### **IEEE P802.11Wireless LANs**

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| TGme Comment Resolution on LB270 WUR Comments |
| Date: 2022-01-09 |
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**Abstract**

The document provides comment resolutions for CIDs: 3066, 3067, 3068, 3069, 3070, 3071, 3072, 3073, 3095, 3096, 3278, 3283, and 3458..

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| **CID** | **Commenter** | **Clause** | **Page/Line** | **Comment** | **Proposed Change** | **Resolution** |
| 3066 | Sean Coffey | 30.1 | 4579/7 | "Clause 30 ... specifies the PHY entity for orthogonal frequency division multiplexing (OFDM) and Multicarrier On-Off Keying (MC-OOK) systems." But (as noted a few sentences later), in the IEEE spec, "OFDM" refers to Clause 17. (It seems a bad idea to have use the name of a general technology for a specific clause, but there it is.) What is the purpose of the reference to OFDM (whether clause 17 or in general) for in the first place? It seems it could be deleted safely. | Delete "orthogonal frequency division multiplexing (OFDM) and" and change "systems" to "system". | **Revised**Edits shown in IEEE 802.11-22/2090r1. |
| 3067 | Sean Coffey | 30.1 | 4579/8 | "Clause 30 ... specifies the PHY entity for ... Multi-Carrier On-Off Keying (OOK)". But does Clause 30 do this? Clause 30 defines the PHY entity for wake-up radio (WUR), and the rest of this introductory subclause mentions only "WUR PHY", until we get to 4579.53: "The WUR PHY uses the multi-carrier on-off keying (MC-OOK) modulation for WUR-Sync and WUR-Data fields". But this bare assertion is not supported by the rest of the clause. The same paragraph goes on to say that the "multicarrier" signal "should" be generated using 13 contiguous subcarriers, but (as far as I can see) never specifies that the WUR PPDU is required to use a multicarrier signal. Instead the detailed version of MC-OOK is offered as an example of a WUR format. This setup causes problems throughout the clause, but the immediate issue on 4579.8 is that the clause isn't specifying the PHY entity for MC-OOK: it is specifying (rather loosely!) the PHY entity for WUR. | Change "multi-carrier on-off keying (MC-OOK)" to wake-up radio (WUR)". | **Accept**Edits shown in IEEE 802.11-22/2090r1. |
| 3068 | Sean Coffey | 30.1 | 4579/54 | "The WUR PHY uses the multi-carrier on-off keying (MC-OOK) modulation for WUR-Sync and WUR-Data fields. MC-OOK is on-off keying, modulated with a multicarrier signal". This is descriptive, not normative. Is there any normative statement that says that the WUR PHY shall use a multicarrier signal? The following sentence says that the multicarrier signal "should" be generated by using 13 contiguous carriers. But "should" implies that it is permissible to generate the signal some other way, i.e., that a compliant WUR PHY might not use 13 contiguous carriers, and indeed (it seems) might not use multicarrier keying at all. If so, the first sentence here is misleading. (Note that the proposed change mirrors the last sentence in the paragraph: "The subcarrier coefficients may take values from the BPSK, QPSK, 16-QAM, 64-QAM, or 256-QAM constellation symbols.") | Change "The WUR PHY uses" to "The WUR PHY may use". | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3069 | Sean Coffey | 30.1 | 4579/58 | "The subcarrier coefficients may take values from the BPSK, QPSK, 16-QAM, 64-QAM, or 256-QAM constellation symbols." It would be more natural to say "constellations" instead of "constellation symbols". | Change "constellation symbols" to "constellations". | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3070 | Sean Coffey | 30.3.10.2 | 4603/51 | "The encoded binary data shall be modulated using MC-OOK, i.e., encoded bits 0 and 1 shall be represented by Off and On Symbols, respectively." Taken together with the rest of the clause, this is confusing. What are the full requirements for MC-OOK? In particular, how can it be determined that a given device does \*not\* use MC-OOK? Most of the discussion of MC-OOK is by example of an implementation. The cited sentence has something approaching a definition, if we take the "i.e.," to mean "this is the same thing". But is the intention really that any modulation in which encoded bits 0 and 1 are represented by Off and On symbols, respectively is therefore, by definition, an MC-OOK system? Or are there other requirements (e.g., does it even have to be--as specified by a shall statement, not a description--multi-carrier?)? The cleanest definition seems to be in 30.3.12.4 (concerning required power ratio). But that does not involve the (murky) concept of MC-OOK. Regardless of the intention, it seems the middle words don't contribute anything concrete, and could be deleted. | Change "using MC-OOK, i.e.," to "so that". | **Accept**Edits shown in IEEE 802.11-22/2090r1. |
