### IEEE P802.11Wireless LANs

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| PHY Comment resolution for Clause 31.2.8 |
| Date: 2019-04-12 |
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Abstract

This submission proposes resolutions for comments of TGba Draft D2.0 with the following CIDs: 2019, 2069, 2070, 2104, 2618, 2619, 2754, and 2825

Note: All the cross-reference is with respect to TGba Draft 2.1

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| **CID** | **P.L** | **Clause** | **Comment** | **Proposed Change** | **Resolution** |
| 2019 | 99.4445 | 31.2.8 | The text states for WUR PPDU with LDR the Xsym is "different" for WUR-Sync and the WUR-Data field. The following 2 sentences state the WUR PPDU with LDR use the same symbol for the entire WUR-Sync field and WUR-Data field. | Fix the ambiguity and update text and/or equation. | Revised. Agree in principle. Sec. 31.2.8 has been updated to incorporate the comment. The subcarrier coefficients for different fields are tabulated in Table 31-4a (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields)TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2019 |
| 2069 | 98.21 | 31.2.8 | "The integer m is described in" - m takes on the values +1,-1, defining it as integer is confusing | replace with "m takes the values,+1,-1 as described in" | Revised. Agree in principle. Sec. 31.2.8 has been updated to incorporate the comment. Reference to m being integer is removed.TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2069 |
| 2070 | 99.22 | 31.2.8 | Missing a formula construction $r\_data(t)$ from $r\_sym(t)$, especially missign the modulating symbol. | Add a line "r\_data (t)=Γêæ\_(n=0)^NΓûÆπÇûd(n) r\_sym (t-nT\_sym)πÇù" where d is the n'th data symbol" or something similary (may be different for the two rates | Revised.Agree in principle. Sec. 31.2.8 has been updated to incorporate the comment. Equation (31-3) provides general representation that hold for WUR-Sync and WUR-Data fields, and the field specific parameters are tabulated in Table 31-4a (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields)TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2070 |
| 2104 | 98.62 | 31.2.8 | It is not clear what a multicarrier signal (i.e., MC-OOK) On symbol is. There is no clear definition. In my proposed change, I give one suggestion on how to fix it (the easiest one). But there are many alternatives. | Change the current paragraph, which reads"For the WUR-Sync ON symbols and WUR-Data MC-OOK ON symbols (SymLDROn and SymHDROn),the baseband signal can be obtained by taking the Inverse Discrete Fourier Transform (IDFT) as describedbelow."change it to"For the WUR-Sync ON symbols and WUR-Data MC-OOK ON symbols (SymLDROn and SymHDROn),the baseband multicarrier signal is described by Equation 31-3." | Revised.Agree in principle. Sec. 31.2.8 has been updated to incorporate the comment and the proposed change.TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2104 |
| 2618 | 98.57 | 31.2.8 | "For the legacy preamble fields (L-STF, L-LTF and L-SIG), the baseband signal is constructed as described in 21.3.7.4 (Transmitted signal). For the BPSK-Mark field, the baseband signal is constructed as described in 31.2.9.2 Non-WUR portion of WUR PHY preamble." The construction of all 20MHz preamble fields have new sections. Need to update accordingly. | Change to "For the legacy preamble fields (L-STF, L-LTF and L-SIG), and BPSK-Mark field, the baseband signal is constructed as described in 31.2.9.2 Non-WUR portion of WUR PHY preamble. | Accept. |
| 2619 | 99.21 | 31.2.8 | "The integer m is described in 31.2.4.4 Symbol Randomizer and Per-antenna Cyclic Shift.", m should have sub index of symbol. | Change "m" to "m\_Sym" in both the equeation and description. | Revised. Agree in principle that m may vary across symbols. However, equation (31-3) is a generic representation for the WUR-Sync and WUR-Data fields. In the description for m, it is explicitly mentioned that it may vary across MC-OOK symbols within the field.TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2619 |
| 2754 | 99.21 | 31.2.8 | "The integer m is described in 31.2.4.4 Symbol Randomizer and Per-antenna Cyclic Shift.", m should have sub index of symbol. | Change "m" to "m\_Sym" in both the equeation and description. | Revised. Agree in principle that m may vary across symbols. However, equation (31-3) is a generic representation for the WUR-Sync and WUR-Data fields. In the description for m, it is explicitly mentioned that it may vary across MC-OOK symbols within the field.TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2754 |
| 2825 | 98.10 | 31.2.8 | The term Data Symbol isn't clearly defined in this draft. Is one data symbol in Figure 31-10 equal to one MC-OOK symbol or equal to 2 or 4 MC-OOK symbols? There are only 3 instances of data symbol in this draft. Maybe we should avoid using the term data symbol to avoid the confusion with the traditional definition of a data symbol (which is an OFDM symbol). | Change all "Data Symbol" in Figure 31-10 to "MC-OOK Symbol". Change "the data symbol" in P66L2 to "the first MC-OOK symbol". And change the first sentence on P113L50 to read "The PHY entity shall begin receiving the MC-OOK symbols in the WUR-Data field." | Revised. Data symbol is replaced with MC-OOK symbol.TGba Editor makes changes as shown in 802.11-19/0649r0 with CID #2825 |

