIG-2. The SIG symbols shall be BCC encoded at rate, R = 1/2, interleaved, mapped to a BPSK constellation, and have pilots inserted following the steps described in 18.3.5.6 (Convolutional encoder), 18.3.5.7 (Data interleaving), 18.3.5.8 (Subcarrier modulation mapping), and 18.3.5.9 (Pilot subcarriers), respectively.

The first and second half of the stream of 96 complex numbers generated by these steps (before pilot insertion) is divided into two groups of 48 complex numbers , , where  respectively. All the 96 complex numbers are rotated by 90° counter-clockwise relative to their original BPSK constellation points in order to accommodate differentiation of the greater than or equal to 2MHz short format PPDU from an 1MHz format PPDU, or from a greater than or equal to 2MHz long format PPDU. The first rotated 48 complex numbers form the first symbol of SIG; and the second rotated 48 complex numbers form the second symbol of SIG.

The time domain waveform for the SIG field in a greater than or equal to 2MHz short format PPDU at transmit chain  shall be as specified in Equation (24-17).

* 

 where

is the number of 2MHz sub-channels that are contained within the whole bandwidth of the current PPDU (e.g.  for a 4MHz PPDU).

* 
* 

where  is defined in Equation (24-20)

* 

and  are defined in 18.3.5.10 (OFDM modulation)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-9 (Cyclic shift values for the S1G short preamble PPDU)

 is defined in Table 24-4 (Timing-related constants)

 is defined by Equation (24-5) ~ Equation (24-8).

is defined in Table 24-4 (Timing-related constants)

is defined in Table 24-6 (Frequently used parameters)

is defined in in 20.3.9.4.6. (HT-LTF definition)

 has the value given in Table 24-7 (Tone scaling factor and guard interval duration values for PHY fields)

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

NOTE—This definition results in a QBPSK modulation on the two symbols of SIG field, where the constellation of the data tones is rotated by 90º counter-clockwise relative to the 3rd and 4th repetitions of LTF1 field in 1MHz format preamble, and relative to the 2nd symbol of SIG-A field of the greater than or equal to 2MHz long format preamble, respectively, as shown in Figure 24-20 (S1G greater than or equal to 2 MHz short format) to Figure 24-22 (S1G 1MHz format) in 24.3.2 (S1G PPDU format)), to facilitate the differentiation among the three preamble formats at the receiver.

|  |
| --- |
|  |
| * Data constellation in SIG field of greater than or equal to 2MHz short format
 |

* CRC calculation for S1G SIGA fields

The CRC protects bits 0-25 of the 1 MHz SIG field and bits 0-37 of the ≥ 2 MHz SIGA field. The value of the CRC field shall be the ones complement of

* 

where

 is the SIG or SIGA represented as a polynomial

where

*N* is 25 for the 1 MHz SIG field and 37 for the >= 2 MHz SIGA field

*mi*is the *i*th bit of the corresponding SIG/SIGA field

 are initialization values that are added modulo 2 to the first 4 bits of SIG/SIGA

 is the CRC generating polynomial



The CRC field is transmitted with c3 first.

Figure 24-29 (4-bit CRC Calculation) shows the operation of the CRC. First, the shift register is reset to all ones. The bits are then passed through the XOR operation at the input. When the last bit has entered, the output is generated by shifting the bits out of the shift register, C3 first, through an inverter.

|  |
| --- |
|  |
| * 4-bit CRC Calculation
 |

As an example, if bits { *m*0 … *m*25 } are given by { 11 0110 0111 0110 1001 1110 1111 }, the output bits {*b*3 … *b*0}, where *b*3 is output first, are { 0101 }.

* Long preamble

Different from 1MHz preamble and greater than or equal to 2MHz short preamble, the greater than or equal to 2MHz long preamble may be used for both SU and MU transmissions.

The long preamble structure uses a structure that is similar to the mixed format as defined in clause 20 and clause 22.

* Omni portion

Omni portion of the long preamble is ~~always~~ single user modulated.