| 3071 | Sean Coffey | 30.3.8 | 4596/46 | "This general representation holds for WUR-Sync and WUR-Data fields, and the field specific parameters are provided in Table 30-5". Again, this is descriptive, i.e., it describes something as being true, but not normative, i.e., saying that it has to be true. There do not seem to be normative statements anywhere in the clause that say this has to be true. The previous sentence says that the baseband signal "should" be obtained by taking the IDFT of a set of subcarrier coefficients. This implies that it is permissible for a compliant device to obtain the baseband signal some other way. This is very confusing, bordering on misleading. | Change " This general representation holds for WUR-Sync and WUR-Data fields, and the field specific parameters are provided in Table 30-5 (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields(11ba))" to "When the baseband signal is generated in this way, the field specific parameters are as shown in Table 30-5 (Field specific parameters for the MC-OOK symbols in WUR-Sync and WUR-Data fields when the baseband signal is generated by taking the IDFT of 13 contiguous subcarriers)". Also, change the title of Table 30-5 (4597.37) to "Field specific parameters for the MC-OOK symbols in WUR-Sync and WUR-Data fields when the baseband signal is generated by taking the IDFT of 13 contiguous subcarriers". | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3072 | Sean Coffey | 30.3.8 | 4598/1 | The discussion in this section up to here is very unclear on what a WUR signal is. Elements of the signal are called MC-OOK, without any requirement that they are generated by a multi-carrier signal. A mathematical description of a multi-carrier signal is provided, without any requirement that the WUR signal is constructed in this way (there's a "should", but this implies "may do something else"). This is an important issue, because subclause 30.3.13.1 (Receiver minimum input sensitivity) imposes normative requirements on the receiver: it has to be able to receive (any) WUR PPDU with specified reliability at the given levels. For that requirement to have any meaning, there has to be adequate notice of the range of different transmitted signals that the receiver might encounter. This should (at the very least) be spelled out in a note. | Add a second note: "NOTE 2--The transmitter's baseband signal is not required to correspond to the IDFT of subcarrier coefficients derived from the stated constellations, and is not required to match the description in Equation (30-3). The only normative requirements that apply to the WUR-Sync and WUR-Data fields are provided in subclauses 30.3.12.1 (Transmit spectrum mask), 30.3.12.2 (Spectral flatness), 30.3.12.3 (Transmit center frequency and symbol clock frequency tolerance) and 30.3.12.4 (Transmit On and Off Symbols power ratio). For the avoidance of doubt, elements of WUR PPDUs that are labeled "MC-OOK" in this clause are not required to be "multi-carrier". | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3073 | Sean Coffey | 30.3.5.7 | 4592/63 | "The samples in Off-WG have zero energy." This is descriptive. Why is it not stated normatively? That would be fine if the normative statement existed anywhere else, but it seems that it doesn't. The same issue arises in two further places a little later on. | At 459.264, 4593.35, and 4593.40, change "The samples in Off-WG have zero energy" to "The samples in Off-WG shall have zero energy.". | **Accept** |
| 3095 | Joe Levy | 3.2 | 218/43 | The definition of MC-OOK symbol is confusing and is not sufficient: The definition is self-referential and MC-OOK symbols are not normatively defined. The 802.11 specification normatively defines the OOK modulation that may be generated using an MC-OOK implementation. But calling these symbols these symbols "MC-OOK symbols" is confusing and incorrect. | Delete the definition | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3096 | Joe Levy | 28 | 4551 | The term MC-OOK is used inconsistently in specification. MC-OOK is used to describe an implementation that can generate the OOK symbols used by WUR using a multi-carrier transmitter. In addition these WUR OOK symbols are referred to as MC-OOK symbols in several locations.in the specification. using the same term to refer to and implementation technique and the modulation symbols is confusing and incorrect. | Use term MC-OOK when referring to the multi-carrier implementation technique for generating the OOK symbols used in WUR. Do not refer to these OOK symbols or modulations using the term MC-OOK as this confuses the implementation technique with the normatively defined symbols and modulations used in WUR. Make the changes provided in 11-22/1035. | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3278 | Mark Rison | 30.3.4 | 4588/56 | "With the 4 us duration MC-OOK On and Off Symbols, the PPDU should meet the Correlation test definedin 30.3.12.5 (Correlation test on MC-OOK symbols)." -- this should be a "shall" else there may be interop issues | Change "should" to "shall" at the referenced location and at line 4 | **Accept** |
| 3283 | Mark Rison | 30 |  | MC-OOK is just an example way of generating waveforms, but the actual requirements on the OOK used for WUR are not specified | Add a subclause defining the "shall"s for WUR PPDUs, and then give MC-OOK as the "should" way to generate them | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |
| 3458 | Mark Rison | 30 | 4579/1 | MC-OOK is a strange definition. Is MC-OOK symbol different than regular OOK symbols, particularly the definition of MC-OOK OFF symbol sounds rather strange. | Make the changes shown in 22/1035r1 | **Revised**TGme Editor makes changes as shown in IEEE 802.11-22/2090r1 |

