IEEE P802.11
Wireless LANs

|  |
| --- |
| (LB200) TGah D1.0 PHY Comment Resolutions on Clause 24.3.4 |
| Date: 2014-03-03 |
| Author(s): |
| Name | Affiliation | Address | Phone | Email |
| Hongyuan Zhang | Marvell |  |  |  |
| Minho Cheong |  |  |  |  |

This document provides PHY resolutions for CIDs on Clause 24.3.4:

CIDs 1313, 1314, 1595, 1596, 1597, 1598, 1599, 2001, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2282, 2674, 2675, 2676, 2677, 2678, 2679, 2680, 2681, 2682, 2683, 2684, 2685, 2686, 2687

| **CID** | **Commenter** | **Page** | **Clause** | **Assignee** | **Comment** | **Proposed Change** | **Resolution** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2103 | Jun Zheng | 263.57 | 24.3.4.3.1 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.TGah editor to make changes as shown in doc. 14/0370r0. |
| [Discussions]MU transmission is only available for long preamble format.But, it has not been agreed in the task group that SU beamformed transmission shall not be allowed with the use of short preamble format. In addition, in clause 9.47.4 (TXOP-based sectorization operation), there are already defined some spatial orthogonal frame exchanges assuming beamforming transmissions with the use of short preamble format. (Please see Figure 9-93, Figure 9-94 and Figure 9-95)So, there seems no critical reason to disallow SU beamformed transmission with the use of short preamble format.Even if beamforming is not conducted, a spatial mapping matrix Q is still needed in certain configurations. As a result, in the mentioned bullet, instead of referring solely to **24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)** for the beamforming case, we should also refer to **24.3.9.11.1 (Transmission in S1G format).**  |
| 2674 | ron porat | 263.57 | 24.3.4.3.1 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |
| 2104 | Jun Zheng | 264.22 | 24.3.4.3.2 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |
| 2675 | ron porat | 264.22 | 24.3.4.3.2 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |
| 2106 | Jun Zheng | 264.32 | 24.3.4.3.4 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |
| 2677 | ron porat | 264.32 | 24.3.4.3.4 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |
| 2105 | Jun Zheng | 264.60 | 24.3.4.3.3 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |
| 2676 | ron porat | 264.60 | 24.3.4.3.3 | Minho | propose to remove the application of spatial mapping as described in 24.3.10 from the greater than or equal short format since this format is not used for MU and shouldn't be used for SU BF as it's better to clearly have 2 distinct purposes for the short and long preambles - the long is for high end devices and SU bF and MU and short for sensors utilizing OL |  | REVISE.Refer to the resolution of CID 2103. |