* Cyclic shift for S1G modulated fields

There are 2 sets of cyclic shift values defined in this subclause. The first set of cyclic shift values defined apply to the Omni portion, or specifically the STF, LTF, SIG-A fields of the S1G long preamble PPDU. These fields are treated as a single spatial stream to be mapped to one or more transmit antennas, at which point the cyclic shifts are applied. The cyclic shift values are defined in Table 24-12 (Per antenna cyclic shift values of S1G long preamble PPDU), which specifies the per-antenna cyclic shift value  for antenna  of the *NTX* total transmit antennas.

|  |
| --- |
| * Per antenna cyclic shift values of S1G long preamble PPDU (continued)
 |
|  for >=2MHz, Omni Portion of Long Preamble PPDU |
| Total number of Tx antennas | Cyclic shift (for Tx Antenna ) (μs) |
| 1 | 2 | 3 | 4 |
| 1 | 0 | - | - | - |
| 2 | 0 | -4 | - | - |
| 3 | 0 | -4 | -2 | - |
| 4 | 0 | -4 | -2 | -6 |

The second set of cyclic shift values defined apply to the Data portion, or specifically the D-STF, D-LTF, SIG-B and Data fields of the S1G long preamble PPDU. In a transmission, these fields are mapped to the transmitted space-time-streams, , at which point the cyclic shifts are applied per space-time stream. The cyclic shift values are defined in Table 24-13 (Per space-time-stream cyclic shift values of S1G

 2MHz long preamble PPDU), which specifies the per-stream cyclic shift value  for space-time stream *n* out of ** total space-time streams. Throughout the S1G long preamble, cyclic shifts are applied to prevent beamforming when similar signals are transmitted in different space-time streams.

For the case of when the S1G long preamble PPDU is used for a MU transmission, the cyclic shifts are applied sequentially, first per user and then per space-time stream up to the total number of users and space-time streams  as follows: the cyclic shift of the space-time stream number m for user u is given by , of the row corresponding to  in Table 24-13 (Per space-time-stream cyclic shift values of S1G

 2MHz long preamble PPDU). In this case, the index n takes into account the cyclic shifts already applied to space-time streams of prior users (M*u*), and the space-time stream index (m) of the current user u in the sequence.

M*u* is given by Table 24-6 (Frequently used parameters)

|  |
| --- |
| * Per space-time-stream cyclic shift values of S1G ≥2MHz long preamble PPDU
 |
|  for 2MHz, Data portion of Long preamble PPDU |
| Total number of space-time streams () | Cyclic for space-time stream n (μs) |
| 1 | 2 | 3 | 4 |
| 1 | 0 | - | - | - |
| 2 | 0 | -4 | - | - |
| 3 | 0 | -4 | -2 | - |
| 4 | 0 | -4 | -2 | -6 |

* STF definition

The STF field for 2 MHz, 4 MHz, 8 MHz and 16 MHz are the same as the STF field in short preamble as specified in 24.3.8.2.1.2 (STF definition).(#270)

The time domain representation of the STF signal at transmit chain  shall be as specified in Equation (24-22).

*

where

is defined in Table 24-4 (Timing-related constants)

 is defined by Equation (24-5) ~ Equation (24-8).

is defined in Table 24-4 (Timing-related constants)

has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields)

 is as defined in 24.3.7 (Mathematical description of signals).

* LTF1 definition

The LTF1 field values for 2 MHz, 4 MHz, 8 MHz and 16 MHz are the same as the LTF field in short preamble as specified in 24.3.8.2.1.3 (LTF definition).

The time domain representation of the LTF1 signal at transmit chain  shall be as specified in Equation (24-23).

*

where

is defined in Table 24-4 (Timing-related constants)

 is defined by Equation (24-5) ~ Equation (24-8)

is defined in Table 24-4 (Timing-related constants)

  has the value given in Table 24-7 (Tone scaling factor and guard interval duration values for PHY fields)

 is as defined in 24.3.7 (Mathematical description of signals).

The LTF1 field consists of two periods of the long training symbol, preceded by a double length (16 s) cyclic prefix. The placement of the first and subsequent LTFs in a greater than or equal to 2MHz short format PPDU is shown in Figure 24-21 (S1G greater than or equal to 2MHz long format).

* SIG-A definition

The SIG-A field of the long preamble carries information required to interpret S1G format PPDUs sent using the long preamble. The structure of the SIG-A field is different for SU PPDUs and MU PPDUs. The structure of the SIG-A field for SU PPDUs for the first symbol (SIG-A1) is shown in Table 24-30 (SIG-A-1 structure for SU PPDU) and for the second symbol (SIG-A2) is shown in Table 24-31 (SIG-A-2 structure for SU PPDU). The structure of the SIG-A field for MU PPDUs for the first symbol (SIG-A1) is shown in Table 24-32 (SIG-A-1 structure for MU PPDU)and for the second symbol (SIG-A2) is shown in Table 24-33 (SIG-A-2 structure for MU PPDU).