***TGba editor: Change the following paragraphs in 31.2.8 Mathematical description of signals: (Track change on) (#2019, 2069, 2070, 2104, 2618, 2619, 2754, 2825)***

* **Mathematical description of signals**

The transmitted signal is described in complex baseband signal notation. The actual transmitted signal on transmit chain , , is related to the complex baseband signal by the relation shown in Equation (31-1).

*



where

represents the real part of a complex variable

 is the center frequency

 is the baseband WUR signal on transmit chain

The transmitted RF signal is obtained by up-converting the complex baseband signal, which consists of
several fields. The timing boundaries for the various fields are shown in Figure 31-11 (Timing boundaries for the WUR PPDU Fields) where *NWUR-Sync* is the number of MC-OOK symbols in the WUR-Sync field and is defined in Table 31-4 (Frequently used parameters).

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| * **Timing boundaries for the WUR PPDU Fields**
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(#566)

The time offset, *tField*, determines the starting time of the corresponding field relative to the start of L-STF
(*t* = 0).

The baseband signal is constructed by the concatenation of several fields as shown in Figure 31-11 (Timing boundaries for the WUR PPDU Fields). It shall be as shown in Equation (31-2):(#664, #217)

*



The timing offset values for various fields are given below:

*tL-LTF* = *TL-STF*

*tL-SIG* = *tL-LTF* + *TL-LTF*

*tBSPK-Mark* = *tL-SIG* + *TL-SIG*

*tWUR-Sync* = *tBSPK-Mark* + *TBSPK-Mark*

*tData* = *tWUR-Sync* + *TWUR-Sync*

where *TField* is the duration of the field, *TWUR-Sync* is the duration of WUR-Sync field, *TWUR-Sync*=*TWUR-sync-LDR* if low data rate is used to transmit the WUR-Data field of a WUR PPDU, and *TWUR-Sync*=*TWUR-sync-HDR* if high data rate is used to transmit the WUR-Data field of a WUR PPDU. The duration of different fields of the WUR PPDU are provided in Table 31-3 (Timing-related constants).

