IEEE P802.11
Wireless LANs

|  |
| --- |
| 11bp PDT PHY UL Modulation And Coding |
| Date: July 17, 2025 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Alice Chen | Qualcomm Technologies, Inc | 5775 Morehouse Dr, San Diego, CA 92131, USA |  | alicel@qti.qualcomm.com |
| Amichai Sanderovich | Wiliot |  |  | amichai.sanderovich@wiliot.com |
| Bin Qian | Huawei |  |  | qianbin14@huawei.com |
| Juan Fang | Intel |  |  | juan.fang@intel.com |
| Lei Zhou | H3C |  |  | zhou.leiH@h3c.com |
| Leif Wilhelmsson | Ericsson |  |  | leif.r.wilhelmsson@ericsson.com |
| Nelson Costa | Haila |  |  | nelson@haila.io |
| Panpan Li | Huawei |  |  | lipanpan25@huawei.com |
| Rui Cao | NXP |  |  | rui.cao\_2@nxp.com |
| Shengquan Hu | MediaTek |  |  | shengquan.hu@mediatek.com |
| Yinan Qi | OPPO |  |  | v-qiyinan@oppo.com |
| You-Wei Chen | MediaTek |  |  | you-wei.chen@mediatek.com |
| Yuxiao Hou | TP-Link |  |  | houyuxiao@tp-link.com.hk |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Abstract

This document contains Proposed Draft Text (PDT) for UL modulation and coding of the proposed TGbp (AMP, Ambient Power) amendment to the 802.11 standard.

**Revision information**

The following is a summary of the important changes that occurred within each revision of this document:

|  |  |
| --- | --- |
| **Revision** | **Major changes** |
| 0 | Initial revision including motions up to 7/17/2025 |
| 1 | Added motions #39, #70 and #96. Updated subclause numbers and spec text. Presented in the TGbp call on 8/19/2025 |
| 2 | Revised per offline comments from Nelson Costa |
|  |  |
|  |  |
|  |  |

**Introduction**

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 TGbp Draft. The abstract, revision information, introduction, explanation of the proposed changes and references sections are not part of the adopted material.

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

**Explanation of the proposed changes:**

The proposed changes to the 802.11 TGbp draft within this document are based on the following motions adopted by the TGbp task group:

# Relevant passing motions:

All the passing motions up to July 17, 2025 (see [1]) are as follows.

[Motion #19, [1] and [11]]

* 11bp defines Manchester encoding for the data portion of UL transmission in 2.4 GHz, including both backscattering and active transmission.

[Motion #21, [1], [14] and [15]]

* 11bp will define On-Off Keying (OOK) modulation for AMP-Sync field and the AMP-Data field in an AMP Uplink PPDU for Active Transmission.

[Motion #31, [1], [28] and [29]]

* 11bp defines the following data rates for AMP uplink transmissions at 2.4GHz
	+ 250kbps and 1Mbps for both backscatter and non-backscatter uplink transmission;
	+ 4Mbps for non-backscatter uplink transmission only.
		- Mandatory or optional is TBD

[Motion #38, [1], [40]]

* The AMP-Sync field and the AMP-Data field of AMP UL PPDU for backscatter communication use OOK modulation.

[Motion #39, [1], [40], [41], [42] and [43]]

* The carrier waveform for AMP Downlink PPDU is constructed by repeating one predefined base waveform of TBD micro-second, and additional pseudo-random phase is applied to each base waveform
* The base waveform definition is TBD.
* Note:
	+ The SYNC and Data fields are OOK modulated on the carrier waveform.
	+ The Excitation field is not OOK modulated.

[Motion #40, [1], [40], [41], [42] and [43]]

* For DL PPDU and UL PPDU for backscattering:
	+ For AMP Manchester encoded OOK of rate 250kbps, each data bit is encoded based on the chip duration of 2us.
	+ For AMP Manchester encoded OOK of rate 1Mbps, each data bit is encoded based on the chip duration of 0.5us.

[Motion #70, [1], [41], [42] and [70]]

* The SYNC, Data field and Excitation field of 11bp DL PPDU use OFDM symbol as base carrier waveform for OOK modulated AMP communication.

[Motion #41 and #79, [1], [40], [41], [42] and [43]]

* For DL PPDU and UL PPDU:
	+ For AMP Manchester encoded OOK, data bit 1 is encoded as chip bits “01” and data bit 0 is encoded as chip bits“10”
	+ Note: same definition as WUR HDR definition.

[Motion #43, [1], [44]]

* The PHY parameters (at least data rate) for AMP UL transmission are indicated by the AMP AP.
	+ Other PHY parameters TBD.

[Motion #78, [1], [44] and [76]]

* For UL PPDU for non backscattering case, for AMP Manchester encoded OOK the chip duration of data portion is different for different data rates. The exact chip duration is TBD.
	+ 4Mbps is TBD.