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 | B2 | B3 B4 | B5 B6 | B7B 15 | B16 | B17 B18 | B19 B22 | B23 |
| MU/SU | STBC | ~~UPLINK~~Uplink Indication | BW | Nsts | ID | SGI | Coding | MCS | Beam-change/Smoothing Indication |
| * SIG-A-1 structure for SU PPDU
 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 B9 | B10 B11 | B12  | B13 | B14 B17 | B18 B23 |
| Aggregation | Length | ResponseIndication | reserved | Doppler | CRC | Tail |
| * SIG-A-2 structure for SU PPDU
 |

 (#145)

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 | B2 | B3 |  |  | B10 | B11 B12 | B13 B18 | B19 | B20 B23 |
| MU/SU | STBC | reserved | Nsts | BW | GID | SGI | Coding-I |
| MU[0]Nsts | MU[1]Nsts | MU[2]Nsts | MU[3]Nsts |
| * SIG-A-1 structure for MU PPDU
 |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| B0 | B1 | B2 B10 | B11 B12 | B13 | B14 B17 | B18 B23 |
| Coding-II | reserved | Length | ResponseIndication | Doppler | CRC | Tail |
|

|  |
| --- |
| * SIG-A-2 structure for MU PPDU
 |

 |

The SIG-A field of S1G format PPDUs sent with a long preamble for SU contains the fields listed in Table 24-14 (Fields in the SIG-A field of long preamble SU PPDU) and for MU with the fields listed in ~~Table 24-15 (Fields in the SIG-A field of long preamble MU PPDU)~~ Table 24-15 (Fields in the SIG-A field of long preamble MU PPDU).

|  |
| --- |
| * Fields in the SIG-A field of long preamble SU PPDU (continued)
 |
| Symbol | Bit | Field | Number of bits | Description |
| SIG-A-1 | B0 | MU/SU  | 1 | Set to 0 for SU PPDUs. |
| B1 | STBC | 1 | Set to 1 if all spatial streams have space time block coding and set to 0 if no spatial streams has space time block coding.Set to 0 in MU PPDUs. |
| B2 | ~~UPLINK~~Uplink Indication | 1 | Set to the value of the TXVECTOR parameter UPLINK. |
| B3-B4 | BW | 2 | Set to 0 for 2 MHz, 1 for 4 MHz, 2 for 8 MHz, 3 for 16 MHz  |
| B5-B6 | Nsts | 2 | 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 streams |
| B7-B15 | ID | 9 | If UPLINK is not present or set to 1, set to the value of the TXVECTOR parameter PARTIAL\_AID. PARTIAL\_AID provides an abbreviated indication of the intended recipient(s) of the PSDU(see Table 9.17b (Group ID, partial AID, UPLINK and Color in S1G PPDUs))). If UPLINK is set to 0, B7-B9 are set to the value of the TXVECTOR parameter COLOR and B10-B15 are set to the value of the TXVECTOR parameter PARTIAL\_AID. |
| B16 | Short GI | 1 | Set to 0 if short guard interval is not used in the Data field.Set to 1 if short guard interval is used in the Data field. |
| B17-B18 | Coding | 2 | B17 set to 0 for BCC and 1 for LDPCIf B17 is 1, B18 is set to 1 if the LDPC PPDU encoding process (of an SU PPDU), results in an extraOFDM symbol (or symbols) as described in 22.3.10.5.4 (LDPC coding), otherwise set to 0.If B17 is 0, B18 is reserved and set to 1. |
| B19-B22 | MCS | 4 | MCS Index |
| B23 | Beam Change/Smoothing Indication | 1 | If Nsts subfield indicates 1 space time stream.(#190) A value of 1 indicates that the Q matrix is changed from the Omni portion to the Data portion of the long preamble, in at least one of the non-zero sub-carriers of the Omni portion.A value of 0 indicates that the Q matrix is un-changed in all the non-zero sub-carriers of the Omni portion. If Nsts subfield indicates more than 1 space time stream. A value of 1 indicates that channel smoothing is recommended, a value of 0 indicates that channel smoothing is not recommended.(#190)See Note-1.See Note-2. |
| SIG-A-2 | B0 | Aggregation | 1 | Set to 1 when aggregation is ON (~~AMPDU~~ A-MPDU), and 0 otherwise.Note: S1G PPDUs shall be transmitted with aggregation ON whenever PHY payload size is greater than 511 bytes  |
| B1-B9 | Length | 9 | Denotes the length of PPDU in number of symbols when aggregation bit is set to 1, and in number of bytes when aggregation bit is set to 0.  |
| B10-B11 | Response Indication | 2 | This field indicates the presence and type of frame a SIFS time after the current frame transmission.Set to 0 if No Response.Set to 1 if NDP Response.Set to 2 if Normal Response.Set to 3 if Long Response. |
| ~~B12~~ | ~~Reserved~~ | ~~1~~ | ~~Reserved. Bit set to 1.~~ |
| ~~B13~~ | ~~Doppler~~ | ~~1~~ | ~~Set to 1 to indicate traveling pilots usage in packet. Otherwise 0 to indicate regular pilot tone locations.~~ |
| B12 | Doppler | 1 | Set to 1 to indicate traveling pilots usage in packet. Otherwise 0 to indicate regular pilot tone locations. |
| B13 | Reserved | 1 | Reserved. Bit set to 1. |
| B14-B17 | CRC | 4 | CRC calculated as in 24.3.8.2.1.5 (CRC calculation for S1G SIGA fields).  |
| B18-B23 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.Set to 0. |
| Note-1: When the Nsts subfield indicates 1 space time stream,(#190) if beam-change indication bit is set to 0, the receiver may do channel smoothing. Otherwise, smoothing is not recommended.Note-2: The Q matrix for Omni portion is  as defined in 24.3.7 (Mathematical description of signals). |