For the legacy preamble fields (L-STF, L-LTF and L-SIG), and BPSK-Mark field, the baseband signal is constructed as described in 31.2.9.2 (Non-WUR portion of WUR PHY preamble). (#2618)

WUR-Sync and WUR-Data fields comprises of MC-OOK symbols as described in 31.2.9.3 (WUR-SYNC field) and 31.2.10 (WUR-Data field) respectively. For the MC-OOK On symbols in the WUR-Sync field (WUR-Sync On symbols) and the MC-OOK On symbols in the WUR-Data field (SymLDROn and SymHDROn), the baseband multicarrier signal is described by Equation 31-3. (#2104) This general representation holds for WUR-Sync and WUR-Data fields, and the field specific parameters are provided in Table 31-4a (#2070, 2019)

*

(#2070, 2019)

where

 is the scaling factor to compensate for 50% duty cycle from On-Off Keying.(#1057)

 is the number of transmit chains as defined in Table 31-4 Frequently used parameters.

 is a windowing function, of duration , used to control spectral leakage. Refer to 17.3.2.5 (Mathematical conventions in the signal descriptions) for a discussion of windowing functions.(#1058) (#2070, 2019)

*m* and *n* are described in 31.2.4.4 Symbol Randomizer and Per-antenna Cyclic Shift. (#2069, 2754) These parameter values may vary across MC-OOK symbols within the field. (#2619) (#1210)

 is the subcarrier frequency spacing and is given in Table 31-3 Timing-related constants.

 is the length of cyclic prefix. (#2070, 2019)

 is the cyclic shift applied to the signal from transmit chain , and equals either or , as given in Table 31-4a (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields). and are implementation dependent and an example values are given in Table AB-3 (Recommended CSD values for the WUR-Sync field and HDR WUR-Data field) and AB-4 (Recommended CSD values for the LDR WUR-Data field).. (#2070, 2019) (#318)

 is the pseudo-random cyclic shift with cyclic shift index *n* described in 31.2.4.4 (Symbol Randomizer and Per-antenna Cyclic Shift). Its values are specified in Table 31-5 (Values of pseudo-random cyclic shift with cyclic shift index n for the WUR-Sync field and HDR WUR-Data field) and Table 31-6 (Values of pseudo-random cyclic shift with cyclic shift index n for the LDR WUR-Data field). (#2070, 2019) (#1211)

, }, are the field specific subcarrier coefficients, and equals either or , as given in Table 31-4a (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields). and are implementation dependent sequences and an example values for these sequences are given in Table AB-1 (Example Values for the Sequence used for the Construction of the 2 μs MC-OOK On symbol) and AB-2 (Example Values for the Sequence used for the Construction of the 4 μs MC-OOK On symbol). (#2070, 2019) (#317, #163, #227, #261, #666, #1059, #306)

 is a tone scaling factor. (#2070, 2019)

The field specific parameter values are tabulated in Table 31-4a (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields). (#2070, 2019)

**Table 31-4a –Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields**

|  |  |  |
| --- | --- | --- |
| Parameter | WUR-Sync field | WUR-Data field |
| SymLDROn | SymHDROn |
|  | 6 | 12 | 6 |
|  | 2 µs | 4 µs | 2 µs |
|  | 0.4 µs | 0.8 µs | 0.4 µs |
| , } |  |  |  |
|  |  |  |  |
|  | Table 31-5 (Values of pseudo-random cyclic shift with cyclic shift index n for the WUR-Sync field and HDR WUR-Data field) | Table 31-6 (Values of pseudo-random cyclic shift with cyclic shift index n for the LDR WUR-Data field) | Table 31-5 (Values of pseudo-random cyclic shift with cyclic shift index n for the WUR-Sync field and HDR WUR-Data field) |

(#2070, 2019)

For the (#228, #191, #262, #667, #1060)MC-OOK Off symbols in the WUR-Sync and WUR-Data fields, = 0. (#2070, 2019)

NOTE—The expression in equation (31-3) is provided for a single 20 MHz WUR channel.

***TGba editor: Change the following paragraphs in 31.2.15 WUR receive procedure: (Track change on) (#2825)***

…………………………………….(several lines of text)…………………………………………..

The PHY entity shall begin receiving the MC-OOK symbols in the WUR-Data field. If signal loss occurs during reception, prior to completion of the PPDU reception, the error condition PHY-RXEND.indication (CarrierLost) shall be reported to the MAC.