[Motion #96, [1] and [97]]

* For mono-static backscattering communication in sub-1 GHz, the maximum allowed clock inaccuracy for the backscattering tag is 100,000 ppm for both receive mode and backscattering transmit mode.
	+ 11bp shall specify an AMP-S1G Downlink PPDU supporting downlink transmission for backscattering AMP STA in sub-1 GHz. AMP-S1G Downlink PPDU contains at least an Excitation field, an AMP-Sync field and an AMP-Data field.
		- Inclusion of an AMP-SIG field is TBD.
		- Inclusion of an 802.11 preamble is TBD.
		- Additionally, there will be one or more Excitation fields
		- Additionally, there may be more than one AMP-Data field
		- Additionally, AMP-Sync and AMP-SIG field may precede each AMP-Data field
	+ 11bp shall specify an AMP-S1G Uplink PPDU supporting uplink transmission for backscattering AMP STA in sub-1 GHz. AMP-S1G Uplink PPDU contains an AMP-Sync field and AMP-Data field.
	+ The AMP-S1G Downlink PPDU and AMP-S1G Uplink PPDU AMP-Data field will use Manchester encoding for backscattering operation.
	+ The AMP-Sync field and the AMP-Data field of AMP-S1G Downlink PPDU and AMP-S1G Uplink PPDU for backscatter communication use OOK modulation

**Text to be adopted begins here.**

***TGbp editor: Please add the following text to the respective subclauses in 802.11bp draft D0.1:***

## 40.3 AMP PHY (2.4GHz)

### 40.3.5 AMP modulation and coding schemes (AMP-MCSs)

The AMP modulation and coding scheme (MCS) represents the modulation and coding scheme used in the AMP-Data field of the AMP PPDUs.

There are two MCSs, corresponding to 250 kb/s and 1 Mb/s data rates, in UL backscattering transmissions in 2.4GHz. There are three data rates, 250 kb/s, 1 Mb/s and 4 Mb/s, in UL active transmissions in 2.4GHz. The UL data rate or MCS in UL backscattering transmissions or UL active transmissions in 2.4GHz is indicated by the AMP AP in the preceding AMP Trigger frame. The rate-dependent parameters for UL backscattering transmissions and UL active transmissions in 2.4GHz are given in Table 40-B (MCS for UL AMP PPDU in Backscattering Transmission in 2.4GHz) and Table 40-C (MCS for UL AMP PPDU in Active Transmission in 2.4GHz), respectively.

### 40.3.9 Data field

#### 40.3.9.1 Modulation

On-off keying (OOK) modulation is used for the AMP-Data field in DL transmissions, UL backscattering transmissions and UL active transmissions in 2.4GHz. The AMP OOK modulation in DL transmissions and UL backscattering transmissions in 2.4GHz shall be generated by using the multicarrier on-off keying (MC-OOK) modulation technique with a signal constructed from multiple subcarriers. The AMP OOK modulation in UL active transmissions in 2.4GHz is generated by TBD.

In UL backscattering transmissions in 2.4GHz, the duration of the AMP OOK symbol corresponding to each encoded bit is dependent on the AMP data rate: 2 μs for 250 kb/s and 0.5 μs for 1 Mb/s. For 250 kb/s, 2 μs duration AMP OOK Off and On symbols are denoted as SymAmpMcOokMcs0Off and SymAmpMcOokMcs0On, respectively. For 1 Mb/s, 0.5 μs duration AMP OOK Off and On symbols are denoted as SymAmpMcOokMcs1Off and SymAmpMcOokMcs1On, respectively.

In DL AMP transmissions or UL backscattering transmissions in 2.4GHz, SymAmpMcOokMcs0On and SymAmpMcOokMcs1On are described in 40.3.7 (Mathematical description of signals). The generation of SymAmpMcOokMcs0On and SymAmpMcOokMcs1On is described in 40.3.3.1 (AMP DL carrier wave generation).

In UL active transmissions in 2.4GHz, the duration of the AMP OOK symbol corresponding to each encoded bit is dependent on the AMP data rate: TBD μs for 250 kb/s, TBD μs for 1 Mb/s, and TBD μs for 4 Mb/s. For 250 kb/s, TBD μs duration AMP OOK Off and On symbols are denoted as SymAtMcs0Off and SymAtMcs0On, respectively. For 1 Mb/s, TBD μs duration AMP OOK Off and On symbols are denoted as SymAtMcs1Off and SymAtMcs1On, respectively. For 4 Mb/s, TBD μs duration AMP OOK Off and On symbols are denoted as SymAtMcs2Off and SymAtMcs2On, respectively.

In UL active transmissions in 2.4GHz, SymAtMcs0On, SymAtMcs1On and SymAtMcs2On are described in 40.3.7 (Mathematical description of signals). The generation of SymAtMcs0On, SymAtMcs1On and SymAtMcs2On is described in 40.3.3.1a (AMP UL active transmission carrier wave generation).

#### 40.3.9.2 Coding

##### 40.3.9.2.1 General

In UL backscattering transmissions in 2.4GHz, the AMP OOK symbols are Manchester encoded for both data rates of 250 kb/s and 1 Mb/s. In UL active transmissions in 2.4GHz, the AMP OOK symbols are Manchester encoded for both data rates of 250 kb/s and 1 Mb/s, and are TBD for 4 Mb/s.