|  |
| --- |
| * Fields in the SIG-A field of long preamble MU PPDU (continued)
 |
| Symbol | Bit | Field | Number of bits | Description |
| SIG-A-1 | B0 | MU/SU  | 1 | Set to 1 for MU PPDUs  |
| B1 | STBC | 1 | Set to 1 if all spatial streams of all users have space time block coding and set to 0 if no spatial streams of any user has space time block coding.NOTE—For some but not all users to have space time block coding is not allowed. |
| B2 | Reserved | 1 | Reserved. Set to 1. |
| B3-B10 | NSTS | 8 | NSTS is divided into 4 user positionsof 2 bits each, , denoted by 4 subfields MU[0] Nsts …MU[3] Nsts. User position *p*, where , uses bits . The space-time streams of user u are indicated at user position  where  and the notation A[*b*] denotes the value of array A at index *b*. Zero space-time streams are indicated at positions not listed in theUSER\_POSITION array.(#3599)Set to 0 for 0 space time streamsSet to 1 for 1 space time streamSet to 2 for 2 space time streamsSet to 3 for 3 space time streams |
| B11-B12 | BW | 2 | Set to 0 for 2 MHz, 1 for 4 MHz, 2 for 8 MHz, 3 for 16 MHz |
| B13-B18 | GID | 6 | In an MU PPDU the Group ID is set as defined in 22.3.11.4 (Group ID) |
| B19 | Short GI | 1 | Set to 0 if short guard interval is not used in the Data field.Set to 1 if short guard interval is used in the Data field. |
| B20-B23 | Coding-I | 4 | If the MU[0] NSTS field is non-zero, then B20 indicates coding for user 0: set to 0 for BCC, 1 for LDPC.If the MU[0] NSTS field is 0, then B20 is reserved and set to 1.If the MU[1] NSTS field is non-zero, then B21 indicates coding for user 1: set to 0 for BCC, 1 for LDPC.If the MU[1] NSTS field is 0, then B21 is is reserved and set to 1.If the MU[2] NSTS field is non-zero, then B22 indicates coding for user 2: set to 0 for BCC, 1 for LDPC.If the MU[2] NSTS field is 0, then B22 is reserved and set to 1.If the MU[3] NSTS field is non-zero, then B23 indicates coding for user 3: set to 0 for BCC, 1 for LDPC.If the MU[3] NSTS field is 0, then B23 is reserved and set to 1. |
| SIG-A-2 | B0 | Coding-II | 1 | Set to 1 if at least one LDPC user’s PPDU encoding process results in an extra OFDM symbol (or symbols) as described in 22.3.10.5.4 (LDPC coding) and 22.3.10.5.5 (Encoding process for MU PPDUs). Set to 0 otherwise. |
| ~~B1~~ | ~~Reserved~~ | ~~1~~ | ~~Reserved. Set to 1.~~ |
| ~~B2-B10~~B1-B9 | Length | 9 | Denotes the length of PPDU in number of symbols.Note: ~~AMPDU~~ A-MPDU is always used for MU PPDUs. |
| ~~B11-B12~~B10-B11 | Response Indication | 2 | This field indicates the presence and type of frame a SIFS time after the current frame transmission. Set to 0 if No Response.Set to 1 if NDP Response.Set to 2 if Normal Response.Set to 3 if Long Response. |
| ~~B13~~B12 | Doppler | 1 | Set to 1 to indicate traveling pilots usage in packet. Otherwise 0 to indicate regular pilot tone locations. |
| B13 | Reserved | 1 | Reserved. Set to 1. |
| B14-B17 | CRC | 4 | CRC calculated as in 24.3.8.2.1.5 (CRC calculation for S1G SIGA fields).  |
| B18-B23 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.Set to 0. |