| **CID** | **Commenter** | **Page** | **Clause** | **Assignee** | **Comment** | **Proposed Change** | **Resolution** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2107 | Jun Zheng | 266.01 | 24.3.4.4.1 | Minho | propose to remove the application of spatial mapping from the 1MHz since this format is not used for 1MHz |  | REVISE.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>It is correct that SU and MU beamforming sounding exchange are not defined for 1MHz. The application of Q matrix could be without beamforming, e.g. for spatial expansion. Therefore, we should keep the Q matrix for 1MHz PPDU encoding process, but instead of referring to **24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming),** we now refer to **24.3.9.11.1 (Transmission in S1G format)**, in which some general Q matrix multiplication procedure is discussed. |
| 2678 | ron porat | 266.01 | 24.3.4.4.1 | Minho | propose to remove the application of spatial mapping from the 1MHz since this format is not used for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2108 | Jun Zheng | 266.29 | 24.3.4.4.2 | Minho | propose to remove the application of spatial mapping from the 1MHz since this format is not used for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2679 | ron porat | 266.29 | 24.3.4.4.2 | Minho | propose to remove the application of spatial mapping from the 1MHz since this format is not used for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2681 | ron porat | 267.39 | 24.3.4.4.4 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2680 | ron porat | 267.04 | 24.3.4.4.3 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2682 | ron porat | 268.29 | 24.3.4.5.1 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2683 | ron porat | 269.24 | 24.3.4.5.2 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2684 | ron porat | 270.03 | 24.3.4.6.1 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2685 | ron porat | 270.43 | 24.3.4.6.2 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
| 2686 | ron porat | 271.08 | 24.3.4.7.1 | Minho | propose to remove the application of spatial mapping from the 1MHz since SU BF or MU is not supported for 1MHz |  | REVISERefer to the resolution of CID 2107 |
|  |
| 2109 | Jun Zheng | 271.37 | 24.3.4.7.4 | Minho | is MU applied to DUP modes? Propose to not use MU for DUP modes. |  | REVISE.Please see doc. 14/0370r0. |
| <Discussion>MU is not applied to 1MHz DUP mode because any kind of 1MHz preamble transmission does not allow MU mode, therefore we should remove the 1MHz DUP related text.The waveform equation of S1G 2MHz duplicate data transmission using SIG\_LONG, which is described in Equation (24-60) in D1.0 is for SU only. Since there is no clear statement in the current draft on disallowing MU using 2MHz DUP, here we add this restriction in 24.3.4.7.1 (see the corresponding revised text below).  |
| 2687 | ron porat | 271.37 | 24.3.4.7.4 | Minho | is MU applied to DUP modes? It's not needed |  | REVISE. Refer to the resolution of CID 2107 |
|  |
| 2001 | Hongyuan Zhang | 263.09 | 24.3.4.2.6 | Minho | 11ac draft 6.0 clause 22.3.4.8 added the descriptions for segment parser and deparser for 160MHz and 80+80MHz, here in 11ah 24.3.4.2.6, we should also add the same segment parser/deparser descriptions for 16MHz. | as comment | ACCEPT.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>As the commenter suggested, we changed clause 24.3.4.2.6 (Construction of SIG-B) accordingly, by following the new changes in 11ac.  |
| 1313 | Adrian Stephens | 265.16 | 24.3.4.3.4 | Minho | "LTF2-LTFNLTF" - the font choice is curious. I believe the 2 and NLTF were intended to be subscripts. | Make the 2 and NLTF subscripts here and throughout this clause in this context (including the PPDU format figures). | REJECT.Same expressions were used in the PPDU diagrams in 24.3.2, as well as many other places in clause 24, here we should keep it constant. |
| 1595 | Brian Hart | 266.47 | 24.3.4.4.3 | Minho | "SMOOTHONG," | SMOOTHING (also P264L39) | ACCEPT.TGah editor to make changes as shown in doc. 14/0370r0. |
| 1596 | Brian Hart | 267.51 | 24.3.4.5 | Minho | Titles for 24.3.4.5 and 24.3.4.6 conflict | Identify that section 24.3.4.5 is for all MCs's except MCS10 | REVISE.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>Changed the title for clause 24.3.4.5 to make it more readable.  |
| 2282 | Li Chia Choo | 267.63 | 24.3.4.5.1 | Minho | No reference to which scrambler used in 24.3.4.5.1 | Add a reference to the scrambler used in 24.3.4.5.1. | ACCEPT.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>Added a reference as the commenter suggested.  |
| 1314 | Adrian Stephens | 271.12 | 24.3.4.7.1 | Minho | "Note that 1MHz PPDU" - grammar | "Note that a 1MHz PPDU" | REVISE.TGah editor to make changes as shown in doc. 14/0370r0. |
| 1597 | Brian Hart | 271.12 | 24.3.4.7.1 | Minho | Missing article in "Note that 1MHz PPDU cannot beused for an MU transmission." | "Note that \*a\* 1MHz PPDU cannot beused for an MU transmission." And maybe concert ot a Note or drop the "Note that" | REVISE.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>Corrected as the commenter pointed out. |
| 1599 | Brian Hart | 271.34 | 24.3.4.7.4 | Minho | "The Q matrix" does not start with the imperative, as per later bullets | Rewrite to "Apply the Q ..." | ACCEPT.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>Corrected as the commenter pointed out. |
| 1598 | Brian Hart | 271.08 | 24.3.4.7.1 | Minho | "except CSD" reads badly | "except that the CSD is across users as described in ..." | REVISE.TGah editor to make changes as shown in doc. 14/0370r0. |
| <Discussion>Corrected as the commenter pointed out. |