**Discussion**

There is concern that the MC-OOK waveform is not required. Here we address that concern by mandating the use of MC-OOK waveform.

**Proposed Resolution**

TGme Editor make the following changes to the Draft,

* Introduction

Clause 30 (Wake-Up Radio (WUR) PHY specification(11ba)) specifies the PHY entity for wake-up radio (WUR) systems. (CID# 3066 and 3067).

The WUR PHY shall use the multicarrier on-off keying (MC-OOK) modulation for (#1128)WUR-Sync and WUR-Data fields. MC-OOK is defined as an on-off keying, modulated with a multicarrier signal. The multicarrier signal shall be generated using contiguous 13 subcarriers, centered within a 20 MHz channel, with a subcarrier spacing of 312.5 kHz and the center subcarrier (#1131)being null. The subcarrier coefficients may take values from the BPSK, QPSK, 16-QAM, 64-QAM, or 256-QAM constellations. (CID# 3069).

* WUR Basic PPDU waveform generation for WUR-Sync field and WUR-Data field with WUR HDR

For a single 20 MHz WUR channel, the 2 µs duration MC-OOK On Symbol shall (CID# 3071, 3072, 3073, 3283) be constructed by the On-WG using center 13 subcarriers of a 64-point IDFT, sampling at 20 MHz as follows:

* The six subcarriers with subcarrier indices *k* = (–6, –4, –2, 2, 4, 6) are used with nonzero input. Other subcarriers are null.
* The coefficients of the nonzero subcarriers are selected from the symbols of any of the following constellations: BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM. Recommended values for the sequence used for the construction of the 2 µs duration MC-OOK On symbol are provided in Annex AC.
* The first 32 values of the 64-point IDFT output are selected.
* Those 32 values are processed by the Symbol Randomizer as described in 30.3.4.4 (Symbol Randomizer and Per-transmit chain Cyclic Shift).
* The last 8 samples of those 32 samples are prepended to the 32 samples generating 40 samples, representing the 2 µs duration MC-OOK On Symbol. This step corresponds to the GI Insertion in Figure 30-6 (An example of an On-WG for the WUR-Sync and WUR-Data fields with WUR HDR(11ba)).