~~NOTE—Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position.~~

Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position

The SIG-A field is composed of two OFDM symbols, SIG-A1 and SIG-A2, each containing 24 data bits, as shown in Table 24-14 (Fields in the SIG-A field of long preamble SU PPDU). SIG-A1 is transmitted before SIG-A2. The SIG symbols shall be BCC encoded at rate, R = 1/2, interleaved, mapped to a BPSK constellation, and have pilots inserted following the steps described in 18.3.5.6 (Convolutional encoder), 18.3.5.7 (Data interleaving), 18.3.5.8 (Subcarrier modulation mapping), and 18.3.5.9 (Pilot subcarriers), respectively. The first and second half of the stream of 96 complex numbers generated by these steps (before pilot insertion) is divided into two groups of 48 complex numbers , , where  respectively. The first group of the 48 complex numbers are rotated by 90° counter-clockwise relative to their original BPSK constellation points in order to accommodate differentiation of the greater than or equal to 2MHz long format PPDU from an 1MHz format PPDU. The second group of the 48 complex numbers without rotations may be used to accommodate differentiation of the greater than or equal to 2MHz long format PPDU from a greater than or equal to 2MHz short format PPDU. The first rotated 48 complex numbers form the first symbol of SIG-A; and the second un-rotated 48 complex numbers form the second symbol of SIG-A.

The time domain waveform for the SIG-A field in a greater than or equal to 2MHz long format PPDU at transmit chain  shall be as specified in Equation (24-24).

*

where

, , and  are the same as those defined in 24.3.8.2.1.4 (SIG definition).

and  are defined in 18.3.5.10 (OFDM modulation)

 is defined in Table 24-4 (Timing-related constants)

 is defined by Equation (24-5) ~ Equation (24-8).

is defined in Table 24-4 (Timing-related constants)

has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields)

 is as defined in 24.3.7 (Mathematical description of signals).

NOTE— As shown in Figure 24-20 (S1G greater than or equal to 2 MHz short format) to Figure 24-22 (S1G 1MHz format) in 24.3.2 (S1G PPDU format), this definition results in a QBPSK modulation on the first symbol of SIG-A field, where the constellation of the data tones is rotated by 90º counter-clockwise relative to the 3rd repetition of LTF1 field in 1MHz format preamble, facilitating its differentiation from 1MHz format; and the second symbol of SIG-A field is BPSK modulated, facilitating its differentiation from greater than or equal to 2MHz short format.

|  |
| --- |
|  |
| * Data constellation in SIG-A field of greater than or equal to 2MHz long format
 |

* Data portion

Data portion of the long preamble could be either single user or multiuser modulated.

* Cyclic shift for S1G modulated fields

Same as 24.3.8.2.1.1 (Cyclic shift for S1G modulated fields).

* D-STF definition

The main purpose of the D-STF field is to improve automatic gain control estimation in a SU or MU MIMO transmission. The duration of the D-STF field is 40 μs. The frequency domain sequence  used to construct the D-STF field is the same as the STF field in short or long preamble as indicated in 24.3.8.2.1.2 (STF definition).

The time domain representation of the D-STF signals at transmit chain  shall be as specified in Equation (24-25).

* 

where

  is defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-13 (Per space-time-stream cyclic shift values of S1G

 2MHz long preamble PPDU)

 is defined by Equation (24-5) ~ Equation (24-8)

 is defined in Table 24-4 (Timing-related constants)

, , , and  are defined in Table 24-6 (Frequently used parameters).

 has the value given in Tone scaling factor and guard interval duration values for PHY fields Table 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

The duration of the D-STF field is  regardless of the Short GI field setting in SIG-A.

* D-LTF definition

The D-LTF field values for 2 MHz, 4 MHz, 8 MHz and 16 MHz are the same as the LTF field in short preamble as specified in 24.3.8.2.1.3 (LTF definition).

The generation of the time domain D-LTF symbols per frequency segment is shown in Figure 24-25 (Generation of LTF symbols) in 24.3.8.2.1.3 (LTF definition).

The time domain representation of the D-LTF signals at transmit chain  shall be as specified in Equation (24-26).



*

where

  is defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-13 (Per space-time-stream cyclic shift values of S1G

 2MHz long preamble PPDU)

 is defined by Equation (24-5) ~ Equation (24-8)

 is defined in Table 24-4 (Timing-related constants)

, , , and  are defined in Table 24-6 (Frequently used parameters)

 is defined in Equation (24-14).

 has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

As indicated by Equation (24-26), the duration of each symbol of the D-LTF field is  regardless of the Short GI field setting in SIG-A.

The generation of the time domain D-LTF symbols is the same as Figure 24-25 (Generation of LTF symbols), with  replaced by .

