IEEE P802.11
Wireless LANs

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| 11bn PDT PHY U-SIG |
| Date: November 23, 2024 |
| Author(s): |
| Name | Affiliation | Address | Phone | email |
| Alice Chen | Qualcomm Technologies, Inc. | 5775 Morehouse Dr, San Diego, CA 92131, USA |  | alicel@qti.qualcomm.com |
| Hari Ram Balakrishnan | NXP |  |  | hariram.balakrishnan@nxp.com |
| Rui Cao | NXP |  |  | rui.cao\_2@nxp.com |
| Lin Yang | Qualcomm Technologies, Inc. |  |  | linyang@qti.qualcomm.com |
| Juan Fang | Intel |  |  | juan.fang@intel.com |
| You-Wei Chen | MediaTek |  |  | you-wei.chen@mediatek.com |
| Mahmoud Kamel | InterDigital |  |  | mahmoud.kamel@interdigital.com |
| Sigurd Schelstraete | MaxLinear |  |  | sschelstraete@maxlinear.com |
| Bo Sun | Sanechips |  |  | sun.bo1@sanechips.com.cn |
| Dongguk Lim | LG Electronics |  |  | dongguk.lim@lge.com |
| Jianhan Liu | MediaTek |  |  | jianhan.liu@mediatek.com |
| Leonardo Lanante | Ofinno |  |  | llanante@ofinno.com |
| Oded Redlich | Huawei |  |  | oded.redlich@huawei.com |
| Mengshi Hu | Huawei |  |  | humengshi@huawei.com |
| Ross Jian Yu | Huawei |  |  | ross.yujian@huawei.com |
| Shengquan Hu | MediaTek |  |  | shengquan.hu@mediatek.com |
| Tianyu Wu | Apple |  |  | tianyu@apple.com |
| Xuwen Zhao | TCL |  |  | zhaoxuwen123@outlook.com |
| Ying Wang | InterDigital |  |  | Ying.Wang@interdigital.com |
| Youhan Kim | Qualcomm Technologies, Inc. |  |  | youhank@qti.qualcomm.com |
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Abstract

This document contains Proposed Draft Text (PDT) for the U-SIG subclause 38.3.14.7 of the proposed TGbn (UHR, Ultra High Reliability) 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 |
| 1 | Updated author list. Added contents based on relevant motions in 11-24/0171r21. Note that Table B and Equation (38-E) and description are consistent to the same contents in 11-24/1981r3 PDT ELR. Table D is consistent to the same contents in 11-24/1981r3 PDT ELR, with changes in the description of the Bandwidth subfield and PPDU Type And Compression Mode subfield. |
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**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 TGbe 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 TGbe 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 TGbn draft within this document are based on the following motions adopted by the TGbn task group:

**Relevant passing motions:**

All the passing motions up to and including those in the 2024 November IEEE 802 Plenary Session (see [1]).

[Motion #22, [1] and [38]]

* “PHY version identifier” is set to 1 in U-SIG field for UHR PPDUs.

[Motion #92, [1] and [175]]

* The BW of ELR PPDU is 20MHz and one Spatial stream is used for ELR transmission.

[Motion #32, [1] and [84]]

* ELR PPDU starts with L-STF, L-LTF, L-SIG, RL-SIG, and U-SIG in the PPDU for the ELR transmission.

[Motion #75, [1] and [168]]

* In ELR PPDU, STA boosts L-STF and L-LTF by 3 dB
	+ For UL, non-AP STA corrects CFO before transmission
	+ NOTE: Non-AP STA pre-correction CFO requirement for residual CFO is TBD

[Motion #78, [1] and [170]]

* ELR packet detection is done at L-STF, which has same length as legacy with 3dB power boosting
	+ L-LTF also has same length as legacy with same power boosting as L-STF

[Motion #33, [1] and [85]]

* In the U-SIG field of a UHR ELR PPDU, the PHY Version Identifier is set to 1. And the PPDU Type And Compression Mode is used to indicate ELR PPDU.

[Motion #79, [1] and [170]]

* U-SIG carries STA-ID in ELR PPDU.

[Motion #91, [1] and [174]]

* The U-SIG field in ELR PPDU consists of 2 OFDM symbols and includes the same version independent fields defined in the U-SIG field of EHT PPDU
* The details for the version dependent fields are TBD.