…………………………………….(several lines of text)…………………………………………..

***TGba editor: Make the following changes in Annex AB: (Track change on)*** (#2070, 2019)

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**Examples of WUR MC-OOK Symbol Design and CSD Design**

Subclauses 31.2.4.1 (WUR PPDU waveform generation for WUR-Sync field and high data rate WUR-Data field), 31.2.4.2 (WUR PPDU waveform generation for low data rate WUR-Data field), and 31.2.4.3 (WUR PPDU WUR-Data field waveform generation for the FDMA transmission) provides a description of how the MC-OOK 2 µs and 4 µs On and Off symbols can be constructed but does not provide the actual frequency domain sequences for those symbols. This annex provides example sequences for the construction of these symbols.

Table AB-1 (Example Values for the Sequence used for the Construction of the 2 µs MC-OOK On symbol) provides example sequences for the construction of the 2 µs MC-OOK On symbol.

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| * **Example Values for the Sequence used for the Construction of the 2 µs MC-OOK On symbol**
 |
| **Index** | **Sequence**  (#160, #1062) |
| Example 1 |  |
| Example 2 |  |
| Example 3 |  |
| NOTE - For Example 2, the scaling factor has been chosen so that the MC-OOK On symbol is normalized to have the same power as the other examples.(#160, #1062) |

Example 1 in Table AB-1 (Example Values for the Sequence used for the Construction of the 2 µs MC-OOK On symbol) has been evaluated under a number of channel conditions and has shown consistent good performance in both multipath fading and additive white Gaussian noise channels. This sequence also has the lowest PAPR among the BPSK MC-OOK On symbols for a single channel transmission.

Example 2 in Table AB-1 (Example Values for the Sequence used for the Construction of the 2 µs MC-OOK On symbol) has been designed to provide good performance in commonly found propagation conditions, including the additive white Gaussian noise channel. This MC-OOK On symbol has nearly constant envelope and power distributed over the full bandwidth. Therefore, it can be transmitted with an output power higher than during the legacy preamble.

Example 3 in Table AB-1 (Example Values for the Sequence used for the Construction of the 2 µs MC-OOK On symbol) has been found to provide good performance through exhaustive search among the OFDM symbols with BPSK modulation. This sequence is optimized for good tradeoff between multipath fading channel performance and PAPR.

Table AB-2 (Example Values for the Sequence used for the Construction of the 4 µs MC-OOK On symbol) provides example sequences for the construction of the 4 µs MC-OOK On symbol.

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| --- |
| * **Example Values for the Sequence used for the Construction of the 4 µs MC-OOK On symbol**
 |
|  **Index** | **Sequence**  (#160, #215,#278, #1064) |
| Example 1 |  |
| Example 2 |  |
| Example 3 |  |
| NOTE - For Example 2, the scaling factor has been chosen so that the MC-OOK On symbol is normalized to have the same power as the other examples.(#160, #1063) |

Example 1 in Table AB-2 (Example Values for the Sequence used for the Construction of the 4 µs MC-OOK On symbol) has been evaluated under a number of channel conditions and has shown consistent good performance in both multipath fading and additive white Gaussian noise channels. This sequence also has the lowest PAPR among the BPSK MC-OOK On symbols for a single channel transmission.

Example 2 in Table AB-2 (Example Values for the Sequence used for the Construction of the 4 µs MC-OOK On symbol) has been designed to provide good performance in commonly found propagation conditions, including the additive white Gaussian noise channel. This MC-OOK On symbol has nearly constant envelope and power distributed over the full bandwidth. Therefore, it can be transmitted with an output power higher than during the legacy preamble.

Example 3 in Table AB-2 (Example Values for the Sequence used for the Construction of the 4 µs MC-OOK On symbol) has been found to provide good performance through exhaustive search among the OFDM symbols with BPSK modulation. This sequence is optimized for good tradeoff between multipath fading channel performance and PAPR.

