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

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| Spec Text on MC-OOK Symbol Randomization |
| Date: 2018-07-DD |
| Author(s): |
| Name | Affiliation | Address | Phone | Email |
| Steve Shellhammer | Qualcomm |  |  | shellhammer@ieee.org |
| Bin Tian | Qualcomm |  |  | btian@qti.qualcomm.com |
| Richard van Nee | Qualcomm |  |  | rvannee@qti.qualcomm.com |
| Miguel Lopez | Ericsson |  |  | miguel.m.lopez@ericsson.com |
| Dennis Sundman | Ericsson |  |  | dennis.sundman@ericsson.com |
| Leif Wilhelmsson | Ericsson |  |  | leif.r.wilhelmsson@ericsson.com |

**Abstract**

This document contains text on “MC-OOK Symbol Randomization” to be adopted into Draft 0.4.

**Discussion**

At the May IEEE meeting [1] it was shown that repeated occurrences of the same MC-OOK On symbol causes spectral lines in the power spectral density, which prevents meeting FCC requirements. The problem can be eliminated by applying a random phase rotation to the MC-OOK On symbols. A simple linear feedback shift register (LFSR) can be used to generate the pseudo random bit sequence which indicates what phase rotation to apply to the MC-OOK On symbol before transmission. At the July meeting [2] it was shown that CSD randomization can be used to flatten the spectrum which leads to an increase in the allowed transmit power in PSD-limited regulatory domains.

This document provides spec text for the MC-OOK Symbol Randomization.

[1] Steve Shellhammer, Bin Tian and Richard van Nee, “WUR Power Spectral Density,” IEEE 802.11/18-824r1, May 2018

[2] Miguel Lopez, Dennis Sundman, Leif Wilhelmsson, Spectral line suppression for MC-OOK, IEEE 802.11-18/1179r1, July 2018

**Motion**

Move to adopt the text in IEEE 802.11-18/0XXXr0 into Draft 0.4.

Moved: Steve Shellhammer

Second:

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***Instructions to 802.11ba Editor***

***Editor Instructions: In Clause 32.2.3 add the text shown in Red.***

… The Sync bit sequence is then used to switch between the On waveform generator (On-WG) and the Off waveform generator (Off-WG). The Symbol Randomizer applies both a pseudo random phase rotation and a pseudo random cyclic shift to the MC-OOK On waveform prior to transmission to remove any spectral lines in the power spectral density.

***Editor Instructions: Replace Figure 32-4 with the following figure.***



***Editor Instructions: Replace Figure 32-5 with the following figure***



***Editor Instructions: In Clause 32.2.3 add the text shown in Red.***

An example of a WUR signal generator for the WUR-Data field is shown in Figure 32-5 (An Example of a WUR signal generator for the WUR-Data field for Antenna $i\_{TX}$). The information bits are mapped by a Manchester-based encoder. Each coded bit is then used to switch between the On waveform generator (On-WG) and the Off waveform generator (Off-WG). The Symbol Randomizer applies both a pseudo random phase rotation and a pseudo random cyclic shift to the MC-OOK On waveform prior to transmission to remove any spectral lines in the power spectral density.

***Editor Instructions: Just before sub-clause 32.2.3.1 add the text shown in Red and the new figure.***

The Symbol Randomizer, shown in Figure 32-XX, uses a linear feedback shift register (LFSR) with a generator polynomial $G\left(z\right)=z^{-7}+z^{-4}+1$ to generate a sequence of psuedo random bits. One of those bits is converted to either +1 or -1 by the BPSK Mapper. The BPSK mapper maps a bit 0 to a value of -1 and a bit 1 to a value of +1. The MC-OOK On Waveform is multiplied by the output of the BPSK Mapper, which is a value of either -1 or +1. Three of the bits (b0, b1, and b2) from the LFSR are converted to an index, *n*, with integer values between zero and seven. That index *n* is used to select a specific cyclic shift value ($T\_{CS}^{n}$). That value of cyclic shift is applied to the waveform.

At the beginning of each PPDU the LFSR is loaded with all zeros. The symbol randomizer is used for both the Sync Field and the Data Field. The LFSR is updated every $T\_{Sync}$ during the Sync Field and updated every $T\_{Sym}$ during the Data Field.

The list of cyclic shift values for the Sync Field and the HDR Data Field are listed in Table 32-XX1 and the list of cyclic values for the LDR Data Field are listed in Table 32-XX2.



Figure: 32-XX: Symbol Randomizer

|  |  |
| --- | --- |
| **Cyclic Shift Index** | **Cyclic Shift Value** |
| 0 | TBD |
| 1 | TBD |
| 2 | TBD |
| 3 | TBD |
| 4 | TBD |
| 5 | TBD |
| 6 | TBD |
| 7 | TBD |

Table: 32-XX1: Cyclic Shift Values for Sync and HDR Data Field, used by Symbol Randomizer

|  |  |
| --- | --- |
| **CSD Index** $n$ | **CSD Value** $T\_{CS}^{n}$ |
| 0 | TBD |
| 1 | TBD |
| 2 | TBD |
| 3 | TBD |
| 4 | TBD |
| 5 | TBD |
| 6 | TBD |
| 7 | TBD |

Table: 32-XX2: Cyclic Shift Values for LDR Data Field, used by Symbol Randomizer