* SIG-B definition

If the SU/MU indication subfield in SIG-A field is set to 0 (SU), then SIG-B field is one symbol that is identical to the first D-LTF field (D-LTF1). In this case, the time domain representation of the SIG-B field at transmit chain  shall be as specified in Equation (24-26) with *n=0*.

If the SU/MU indication subfield in SIG-A field is set to 1 (MU), then SIG-B field is one symbol and contains 26 bits in a 2 MHz PPDU, 27 bits in a 4 MHz PPDU and 29 bits in 8 MHz and 16 MHz PPDUs for each user. The fields in the SIG-B field are listed in Table 24-16 (Fields in the SIG-B field).

|  |
| --- |
| * Fields in the SIG-B field (continued)
 |
| Field | Bit Allocation (number of bits) | Description |
| 2 MHz | 4 MHz | 8 MHz | 16 MHz |
| MCS | B0-B3 (4) | B0-B3 (4) | B0-B3 (4) | B0-B3 (4) | Per-user MCS in MU-MIMO |
| Reserved | B4-B11 (8) | B4-B12 (9) | B4-B14 (11) | B4-B14 (11) | All 1s |
| CRC | B12-B19 (8) | B13-B20 (8) | B15-B22 (8) | B15-B22 (8) |   |
| Tail | B20-B25 (6) | B21-B26 (6) | B23-B28 (6) | B23-B28 (6) | All 0s |
| Total # bits | 26 | 27 | 29 | 29 |   |

(#880)

In this case, the ~~padding,~~ repetition, encoding, interleaving and modulation flow for the data subcarriers of SIG-B field in 2 MHz, 4 MHz, 8 MHz and 16 MHz are identical to those specified for 20 MHz, 40 MHz, 80 MHz and 160 MHz, respectively, as shown in 22.3.8.2.6 (VHT-SIG-B definition). Different from the VHT-SIG-B field defined in clause 22, the pilot subcarriers of SIG-B field ~~is~~ are mapped by the first column of *P*HTLTF matrix to *N*STS, total space-time streams, and the pilot polarity of the SIG-B symbol is *p2* instead of *p3*. The time domain representation for SIG-B field signal at transmit chain  shall be as specified in :



where

  is defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-13 (Per space-time-stream cyclic shift values of S1G

 2MHz long preamble PPDU)

 is defined by Equation (24-5) ~ Equation (24-8)

 is defined in Table 24-4 (Timing-related constants)

, , , and  are defined in Table 24-6 (Frequently used parameters)

 is defined in Equation (20-27) in 20.3.9.4.6 (HT-LTF definition)

 is defined in 18.3.5.10 (OFDM modulation)

 is defined in 22.3.10.10 (Pilot Subcarriers)

 has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

For a 2 MHz transmission,

* 

* 

For a 4 MHz transmission,

* 



For an 8 MHz transmission,

* 
* 

For a 16 MHz transmission 

*



* 1 MHz PHY
* Cyclic shift for S1G modulated fields

The cyclic shift values defined in this subclause apply to the STF, LTF, SIG and Data fields of the S1G 1MHz PPDU. Throughout the S1G 1MHz preamble, cyclic shifts are applied to prevent beamforming when similar signals are transmitted in different space-time streams. The same cyclic shift is applied to these streams during the transmission of the Data field of the S1G 1MHz PPDU. The cyclic shift value  for space-time stream *n* out of *NSTS,total* total space-time streams is shown in Table 24-17 (Cyclic shift values of S1G 1MHz PPDU).

|  |
| --- |
| * Cyclic shift values of S1G 1MHz PPDU (continued)
 |
|  values for 1MHz PPDU |
| Total number of space-time streams (*NSTS,total* ) | Cyclic shift for space-time stream n (μs) |
| 1 | 2 | 3 | 4 |
| 1 | 0 | - | - | - |
| 2 | 0 | -4 | - | - |
| 3 | 0 | -4 | -1 | - |
| 4 | 0 | -4 | -1 | -5 |

* STF definition

The STF field in 1MHz preamble is repeated with 4 OFDM symbols, i.e. twice the duration of the STF fields in greater than or equal to 2MHz preambles.

The time domain representation of the STF signal at transmit chain  shall be as specified in Equation (24-36).