For the WUR-Sync field and the HDR WUR-Data field, which are both constructed from 2 µs MC-OOK symbols, Table AB-3 (Recommended CSD values for the WUR-Sync field and HDR WUR-Data field) provides recommended CSD values for up to eight transmit antennas, for each of the three recommended MC-OOK symbols from Table AB-1 (Example Values for the Sequence used for the Construction of the 2 µs MC-OOK On symbol).

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| * **Recommended CSD values for the WUR-Sync field and HDR WUR-Data field**(#977)
 |
| **Example Sequence** | **Number of Transmit Antennas** | **CSD Values (ns)** |
| Example 1 | 1 | [0] |
| 2 | [0, -600] |
| 3 | [0, -600, -1100] |
| 4 | [0, -600, -1100, -1350] |
| 5 | [0, -600, -1100, -1350, -350] |
| 6 | [0, -600, -1100, -1350, -350, -850] |
| 7 | [0, -600, -1100, -1350, -350, -850, -600] |
| 8 | [0, -600, -1100, -1350, -350, -850, -600, -1350] |
| Example 2 | 1 | [0] |
| 2 | [0, -100] |
| 3 | [0, -850, -100] |
| 4 | [0, -1100, -600, -100] |
| 5 | [0, -1200, -850, -450, -100] |
| 6 | [0, -1300, -1000, -700, -400, -100] |
| 7 | [0, -1350, -1100, -850, -600, -350, -100] |
| 8 | [0, -1400, -1150, -950, -750, -550, -300, -100] |
| Example 3 | 1 | [0] |
| 2 | [0, -100] |
| 3 | [0, -850, -100] |
| 4 | [0, -1100, -600, -100] |
| 5 | [0, -1200, -850, -450, -100] |
| 6 | [0, -1300, -1000, -700, -400, -100] |
| 7 | [0, -1350, -1100, -850, -600, -350, -100] |
| 8 | [0, -1400, -1150, -950, -750, -550, -300, -100] |

For the LDR WUR-Data field, which is constructed from 4 µs MC-OOK symbols, Table AB-4 (Recommended CSD values for the LDR WUR-Data field) provides recommended CSD values for up to eight transmit antennas, for each of the three recommended MC-OOK symbols from Table AB-2 (Example Values for the Sequence used for the Construction of the 4 µs MC-OOK On symbol).

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| * **Recommended CSD values for the LDR WUR-Data field**(#977)
 |
| **Example Sequence** | **Number of Transmit Antennas** | **CSD Values (ns)** |
| Example 1 | 1 | [0] |
| 2 | [0, -1200] |
| 3 | [0, -1200, -2200] |
| 4 | [0, -1200, -2200, -2700] |
| 5 | [0, -1200, -2200, -2700, -700] |
| 6 | [0, -1200, -2200, -2700, -700, -1700] |
| 7 | [0, -1200, -2200, -2700, -700, -1700, -1200] |
| 8 | [0, -1200, -2200, -2700, -700, -1700, -1200, -2700] |
| Example 2 | 1 | [0] |
| 2 | [0, -200] |
| 3 | [0, -1700, -200] |
| 4 | [0, -2200, -1200, -200] |
| 5 | [0, -2450, -1700, -950, -200] |
| 6 | [0, -2600, -2000, -1400, -800, -200] |
| 7 | [0, -2700, -2200, -1700, -1200, -700, -200] |
| 8 | [0, -2750, -2350, -1900, -1500, -1050, -650, -200] |
| Example 3 | 1 | [0] |
| 2 | [0, -200] |
| 3 | [0, -1700, -200] |
| 4 | [0, -2200, -1200, -200] |
| 5 | [0, -2450, -1700, -950, -200] |
| 6 | [0, -2600, -2000, -1400, -800, -200] |
| 7 | [0, -2700, -2200, -1700, -1200, -700, -200] |
| 8 | [0, -2750, -2350, -1900, -1500, -1050, -650, -200] |