[Motion #96, [1] and [177]]

* The contents of the U-SIG field in ELR PPDU is defined as follows.

|  |  |  |  |
| --- | --- | --- | --- |
| **Two parts of U-SIG** | **Field** | **Bit Pos** | **Bits** |
| **U-SIG-1** | PHY Version Identifier | B0-B2 | 3 |
| Bandwidth | B3-B5 | 3 |
| UL/DL | B6 | 1 |
| BSS Color | B7-B12 | 6 |
| TXOP | B13-B19 | 7 |
| Disregard | B20-B24 | 5 |
| Validate | B25 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
| **Two parts of U-SIG** | **Field** | **Bit Pos** | **Bits** |
| **U-SIG-2** | PPDU Type And Compression Mode | B0-B1 | 2 |
| STA-ID | B2-B12 | 11 |
| ELR Validate bits  | B13-B15 | 3 |
| CRC | B16-B19 | 4 |
| Tail | B20-B25 | 6 |

* ELR PPDU indication: PPDU Type And Compression Mode set to ‘11’.
* STA-ID (11 bit): B2-B12 bit in U-SIG-2.
* ELR Validate bits (B13-B15 of USIG-2): Set to all ‘1’ for ELR PPDU.
* Note: B11-B15 – in EHT MU PPDU indicates “Number of EHT-SIG symbols”, and in UHR MU PPDU indicates “Number of UHR-SIG symbols”

[Motion #111, [1] and 184]

* The pre-UHR portion (the portion up-to and including UHR-SIG) of the Co-BF PPDU shall be transmitted in a non-beamformed (omni) manner.

[Motion #112, [1] and 184]

* The pre-UHR portion of a Co-BF PPDU shall have identical content across two APs.

[Motion #113, [1] and 184]

* Co-BF data transmission shall be indicated in the U-SIG field for IEEE802.11bn

[Motion #103, [1] and 179]

* In the UHR sounding process for Co-BF, for the joint sounding case as well as for the sequential sounding case, the NDP shall always carry the BSS color of the AP which transmitted the NDPA.

**Text to be adopted begins here.**

***TGbn editor: Please add the following new subclause 38.x.y.7 U-SIG to the 802.11bn draft D0.1:***

# 38.3 UHR PHY

## 38.3.14 UHR Preamble

### 38.3.14.7 U-SIG

#### 38.3.14.7.1 General

The U-SIG field carries information necessary to interpret UHR PPDUs. The integer fields of the U-SIG field are transmitted in unsigned binary format, LSB first, where the LSB is in the lowest numbered bit position.

#### 38.3.14.7.2 Content

The U-SIG field in the UHR preamble is designed for backword and forward compatibility. It includes 5 version independent fields (i.e., PHY Version Identifier, Bandwidth, UL/DL, BSS Color, and TXOP) in the beginning and CRC and Tail fields at the end, where each of these fields has consistency in location, bitwidth and interpretation across multiple IEEE 802.11 PHY clauses that are defined for 2.4 GHz, 5 GHz, and 6 GHz spectrum starting from Clause 36 (Extremely high throughput (EHT) PHY specification). In addition, the U-SIG field in the UHR preamble has some version dependent fields specific to UHR.

The length of the U-SIG field for a UHR MU PPDU, UHR TB PPDU and UHR ELR PPDU is two OFDM symbols.

Similar to their counterparts in the EHT preamble, reserved fields in the UHR preamble or reserved values of the fields in the UHR preamble are divided into two categories: Validate (which indicates whether to continue reception of a PPDU at an EHT or UHR STA) and Disregard (which has no impact on an EHT or UHR STA’s continued reception of the PPDU). For further details on the definition of these two categories, refer to 36.3.12.7.2 (Content). For further details on the receive behavior when encountered with Validate and Disregard fields or any field as being set to a value identified as Validate or Disregard, refer to 36.3.23 (EHT receive procedure) and 38.3.25 (UHR receive procedure).

It is possible that a certain combination of U-SIG field values in a U-SIG field that indicates a valid CRC, leads to an invalid UHR-SIG CRC. Further details on receive behavior for the aforementioned case, can be found in 38.3.25 (UHR receive procedure).