* 

where

  is defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-17 (Cyclic shift values of S1G 1MHz PPDU)

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-6 (Frequently used parameters)

 is defined in Equation (20-27) in 20.3.9.4.6 (HT-LTF definition)

 has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

 has non-zero values  on tones (#272) respectively

 is an MCS dependent scaling factor, with the following value

 

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

* LTF definition

The duration of the first LTF (LTF1) field in 1MHz preamble is of 4 OFDM symbols with repetitions, i.e. twice the duration of the LTF1 fields in greater than or equal to 2MHz preambles. The first two repetitions have the same structure as the LTF1 field in greater than or equal to 2MHz preambles, i.e. they consist of two periods of the long training symbol, preceded by a double length (16 s) cyclic prefix. Each of the last two repetitions of LTF1 field consists one period of the long training symbol preceded by a normal length (8 *s*) cyclic prefix. The duration of the each of the remaining LTFs in 1MHz preamble is of one OFDM symbol.

The placement of the first and subsequent LTFs in a 1MHz format PPDU is shown in Figure 24-22 (S1G 1MHz format).

The generation of the time domain LTF(#273) symbols is the same as Table 24-25 (Generation of LTF symbols).

The time domain representation of the first two repetitions of the LTF1 field, and the last two repetitions of the LTFs field shall be as specified in Equation (24-37) and Equation (24-38), respectively

* 
* $r\_{LTF1\\_1,2}^{\left(i\_{rx}\right)} (t)=\frac{1}{\sqrt{N\_{LTF}^{Tone}N\_{STS}}}w\_{T\_{LTF1}}\left(t\right)\sum\_{k=-N\_{SR}}^{N\_{SR}}\sum\_{m=1}^{N\_{STS}}\left(\genfrac{}{}{0pt}{}{\left[Q\_{k}\right]\_{i\_{TX},m}Υ\_{k,BW}\left[A\_{LTF}^{k}\right]\_{m,1}LTF\_{k} }{∙exp⁡(j2πkΔ\_{F}\left(t-T\_{GI2}-T\_{CS}\left(m\right)\right)}\right)$
* 
* $r\_{LTF1\\_3,4}^{\left(i\_{rx}\right)} (t)=\frac{1}{\sqrt{N\_{LTF}^{Tone}N\_{STS}}}w\_{T\_{LTF1}}\left(t\right)\sum\_{k=-N\_{SR}}^{N\_{SR}}\sum\_{m=1}^{N\_{STS}}\left(\genfrac{}{}{0pt}{}{\left[Q\_{k}\right]\_{i\_{TX},m}Υ\_{k,BW}\left[A\_{LTF}^{k}\right]\_{m,1}LTF\_{k} }{∙exp⁡(j2πkΔ\_{F}\left(t-T\_{GI}-T\_{CS}\left(m\right)\right)}\right)$

where

 and  are defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-17 (Cyclic shift values of S1G 1MHz PPDU)

 is defined by Equation (24-5) ~ Equation (24-8)

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-6 (Frequently used parameters)

 has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

 is defined in Equation (24-39).

* 

where

 is the subcarrier indices for the fixed pilot tones. For a 1 MHz transmission, .

is the first column of the *PHTLTF* matrix.

={0 0 0 1 -1 1 -1 -1 1 -1 1 1 -1 1 1 1 0 -1 -1 -1 1 -1 -1 -1 1 -1 1 1 1 -1 0 0}

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

NOTE-1 – This LTF sequence is chosen to be orthogonal to both halves of the 2MHz LTF sequence in order to facilitate classification between 1MHz and 2MHz preambles. The orthogonality metric between two equal length sequences {A} and {B} is defined as with k=1,2,3,..16,18,19,..31 skipping the 1MHz DC location on k=17.

NOTE-2 —This definition results in a BPSK modulation on the last two symbols of LTF1 field, to facilitate the differentiation from the greater than or equal to 2MHz preambles.

The time domain representation of the LTF2~LTFNLTF signals at transmit chain shall be as specified in Equation (24-40).

* 

where

 and  are defined in Table 24-4 (Timing-related constants)

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-13 (Per space-time-stream cyclic shift values of S1G

 2MHz long preamble PPDU)

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-6 (Frequently used parameters)

 is defined in Equation (24-39)

 has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

* SIG definition

The SIG field carries information required to interpret 1MHz S1G format PPDUs sent with a short preamble. The structure of the 6 symbol SIG field (which carries 6 information bits per symbol) is shown in Figure 24-35 (Structure of the 6 symbol SIG field of S1G 1MHz PPDU)(#299). Note that unlike other SIG field structures the indexing of the bits incorporates all the SIG symbols. i.e., B0-B5 denote the first symbol, B6-B11 the second, and so on.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| B0 B1 | B2 | B3B4 | B5 | B6 | B7 B10 | B11 | B12 B20 | B21 B22 | B23 | B24 | B25 | B26 B29 | B30 B35 |
| Nsts | SGI | Coding | STBC | reserved | MCS | Aggregation | Length | ResponseIndication | Smoothing | Doppler | NDP Indication | CRC | Tail |
| * Structure of the 6 symbol SIG field of S1G 1MHz PPDU
 |