For a single 20 MHz WUR channel, the 2 µs duration MC-OOK Off Symbol shall (CID# 3071, 3072, 3073, 3283) be constructed by the Off-Waveform Generator (Off-WG) as zero for 2 µs.

With the 2 µs duration MC-OOK On and Off Symbols, the PPDU should meet the Correlation test defined in 30.3.12.5 (Correlation test on MC-OOK symbols).

* WUR Basic PPDU waveform generation for WUR-Data field

For a single 20 MHz WUR channel the 4 µs duration MC-OOK On Symbol shall (CID# 3071, 3072, 3073, 3283) be constructed by the On-WG using center 13 subcarriers of a 64-point IDFT, sampling at 20 MHz as follows:

* The 12 subcarriers with subcarrier indices *k* = (–6, –5, -4, -3, -2 –1, 1, 2, 3, 4, 5, 6) are used with nonzero input. Other subcarriers are null.
* The coefficients of the nonzero subcarriers are selected from the symbols of any of the following constellations: BPSK, QPSK, 16-QAM, 64-QAM, and 256-QAM. Recommended values for the sequence used for the construction of the 4 µs duration MC-OOK On symbol are provided in Annex AC.
* The 64 values from the 64-point IDFT are processed by the Symbol Randomizer as described in 30.3.4.4 (Symbol Randomizer and Per-transmit chain Cyclic Shift).
* The last 16 values of the 64-point IDFT output are prepended to the 64 samples generating 80 samples, representing the 4 µs duration MC-OOK On Symbol. This step corresponds to the GI Insertion in Figure 30-7 (An example of an On-WG for the WUR-Data fields with WUR LDR(11ba)).

For a single 20 MHz WUR channel the 4 µs duration MC-OOK Off Symbol shall (CID# 3071, 3072, 3073, 3283) be constructed by the Off-Waveform Generator (Off-WG) as zero for 4 µs.

With the 4 µs duration MC-OOK On and Off Symbols, the PPDU should meet the Correlation test defined in 30.3.12.5 (Correlation test on MC-OOK symbols).

* WUR FDMA PPDU WUR-Data field waveform generation

The MC-OOK On Symbol for the 20 MHz WUR FDMA waveform shall (CID# 3071, 3072, 3073, 3283) be generated according to 30.3.4.1 (WUR Basic PPDU waveform generation for WUR-Sync field and WUR-Data field with WUR HDR) or 30.3.4.2 (WUR Basic PPDU waveform generation for WUR-Data field with WUR LDR) depending on WUR\_DATARATE. The 40 MHz or 80 MHz WUR FDMA PPDU should be generated by multiplexing multiple 20 MHz WUR waveforms in the corresponding channel as shown in Figure 30-8 (An example of a WUR-Data field signal generator for the FDMA transmission(11ba)).

* Mathematical description of signals

The WUR-Sync and WUR-Data fields comprises of MC-OOK symbols as described in 30.3.9.3 (WUR-Sync field) and 30.3.10 (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 signal shall be obtained by taking the Inverse Discrete Fourier Transform (IDFT) of a set of subcarrier coefficients, which is described by Equation (30-3). This general representation holds for WUR-Sync and WUR-Data fields, and the field specific parameters are provided in Table 30-5 (Field specific parameter values for the MC-OOK symbols in WUR-Sync and WUR-Data fields(11ba)).

* WUR-Data field for WUR LDR and WUR HDR

The encoded binary data shall be modulated so that encoded bits 0 and 1 shall be represented by Off and On Symbols, respectively. (CID# 3070).

SymLDROn and SymHDROn shall (CID# 3071, 3072, 3073, 3283) be generated using contiguous 13 subcarriers, centered within a 20 MHz channel, with a subcarrier spacing of 312.5 kHz and the center subcarrier being null. The subcarrier coefficients may take values from the BPSK, QPSK, 16-QAM, 64-QAM, or 256-QAM constellations. (CID# 3069)