IEEE P802.11
Wireless LANs

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| CR for Mathematical description of signals Part 1 |
| Date: 2018-11-12 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Miguel Lopez | Ericsson |  |  | miguel.m.lopez@ericsson.com |
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Abstract

This contribution proposes comment resolutions for Section 32.2.7 of the TGba Draft D1.0. The CIDs resolved are: 163, 227, 261, 317, 666, 1059, 191, 228, 262, 667,1060, 192, 663, 664, 217, 162, 1057, 1058, 1210, 1211, 193, 1208, 161, 159, 964,

Revisions:

* Rev 0: Initial version of this document
* Rev 1: Added proposals to solve CIDs 964, 977, 665, 212
* Rev 2: Updated after presentation. Removed CIDs 158, 263, 1061, 194, 665, 212, 977 for further consideration.

Interpretation of a Motion to Adopt

A motion to approve this submission means that the editing instructions and any changed or added material are actioned in the TGba D1.0 Draft. This introduction is not part of the adopted material.

***Editing instructions formatted like this are intended to be copied into the TGba D1.0 Draft (i.e. they are instructions to the 802.11 editor on how to merge the text with the baseline documents).***

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

# Comments on clause 32.2.7

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 317 | 32.2.7 | 79.43 | The definition of the values of X\_{sym}(k), -31<=k<=32, are unclear. What does "suggested values" mean? Annex AB doesn't mention "subcarrier coefficients" but "sequence S\_{-6,6}." Are they the same? | "X\_{sym}(k), -31<=k<=32 are the subcarrier coefficients, and X\_{sym}(k) equals to S-6,6(k) if -6<=k<=6 and 0 otherwise. S-6,6(k) is the implementation dependent sequence, and example sequences are described in Annex AB." | **Revised** (Accepted with minor editorial changes)The TGba Editor makes changes as shown in 802.11-18/1914r1. |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 163 | 32.2.7 | 79.43 | X(k) is defined on subcarriers -31 to 32. Usually the numbers are -32 to 31. Anyway in other clauses the sequence is defined with at most -28 to 28. Anyway the sequences in Anex AB are from -6 to 6 | Define the range or K correctly or define X(k) better in terms of sequences defined in the annex | **Revised**The TGba Editor makes the changes proposed for CID 317 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 227 | 32.2.7 | 79.43 | the subcarrier coefficient described in Annex AB is for -6 Γëñk Γëñ6. | change -31ΓëñkΓëñ32 to -6Γëñ kΓëñ 6 in P79L43 | **Revised**The TGba Editor makes the changes proposed for CID 317 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 261 | 32.2.7 | 79.43 | X\_sym(k) has non-zero coefficients only from -6 to 6 of k. | Change -31ΓëñkΓëñ32 to -6ΓëñkΓëñ6. | **Revised**The TGba Editor makes the changes proposed for CID 317 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 666 | 32.2.7 | 79.43 | The text reads "-31 <= k <= 32". This is inconsistent with both Equation (32-2) and Annex AB | change to "-6 <= k <= 6". | **Revised**The TGba Editor makes the changes proposed for CID 317 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1059 | 32.2.7 | 79.43 | Only the center 13 subcarrier coefficients are defined. The index of the subcarrier coefficients should be -6<=k<=6.Change the running index of k from -6 to 6. | As shown in the comment. | **Revised**The TGba Editor makes the changes proposed for CID 317 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 228 | 32.2.7 | 79.45 | N\_sym^Tone means the used number of sub-carrier. | change the sentence of P79L45 with " N\_Sym\_Tone is a tone scaling factor. And the value of this factor is 12 for LDR and 6 for HDR respectively | **Revised**(Accepted with minor editorial changes)The TGba Editor makes changes as shown in 802.11-18/1914r1. |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 191 | 32.2.7 | 79.04 | In eq 32-2, shouldn't use Nsym\_tone for normalization since the summation only applies to the index from -6 to 6; | as in the comment | **Revised**The TGba Editor makes the changes proposed for CID 228 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 262 | 32.2.7 | 79.45 | N\_Sym^Tone should be the number of used subcarriers. | Corret the definition of N\_Sym^Tone as follows.N\_Sym^Tone = 12 for LDR, 6 for HDR | **Revised**The TGba Editor makes the changes proposed for CID 228 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 667 | 32.2.7 | 79.45 | The sentence reads "N\_Sym^Tone is the FFT size, and it is equal to 64." This usage of N^Tone is inconsistent with the use of N^Tone elsewhere in the 802.11-16 spec, where N^Tone refers to the number of active subcarriers in the OFDM symbol. | Change the sentence to "N\_Sym^Tone is equal to 12." (since 12 is the number of active subcarriers). | **Revised**The TGba Editor makes the changes proposed for CID 228 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1060 | 32.2.7 | 79.45 | The value of the parameter is 12 for 4 us symbols and is 6 for 2 us symbols.Change the parameter value from "64" to "12 for 4 us symbols and it is 6 for 2 us symbols". | As shown in the comment. | **Revised**The TGba Editor makes the changes proposed for CID 228 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 192 | 32.2.7 | 79.26 | T\_GI\_sym should use the TGI\_WUR which is defined in the timing-related constant. | as in the comment | **Reject**T\_GI\_WUR has the value 0.8 us (table 32.3). On the other hand, T\_GI\_sym has the value 0.4 us for HDR.  |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 663 | 32.2.7 | 78.31 | The equation is missing a number. | Add a number to the equation | **Accept** |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 664 | 32.2.7 | 78.26 | The sentence reads "It can be mathematically described as:" This sentence ought to contain normative text. As described in 11-09/1034 the usage of the verb "can" is non-normative and its use should be considered carefully. If this text is not normative, then the presence of the legacy preamble (L-STF, L-LTF, L-SIG) and the BPSK Mark are optional. This would prevent backwards compatibility with legacy STAs. Section 32.2.7 should be compared to Section 19.3.7 of 802.11-2016, which is also normative, and in which Equation 19-2 is normative. Furthermore, the sentence should refer to the equation number introduced in the previous comment | Change the text to "It shall be as shown in Equation (32-XYZ)" (See also IEEE 802.11-16 page 2535, Equation (21-12) and its description) | **Accept** |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 217 | 32.2.7 | 78.24 | The baseband signal is not properly defined. It says "The baseband signal is constructed by the concatenation of several fields as shown in Figure 32-10 (Timing boundaries for the WUR PPDU Fields). It can be mathematically described as:", but it should be mandatory like this. | The baseband signal shall be constructed by the concatenation of several fields as shown in Figure 32-10 (Timingboundaries for the WUR PPDU Fields) and mathematically described as: | **Revised**The TGba Editor makes the changes proposed for CID 664 |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 162 | 32.2.7 | 79.03 | It is not clear how is the modulated bit/sym related to r\_Sym. None of the symbols in the formula are have any direct or indirect relation to modulated bit/sym | Add the modulated bit to the formula, or add that formula to each subclause that describes data transmission or explain the connection between (probably X) to the modulated data | **Reject.** The text in page 78.62-78.65 explains that r\_sym can be either of SymLDROn or SymHDROn, depending on the data rate. Moreover, Tables 32-10, 32-11 explain the relation between the modulated bit and SymLDROn/SymHDROn |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1057 | 32.2.7 | 79.10 | In Eq. (32-2), it is not clear why sqrt(2) term is present in the numerator.Add the following note below Eq. (32-2):"sqrt(2) is the scaling factor, to compensate for 50% duty cycle from On-Off Keying." | As shown in the comment. | **Accept** |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1058 | 32.2.7 | 79.18 | Description of windowing function for 2 us symbol is missing | As shown in the comment. | **Revised**In fact Section 17.3.2.5 gives a general window function, valid not only for a duration parameter T = 4 us but more generally for any duration parameter T.The TGba Editor makes changes as shown in 802.11-18/1914r1. |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1210 | 32.2.7 | 79.20 | m described in 32.2.3 which is a whole chapter. Need to be specfic by using term with "phase rotation" somewhere-specific in 32.2.3. | as in comment | **Accept** |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1211 | 32.2.7 | 79.37 | pseudo-random cyclic shift with cyclic shift index n described in 32.2.3 which is a whole chapter. Need to be specfic somewhere-specific in 32.2.3. | as in comment | **Accept** |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 193 | 32.2.7 | 79.31 | T\_CS,Sym: should remove the sym from subscript since CSD is not symbold dependent | as in the comment | **Reject**CSD is symbol dependent, as exemplified in Annex AB. |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 1208 | 32.2.7 | 77.61 | claify what is the WUR signal. Here, it is used to indicate WUR PPDU including legacy preamble. Somewhere in the spec, it is used to indicate only WUR corresponding part (sync and data fields) | as in comment | **Reject**The WUR PPDU in P77L61 is already described in detail in P78L31.  |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 161 | 32.2.7 | 79.03 | It is not clear how r\_data is composed from r\_Sym | Add a formula to explain that issue | **Reject**The comment fails to identify changes in sufficient detail so that the specific wording of the changes that will satisfy the commenter can be determined. |

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| 159 | 32.2.7 | 80.00 | It is not clear if the values in Table 32-6 and Table 32-7 are optional (i.e., they are examples) or mandatorily required. | Add a statement to clarify | **Reject**Note: there is probably a typo in the comment, it seems to refer to Table 32-5 and Table 32-6 (instead of Table 32-7), since these are the tables in P80. The text in P79L36 reads:“is the pseudo-random cyclic shift with cyclic shift index *n* described in 32.2.3 (Transmitter block diagram). Its values are specified in Table 32-5 (Values of pseudo-random cyclic shift with cyclic shift index n for the Sync field and HDR Data field) and Table 32-6 (Values of pseudo-random cyclic shift with cyclic shift index n for the LDR Data field)”This text states that the tables specify the values of T^n\_CSR,Sym |

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| **CID** | **Clause** | **Page/line** | **Comment** | **Proposed change** | **Resolution** |
| 964 | 32.2.7 | 79.28 | "WUR Sync On" should not have spaces | Change "WUR Sync On" to "WURSyncOn" | **Reject**WURSyncOn is not defined in the text.  |

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**Discussion:** *None.*

**Propose:** Accepted for CID 663, 664, 1058, 1210, 1211, revised for CID 163, 227, 261, 317, 666, 1059, 191, 228, 262, 667,1060, 192, 217, 162, 1057, 193, 1208, 161, 159, 964, per discussion and editing instructions in 11-18/1914r2.