**TGah editor: modify the D1.2 text from P305L28, as follows**

* Overview of the PPDU encoding process
* General

This subclause provides an overview of the S1G PPDU encoding process.

* **Construction of the Preamble part in an S1G\_LONG PPDU**
* Construction of STF

Construct the STF field as defined in with the following highlights:

* Determine the CH\_BANDWIDTH from the TXVECTOR.
* Sequence generation: Generate the STF sequence over the CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* CSD: Apply CSD for each transmit chain and frequency segment as described in .
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in .
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of the LTF1

Construct the LTF1 field as defined in with the following highlights:

* Determine the CH\_BANDWIDTH from the TXVECTOR.
* Sequence generation: Generate the LTF1 sequence over the CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* CSD: Apply CSD for each transmit chain and frequency segment as described in .
* Insert GI and apply windowing: Prepend a GI (2 x LONG\_GI) and apply windowing as described in .
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of SIG-A

The SIG-A field consists of two symbols, SIG-A1 and SIG-A2, as defined in and is constructed as follows:

* Obtain the CH\_BANDWIDTH, STBC, MU\_SU, GROUP\_ID (MU only), PARTIAL\_AID (SU only), NUM\_STS, GI\_TYPE, FEC\_CODING, MCS (SU only), NUM\_USERS, LENGTH, AGGREGATION (SU only), RESPONSE\_INDICATION, BEAM\_CHANGE (SU only for single space-time stream), SMOOTHING and DOPPLER from the TXVECTOR. Add the reserved bits, append the calculated 4 bit CRC, then append the Ntail tail bits as shown in . This results in 48 uncoded bits.
* BCC encoder: Encode the data by a convolutional encoder at the rate of R=1/2 as described in 18.3.5.6 (Convolutional encoder).
* BCC interleaver: Interleave as described in 18.3.5.7 (Data interleaving).
* Constellation mapper: QBPSK modulate the first 48 interleaved bits by rotating by 90° counter-clockwise relative to the original BPSK as described in to form the first symbol of SIG-A. BPSK modulate the second 48 interleaved bits to form the second symbol of SIG-A.
* Pilot insertion: Insert pilots as described in 18.3.5.10 (OFDM modulation).
* Duplication and phase rotation: Duplicate SIG-A1 and SIG-A2 over each 2 MHz of the CH\_BANDWIDTH. Apply the appropriate phase rotation for each 2 MHz subchannel as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* CSD: Apply CSD for each transmit chain as described in .
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of D-STF

The D-STF field is defined in and constructed as follows:

* Sequence generation: Generate the D-STF in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of D-LTF

The D-LTF field is defined in and constructed as follows:

* Sequence generation: Generate the D-LTF sequence in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* ALTF matrix mapping: Apply the *PHTLTF* matrix to the D-LTF sequence (the pilot tones are processed differently) as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of SIG-B

The SIG-B field is constructed per-user as follows:

* Obtain the MCS (for MU only) from the TXVECTOR.
* SIG-B bits: Set the MCS (for MU only) as described in . Add the reserved bits and Ntail bits of tail.
* SIG-B Bit Repetition: Repeat the SIG-B bits as a function of CH\_BANDWIDTH as defined in .
* BCC encoder: Encode the SIG-B field using BCC at rate R=1/2 as described in 18.3.5.6 (Convolutional encoder).
* Segment parser (if needed): For a 16 MHz transmission, divide the output bits of the BCC encoder into two frequency subblocks as described in 24.3.9.7 (Segment parser). This block is bypassed for 2 MHz, 4 MHz and 8 MHz S1G PPDU transmissions. *(To Editor: please correct the alphabet mark in order!)*
* BCC interleaver: Interleave as described in 24.3.9.8 (BCC interleaver).
* Constellation mapper: Map to a BPSK constellation as defined in 18.3.5.8 (Subcarrier modulation mapping).
* Segment deparser (if needed): For a 16 MHz transmission, merge the two frequency subblocks into one frequency segment as described in 24.3.9.9.3 (Segment deparser). This block is bypassed for 2 MHz, 4 MHz, 8 MHz S1G PPDU transmissions. *(To Editor: please correct the alphabet mark in order!)*
* Pilot insertion: Insert pilots following the steps described in .
* *PHTLTF* matrix mapping: Apply the mapping of the 1st column of the *PHTLTF* matrix to the data subcarriers as described in . The total number of data and pilot subcarriers is the same as in the Data field.
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* Phase rotation: Apply the appropriate phase rotations for each 2 MHz subchannel as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* **Construction of the Preamble part in an S1G\_SHORT PPDU**
* Construction of STF

The STF field is defined in and constructed as follows:

* Determine the CH\_BANDWIDTH from the TXVECTOR.
* Sequence generation: Generate the STF in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* PHTLTF matrix mapping: Apply the mapping of the first column of the *PHTLTF* matrix to the STF sequence as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of LTF1

The LTF1 field is defined in and constructed as follows:

* Sequence generation: Generate the LTF1 sequence in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* ALTF matrix mapping: Apply the mapping of the first column of the *PHTLTF* matrix to the LTF1 sequence (the pilot tones are processed differently) as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (2 x LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of SIG

The SIG field is constructed per-user as follows:

* Obtain the CH\_BANDWIDTH, STBC, PARTIAL\_AID, NUM\_STS, GI\_TYPE, FEC\_CODING, MCS, SMOOTHING, NUM\_USERS, LENGTH, AGGREGATION, RESPONSE\_INDICATION, NDP\_FRAME and DOPPLER from the TXVECTOR. Add the reserved bits, append the calculated 4 bit CRC, then append the N*tail* tail bits as shown in . This results in 48 uncoded bits.
* BCC encoder: Encode the data by a convolutional encoder at the rate of R=1/2 as described in 18.3.5.6 (Convolutional encoder).
* BCC interleaver: Interleave as described in 18.3.5.7 (Data interleaving).
* Constellation mapper: QBPSK modulate the first 48 interleaved bits as described in 18.3.5.8 (Subcarrier modulation mapping) to form the first symbol of SIG. QBPSK modulate the second 48 interleaved bits to form the second symbol of SIG.
* Pilot insertion: Insert pilots as described in 18.3.5.10 (OFDM modulation).
* *PHTLTF* matrix mapping: Apply the mapping of the 1st column of the *PHTLTF* matrix to the data subcarriers as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* Duplication and phase rotation: Duplicate two symbols of SIG over each 2 MHz of the CH\_BANDWIDTH. Apply the appropriate phase rotation for each 2 MHz subchannel as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* **Construction of LTF2-LTFNLTF**

The LTF2-LTFNLTF field is defined in and constructed as follows:

* Sequence generation: Generate the LTF2-LTFNLTF sequence in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 2 MHz subchannel as described in , and .
* ALTF matrix mapping: Apply the mapping of the *PHTLTF* matrix (from the 2nd column to the last column) to the LTF2-LTFNLTF sequence (the pilot tones are processed differently) as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* **Construction of the Preamble part in an S1G\_1M PPDU**
* Construction of 1MHz STF

The 1MHz STF field is defined in and constructed as follows:

* Determine the CH\_BANDWIDTH from the TXVECTOR if 1MHz Duplicate PPDU.
* Sequence generation: Generate the 1MHz STF in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in . Apply the 3dB power boosting if the MCS from the TXVECTOR equals MCS10 as described in .
* Phase rotation: Apply appropriate phase rotation for each 1 MHz subchannel if 1MHz Duplicate PPDU as described in and .
* PHTLTF matrix mapping: Apply the mapping of the first column of the *PHTLTF* matrix to the 1MHz STF sequence as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in ~~24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)~~ 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of 1MHz LTF1

The 1MHz LTF1 field is defined in and constructed as follows:

* Sequence generation: Generate the 1MHz LTF1 sequence in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 1 MHz subchannel if 1MHz Duplicate PPDU as described in and .
* ALTF matrix mapping: Apply the mapping of the first column of the *PHTLTF* matrix to the 1MHz LTF1 sequence (the pilot tones are processed differently) as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in ~~24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)~~ 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (2 x LONG\_GI) for the first two symbols and insert a GI (LONG\_GI) per each subsequent symbol. Apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of 1MHz SIG

The SIG field is constructed per-user as follows:

* Obtain the STBC, NUM\_STS, GI\_TYPE, FEC\_CODING, MCS, SMOOTHING, LENGTH, AGGREGATION, RESPONSE\_INDICATION, NDP\_FRAME and DOPPLER from the TXVECTOR. Add the reserved bits, append the calculated 4 bit CRC, then append the N*tail* tail bits as shown in . This results in 36 uncoded bits.
* BCC encoder: Encode the data by a convolutional encoder at the rate of R=1/2 as described in 18.3.5.6 (Convolutional encoder) and apply the block-wise 2 times repetition on a per-OFDM symbol basis.
* BCC interleaver: Interleave as described in 18.3.5.7 (Data interleaving).
* Constellation mapper: BPSK modulate the interleaved bits as described in 18.3.5.8 (Subcarrier modulation mapping) to form the 6 symbols of SIG.
* Pilot insertion: Insert pilots as described in 18.3.5.10 (OFDM modulation).
* *PHTLTF* matrix mapping: Apply the mapping of the 1st column of the *PHTLTF* matrix to the data subcarriers as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in ~~24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)~~ 24.3.9.11.1 (Transmission in S1G format).
* Duplication and phase rotation: Duplicate 6 symbols of SIG over each 1 MHz of the CH\_BANDWIDTH if 1MHz Duplicate PPDU. Apply the appropriate phase rotation for each 1 MHz subchannel as described in if 1MHz Duplicate PPDU as described in and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of 1MHz LTF2-LTFNLTF

The 1MHz LTF2-LTFNLTF field is defined in and constructed as follows:

* Sequence generation: Generate the 1MHz LTF2-LTFNLTF sequence in the frequency-domain over the bandwidth indicated by CH\_BANDWIDTH as described in .
* Phase rotation: Apply appropriate phase rotation for each 1 MHz subchannel as described in and if 1MHz Duplicate PPDU.
* ALTF matrix mapping: Apply the mapping of the *PHTLTF* matrix (from the 2nd column to the last column) to the 1MHz LTF2-LTFNLTF sequence (the pilot tones are processed differently) as described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in .
* Spatial mapping: Apply the *Q* matrix as described in ~~24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)~~ 24.3.9.11.1 (Transmission in S1G format).
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions).
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of the Data field in an S1G SU PPDU for All Cases Except 1MHz MCS10
* Using BCC

The construction of the Data field in an S1G SU PPDU with BCC encoding proceeds as follows:

* SERVICE field: Generate the SERVICE field as described in and append the PSDU to the SERVICE field.
* PHY padding: Append the PHY pad bits to the PSDU as described in .
* Scrambler: Scramble the PHY padded data as described in 24.3.9.3 (Scrambler).
* BCC encoder: Divide the scrambled bits between the encoders by sending bits to different encoders in a round robin manner. The number of encoders is determined by rate-dependent parameters described in . BCC encode as described in and 24.3.9.4.3 (Binary convolutional coding and puncturing).
* Stream parser: Rearrange the output of the BCC encoders into blocks as described in .
* Segment parser (if needed): For a contiguous 16 MHz transmission, divide the output bits of each stream parser into two frequency subblocks as described in . This block is bypassed for 1 MHz, 2 MHz, 4 MHz and 8 MHz S1G PPDU transmissions.
* BCC interleaver: Interleave as described in 24.3.9.8 (BCC interleaver).
* Constellation mapper: Map to BPSK, QPSK, 16-QAM, 64-QAM or 256-QAM constellation points as described in .
* Segment deparser (if needed): For a contiguous 16 MHz transmission, merge the two frequency subblocks into one frequency segment as described in 24.3.9.9.3 (Segment deparser). This block is bypassed for 1 MHz, 2 MHz, 4 MHz, 8 MHz S1G PPDU transmissions.
* STBC: Apply STBC as described in .
* Pilot insertion: Insert pilots following the steps described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in if 2MHz short preamble is used, if 2MHz long preamble is used and if 1MHz preamble is used.
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* Phase rotation: Apply the appropriate phase rotations for each 2 MHz subchannel if 2 MHz preamble is used or for each 1 MHz subchannel if 1 MHz Duplicate PPDU as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (SHORT\_GI or LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions). Note that SHORT\_GI can be applied from the 2nd symbol of data field.
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Using LDPC

The construction of the Data field in an S1G SU PPDU with LDPC encoding proceeds as follows:

* SERVICE field: Generate the SERVICE field as described in and append the PSDU to the SERVICE field.
* PHY padding: Append the PHY pad bits to the PSDU as described in .
* Scrambler: Scramble the PHY padded data as described in 24.3.9.3 (Scrambler).
* LDPC encoder: The scrambled bits are encoded using the LDPC code with the LENGTH from the TXVECTOR as described in .
* Stream parser: The output of the LDPC encoder is rearranged into blocks as described in .
* Segment parser (if needed): For a contiguous 16 MHz transmission, divide the output bits of each stream parser into two frequency subblocks as described in . This block is bypassed for 1 MHz, 2 MHz, 4 MHz and 8 MHz S1G PPDU transmissions.
* Constellation mapper: Map to BPSK, QPSK, 16-QAM, 64-QAM or 256-QAM constellation points as described in..
* LDPC tone mapper: The LDPC tone mapping shall be performed on all LDPC encoded streams as described in . LDPC tone mapper is bypassed for 1MHz transmission.
* Segment deparser (if needed): For a contiguous 16 MHz transmission, merge the two frequency subblocks into one frequency segment as described in 24.3.9.9.3 (Segment deparser). This block is bypassed for 1 MHz, 2 MHz, 4 MHz and 8 MHz S1G PPDU transmissions.
* STBC: Apply STBC as described in .
* Pilot insertion: Insert pilots following the steps described in .
* CSD: Apply CSD for each space-time stream and frequency segment as described in if 2MHz short preamble is used, if 2 MHz long preamble is used and if 1 MHz preamble is used.
* Spatial mapping: Apply the *Q* matrix as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming) and 24.3.9.11.1 (Transmission in S1G format).
* Phase rotation: Apply the appropriate phase rotations for each 2 MHz subchannel if 2 MHz preamble is used or for each 1 MHz subchannel if 1 MHz Duplicate PPDU as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (SHORT\_GI or LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions). Note that SHORT\_GI can be applied from the 2nd symbol of data field.
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of the Data field in an S1G SU PPDU (1MHz MCS10 mode)
* Using BCC

The construction of the Data field in an S1G SU PPDU (1MHz MCS10 mode) with BCC encoding proceeds as follows:

* SERVICE field: Generate the SERVICE field as described in and append the PSDU to the SERVICE field.
* PHY padding: Append the PHY pad bits to the PSDU as described in .
* Scrambler: Scramble the PHY padded data as described in 24.3.9.3 (Scrambler).
* BCC encoder: BCC encode as described in and 24.3.9.4.3 (Binary convolutional coding and puncturing).
* Block repetition: Apply the block-wise 2 times repetition on a per-OFDM symbol basis as described in .
* BCC interleaver: Interleave as described in 24.3.9.8 (BCC interleaver).
* Constellation mapper: Map to BPSK constellation points as described in .
* Pilot insertion: Insert pilots following the steps described in .
* Spatial mapping: Apply the *Q* matrix as described in ~~24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)~~ 24.3.9.11.1 (Transmission in S1G format).
* Phase rotation: Apply the appropriate phase rotations for each 1 MHz subchannel if 1 MHz Duplicate PPDU as described in and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (SHORT\_GI or LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions). Note that SHORT\_GI can be applied from the 2nd symbol of data field.
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Using LDPC

The construction of the Data field in an S1G SU PPDU (1MHz MCS10 mode) with LDPC encoding proceeds as follows:

* SERVICE field: Generate the SERVICE field as described in and append the PSDU to the SERVICE field.
* PHY padding: Append the PHY pad bits to the PSDU as described in .
* Scrambler: Scramble the PHY padded data as described in 24.3.9.3 (Scrambler).
* LDPC encoder: The scrambled bits are encoded using the LDPC code with the LENGTH from the TXVECTOR as described in .
* Block repetition: Apply the block-wise 2 times repetition on a per-OFDM symbol basis as described in .
* Constellation mapper: Map to BPSK constellation points as described in .
* Pilot insertion: Insert pilots following the steps described in .
* Spatial mapping: Apply the *Q* matrix as described in ~~24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming)~~ 24.3.9.11.1 (Transmission in S1G format).
* Phase rotation: Apply the appropriate phase rotations for each 1 MHz subchannel if 1 MHz Duplicate PPDU as described in and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (SHORT\_GI or LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions). Note that SHORT\_GI can be applied from the 2nd symbol of data field.
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.
* Construction of the Data field in an S1G MU PPDU
* General

For an MU transmission, the PPDU encoding process is performed on a per-user basis up to the input of the Spatial Mapping block except that the CSD is applied across users as described in if an ~~2 MHz long~~ S1G\_LONG preamble is used. All user data is combined and mapped to the transmit chains in the Spatial Mapping block. An ~~1MHz~~S1G\_1M PPDU, or an S1G\_SHORT PPDU, or an 2MHz Duplicated PPDU in S1G\_LONG format ~~cannot~~ shall not be used for an MU transmission.

* Using BCC

A Data field with BCC encoding is constructed using the process described in and before the spatial mapping block and repeated for each user that uses BCC encoding.

* Using LDPC

A Data field with LDPC encoding is constructed using the process described in and before the spatial mapping block and repeated for each user that uses LDPC encoding.

* Combining to form an S1G MU PPDU

The per-user data is combined as follows:

* Spatial Mapping: Apply the *Q* matrix is applied as described in 24.3.10 (SU-MIMO and DL-MU-MIMO Beamforming). The combining of all user data is done in this block.
* Phase rotation: Apply the appropriate phase rotations for each 2 MHz subchannel ~~if 2 MHz preamble is used~~ as described in , and .
* IDFT: Compute the inverse discrete Fourier transform.
* Insert GI and apply windowing: Prepend a GI (SHORT\_GI or LONG\_GI) and apply windowing as described in 18.3.2.5 (Mathematical conventions in the signal descriptions). Note that SHORT\_GI can be applied from the 2nd symbol of data field.
* Analog and RF: Up-convert the resulting complex baseband waveform associated with each transmit chain to an RF signal according to the center frequency of the desired channel and transmit. Refer to and for details.