##### 40.3.9.2.2 Manchester coding

Manchester encoded bits corresponding to each input bit are shown in Table 40-A (AMP Manchester encoded bits). The encoded binary data shall be modulated so that encoded bits 0 and 1 shall be represented by Off and On symbols, respectively.

###### Table 40-A AMP Manchester encoded bits

|  |  |
| --- | --- |
| **Input bit** | **Encoded bits** |
| 0 | 10 |
| 1 | 01 |

## 40.4 AMP PHY (Sub-1 GHz)

### 40.4.5 AMP modulation and coding schemes (AMP-MCSs)

There are TBD MCSs, corresponding to TBD data rates, in UL mono-static backscattering transmissions in Sub-1 GHz. The rate-dependent parameters for UL mono-static backscattering transmissions in Sub-1 GHz are given in Table 40-D (MCS for UL AMP PPDU in Mono-Static Backscattering Transmission in Sub-1 GHz).

### 40.4.9 Data field

#### 40.4.9.1 Modulation

OOK modulation is used for the AMP-Data field in DL transmissions for mono-static backscatter communication and UL mono-static backscattering transmissions in Sub-1 GHz. The AMP OOK modulation in DL transmissions for mono-static backscatter communication and UL mono-static backscattering transmissions in Sub-1 GHz shall be generated by TBD.

#### 40.4.9.2 Coding

##### 40.4.9.2.1 General

In UL mono-static backscattering transmissions in Sub-1 GHz, the AMP OOK symbols are Manchester encoded for TBD data rates.

##### 40.4.9.2.2 Manchester coding

Manchester coding used in Sub-1 GHz is the same as that in 2.4GHz as described in 40.3.9.2.2 (Manchester coding).

## 40.6 Parameters for AMP-MCSs

The rate-dependent parameters for UL backscattering transmissions in 2.4GHz are given in Table 40-B (MCS for UL AMP PPDU in Backscattering Transmission in 2.4GHz). Manchester encoding and OOK modulation shall be used for all MCS in the AMP-Data field of an UL AMP PPDU in backscattering transmission in 2.4GHz.

###### Table 40-B MCS for UL AMP PPDU in Backscattering Transmission in 2.4GHz

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **AMP-UL-BS-MCS index** | **Modulation** | **Symbol Structure** | **Equivalent information bit duration** | **NSPDB** | **Data rate (kb/s)** |
| 0 | AMP MC-OOK | Information 0 | [SymAmpMcOokMcs0On, SymAmpMcOokMcs0Off] | 4 μs | 2 | 250 |
| Information 1 | [SymAmpMcOokMcs0Off, SymAmpMcOokMcs0On] |
| 1 | AMP MC-OOK | Information 0 | [SymAmpMcOokMcs1On, SymAmpMcOokMcs1Off] | 1μs | 2 | 1000 |
| Information 1 | [SymAmpMcOokMcs1Off, SymAmpMcOokMcs1On] |

The rate-dependent parameters for UL active transmissions in 2.4GHz are given in Table 40-C (MCS for UL AMP PPDU in Active Transmission in 2.4GHz). Manchester encoding and OOK modulation shall be used for 250 kb/s and 1 Mb/s in the AMP-Data field of an UL AMP PPDU in active transmission in 2.4GHz. Whether or not to use Manchester encoding for 4 Mb/s in the AMP-Data field of an UL AMP PPDU in active transmission in 2.4GHz is TBD. In UL active transmissions in 2.4GHz, the duration of the AMP OOK symbol corresponding to each encoded bit is different for different data rates. The duration of the AMP OOK symbol corresponding to each encoded bit for each data rate is TBD.

###### Table 40-C MCS for UL AMP PPDU in Active Transmission in 2.4GHz

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **AMP-UL-AT-MCS index** | **Modulation** | **TBD** | **TBD** | **TBD** | **TBD** | **Data rate (kb/s)** |
| 0 | AMP OOK | TBD | TBD | TBD | TBD | 250 |
| TBD | TBD | TBD | TBD |
| 1 | AMP OOK | TBD | TBD | TBD | TBD | 1000 |
| TBD | TBD | TBD | TBD |
| 2 | AMP OOK | TBD | TBD | TBD | TBD | 4000 |
| TBD | TBD | TBD | TBD |

The rate-dependent parameters for UL mono-static backscattering transmissions in Sub-1 GHz are given in Table 40-D (MCS for UL AMP PPDU in Mono-Static Backscattering Transmission in Sub-1 GHz). Manchester encoding and OOK modulation shall be used for TBD MCS in the AMP-Data field of an UL AMP PPDU in mono-static backscattering transmission in Sub-1 GHz.

###### Table 40-D MCS for UL AMP PPDU in Mono-Static Backscattering Transmission in Sub-1 GHz

TBD

**Text to be adopted ends here.**

**References:**

1. [11-24-1613r12](https://mentor.ieee.org/802.11/dcn/24/11-24-1613-12-00bp-specification-framework-for-tgbp.docx): Specification Framework for TGbp, Yinan Qi (OPPO)