***TGba editor: Change 32.2.7 Mathematical description of signals as follows: (Track change on)***

* 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 (32-1).

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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 derived by up-converting the complex baseband signal, which consists of
several fields. The timing boundaries for the various fields are shown in Figure 32-10 (Timing boundaries for the WUR PPDU Fields) where *NWUR-SYNC* is the number of WUR-Sync symbols and is defined in Table 32-4 (Frequently used parameters).

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| * Timing boundaries for the WUR PPDU Fields
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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 32-10 (Timing boundaries for the WUR PPDU Fields). It shall be as shown in Equation (32-XYZ)(#664)(#217):

(32-XYZ)(#663)

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 32-3 (Timing-related constants).

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 32.2.8.2 (Non-WUR portion of WUR PHY preamble).

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 described below.

*

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 32-4 (Frequently used parameters).

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

The integer *m* is described in32.2.3.4 (Symbol Randomizer). (#1210)

 is the subcarrier frequency spacing and is given in Table 32-3 (Timing-related constants).

 is the length of cyclic prefix. For 4 µs symbol (SymLDROn),  is equal to 0.8 µs, and for 2

µs symbol (SymHDROn and WUR Sync ON),  is equal to 0.4 µs.

 is the cyclic shift applied to the signal from transmit chain , and a suggested value is

specified in Annex AB.

is the pseudo-random cyclic shift with cyclic shift index *n* described in 32.2.3.4 (Symbol Randomizer)(#1211). Its values are specified in Table 32-5 (Values of pseudo-random cyclic shift with cyclic shift index n for the Sync field and HDR Data field) and Table 32-6 (Values of pseudo-random cyclic shift with cyclic shift index n for the LDR Data field).

, are the subcarrier coefficients, and equals if and 0 otherwise. is an implementation dependent sequence. Example sequences are described in Table AB-1 and Table AB-2(#317)(#163)(#227)(#261)(#666)(1059).

 is a tone scaling factor. The value of this factor is 12 for LDR and 6 for HDR, respectively.(#228)(#191)(#262)(#667)(#1060)

NOTE—The expression in equation (32-2) is provided for a single 20 MHz WUR channel.

Table 32-5 (Values of pseudo-random cyclic shift with cyclic shift index n for the Sync field and HDR Data field) provides, for each value of the index *n*, the cyclic shift values, , for the Sync field and the HDR Data field.

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| * Values of pseudo-random cyclic shift with cyclic shift index n for the Sync field and HDR Data field
 |
| *n* | (ns) |
| 0 | 0 |
| 1 | -200 |
| 2 | -400 |
| 3 | -600 |
| 4 | -800 |
| 5 | -1000 |
| 6 | -1200 |
| 7 | -1400 |

Table 32-6 (Values of pseudo-random cyclic shift with cyclic shift index n for the LDR Data field) provides, for each value of the index *n*, the cyclic shift values, , for the LDR Data field.

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| * Values of pseudo-random cyclic shift with cyclic shift index n for the LDR Data field
 |
| *n* | (ns) |
| 0 | 0 |
| 1 | -400 |
| 2 | -800 |
| 3 | -1200 |
| 4 | -1600 |
| 5 | -2000 |
| 6 | -2400 |
| 7 | -2800 |

Table 32-7 (The values of the LFSR, bits b2, b1, b0, value of n, and pseudo-random cyclic shift with cyclic shift index n for the Sync field) provides the values of the LFSR, the three bits (b2, b1, b0), the index value *n*, and the time delay value for for the first seven states of the LFSR.

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| * *The values of the LFSR, bits b2, b1, b0, value of* n*, and* pseudo-random cyclic shift with cyclic shift index n *for the Sync field*
 |
| Time Step | LFSR X7...X1 | b2 b1 b0 | Index *n* | (ns) |
| 1 | 1 1 1 1 1 1 1 | 1 1 1 | 7 | -1400 |
| 2 | 1 1 1 1 1 1 0 | 1 1 0 | 6 | -1200 |
| 3 | 1 1 1 1 1 0 0 | 1 0 0 | 4 | -800 |
| 4 | 1 1 1 1 0 0 0 | 0 0 0 | 0 | 0 |
| 5 | 1 1 1 0 0 0 0 | 0 0 0 | 0 | 0 |
| 6 | 1 1 0 0 0 0 1 | 0 0 1 | 1 | -200 |
| 7 | 1 0 0 0 0 1 1 | 0 1 1 | 3 | -600 |