(#873)

The SIG field of S1G 1MHz PPDUs contains the fields listed in Table 24-18 (Fields in the SIG field of 1MHz PPDU).

|  |
| --- |
| * Fields in the SIG field of 1MHz PPDU (continued)
 |
| Symbol | Bit | Field | Number of bits | Description |
| SIG-1 | B0-B1 | NSTS | 2 | 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 streams |
| B2 | Short GI | 1 | Set to 0 if short guard interval is not used in the Data field.Set to 1 if short guard interval is used in the Data field. |
| B3-B4 | Coding | 2 | B3 set to 0 for BCC and 1 for LDPCIf B3 is 1, B4 is set to 1 if the LDPC PPDU encoding process (of an SU PPDU), results in an extraOFDM symbol (or symbols) as described in 22.3.10.5.4 (LDPC coding), otherwise set to 0.If B3 is 0, B4 is reserved and set to 1. |
| B5 | STBC | 1 | Set to 1 if all spatial streams havespace time block coding and set to 0 if no spatial streams has space time block coding. |
| SIG-2 | B6 | Reserved | 1 | Reserved. Set to 1. |
| B7-B10 | MCS | 4 | MCS Index |
| B11 | Aggregation | 1 | Set to 1 when aggregation is ON (~~AMPDU~~ A-MPDU), and 0 otherwise.Note: S1G PPDUs shall be transmitted with aggregation ON whenever PHY payload size is greater than 511 bytes |
| SIG-3 and SIG-4 | B12-B20 | Length | 9 | Denotes the length of PPDU in number of symbols when aggregation bit is set to 1, and in number of bytes when aggregation bit is set to 0. |
| B21-22 | Response Indication | 2 | This field indicates the presence and type of frame a SIFS time after the current frame transmission.Set to 0 if No Response.Set to 1 if NDP Response.Set to 2 if Normal Response.Set to 3 if Long Response. |
| B23 | Smoothing | 1 | A value of 1 indicates that channel smoothing is recommended.A value of 0 indicates that channel smoothing is not recommended. |
| SIG-5 | B24 | Doppler | 1 | Set to 1 to indicate traveling pilots usage in packet. Otherwise 0 to indicate regular pilot tone locations. |
| B25 | NDP Indication | 1 | Used to indicate that frame is a Control NDP frame. If set to 1, then the SIG field contents follow the description in 8.3.5 (NDP MAC frames) |
| B26-B29 | CRC | 4 | CRC calculated as in 24.3.8.2.1.5 (CRC calculation for S1G SIGA fields).  |
| SIG-6 | B30-B35 | Tail | 6 | Used to terminate the trellis of the convolutional decoder.Set to 0. |

~~NOTE—Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position.~~

Integer fields are represented in unsigned binary format with the least significant bit in the lowest numbered bit position.

The SIG field of 1MHz format is composed of six OFDM symbols, SIG-1 ~ SIG-6, each containing 6 data bits, as shown in Table 24-18 (Fields in the SIG field of 1MHz PPDU). SIG-1 is transmitted first and SIG-6 is the last. The SIG symbols shall be BCC encoded at rate, R = 1/2, and repeated two times for the encoded bits within each OFDM symbol, interleaved, mapped to a BPSK constellation, and have pilots inserted, following the steps for MCS10 transmission flow described in Clause 24.3.9 (Data field). The stream of 144 complex numbers generated by these steps (before pilot insertion) is divided into six groups of 24 complex numbers , , where  respectively. All the 144 complex numbers are BPSK modulated. The first 24 complex numbers form the first symbol of SIG; and the second ~~rotated~~ 24 complex numbers form the second symbol of SIG, and so forth.

The time domain waveform for the SIG field in a 1MHz format PPDU at transmit chain  shall be as specified in Equation (24-41).

* 

where

 is defined in 18.3.5.10 (OFDM modulation), and  is defined in 22.3.10.10 (Pilot Subcarriers).

 represents the cyclic shift for space-time stream *m* with a value given in Table 24-17 (Cyclic shift values of S1G 1MHz PPDU)

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-4 (Timing-related constants)

 is defined in Table 24-6 (Frequently used parameters)

 is defined in Equation (20-27) in 20.3.9.4.6 (HT-LTF definition)

 has the value given in Tone scaling factor and guard interval duration values for PHY fieldsTable 24-7 (Tone scaling factor and guard interval duration values for PHY fields).

$Q\_{k}$ is as defined in 24.3.7 (Mathematical description of signals).

* 

where

 is defined in Equation (24-53)

* 