For a 40 MHz UHR MU PPDU, the U-SIG field content shall be identical in both 20 MHz subchannels. For an 80 MHz UHR MU PPDU, the U-SIG field content shall be identical in all nonpunctured 20 MHz subchannels. For a 160 MHz or 320 MHz UHR MU PPDU, the U-SIG field content shall be identical in all nonpunctured 20 MHz subchannels within each 80 MHz frequency subblock, and the U-SIG field content in different 80 MHz frequency subblocks may be different. A UHR MU PPDU with TXVECTOR parameter UHR\_PPDU\_TYPE equal to 1 or 2 has the same U-SIG content for all nonpunctured 20 MHz subchannel for all PPDU bandwidths. A UHR MU PPDU with TXVECTOR parameter UHR\_PPDU\_TYPE equal to 0 has the same U-SIG content for all nonpunctured 20 MHz subchannel for all PPDU bandwidths, except that the Punctured Channel Information field might have different values between different 80 MHz frequency subblocks. For a 40 MHz, 80 MHz, 160 MHz or 320 MHz UHR TB PPDU, the U-SIG content shall be identical in all nonpunctured 20 MHz subchannels where the non-AP UHR STA’s UHR modulated fields are occupied. A UHR ELR PPDU is only defined as a 20MHz PPDU.

The U-SIG field for a UHR MU PPDU contains the fields listed in Table 38-A (U-SIG field of a UHR MU PPDU).

**Table 38-A U-SIG field of a UHR MU PPDU**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two parts of U-SIG** | **Bit** | **Field** | **Number of bits** | **Description** |
| U-SIG-1 | B0–B2 | PHY Version Identifier | 3 | Differentiate between different PHY clauses.Set to 1 for UHR.Values 2–7 are Validate.NOTE—Set to 0 for EHT (see 36.3.12.7.2). |
|  | B3–B5 | Bandwidth | 3 | Set to 0 for 20 MHz.Set to 1 for 40 MHz.Set to 2 for 80 MHz.Set to 3 for 160 MHz.Set to 4 for 320 MHz-1.Set to 5 for 320 MHz-2.See definition of 320 MHz-1 and 320 MHz-2 in [36.3.24.2 (Channelization for 320 MHz](#_bookmark328) [channel)](#_bookmark328).Values 6 and 7 are Validate. |
|  | B6 | UL/DL | 1 | Indicates whether the PPDU is sent in UL or DL. Set to the TXVECTOR parameter UPLINK\_FLAG.A value of 1 indicates the PPDU is addressed to an AP.A value of 0 indicates the PPDU is addressed to a non-AP STA. |
|  | B7–B12 | BSS Color | 6 | An identifier of the BSS.Set to the TXVECTOR parameter BSS\_COLOR. |
|  | B13–B19 | TXOP | 7 | If the TXVECTOR parameter TXOP\_DURATION is UNSPECIFIED, set to 127 to indicate the absence of duration information.If the TXVECTOR parameter TXOP\_DURATION is an integer value, set to a value less than 127 to indicate duration information for NAV setting and protection of the TXOP as follows:If the TXVECTOR parameter TXOP\_DURATION is less than 512, set to 2x**⎣**(TXOP\_DURATION)/8**⎦**.Otherwise, set to 2x**⎣**(TXOP\_DURATION-512)/128**⎦+**1. |
|  | B20–B25 | TBD | TBD | TBD. |

**Table 38-A U-SIG field of a UHR MU PPDU (*continued*)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two parts of U-SIG** | **Bit** | **Field** | **Number of bits** | **Description** |
| U-SIG-2 | B0–B1 | PPDU Type And Compression Mode | 2 | If the UL/DL field is set to 0:A value of 0 indicates a DL OFDMA transmission.A value of 1 indicates a UHR SU transmission.A value of 2 indicates a non-OFDMA DL MU-MIMO transmission.NOTE—A value of 3 indicates an ELR PPDU. Refer to [Table 38-D (U-SIG field](#_bookmark105) [of a UHR ELR PPDU)](#_bookmark105).If the UL/DL field is set to 1:A value of 1 indicates a UHR SU transmission. Value 2 is Validate.NOTE—A value of 0 indicates a TB PPDU. Refer to [Table 38-C (U-SIG field](#_bookmark105) [of a UHR TB PPDU)](#_bookmark105). A value of 3 indicates an ELR PPDU. Refer to [Table 38-D (U-SIG field](#_bookmark105) [of a UHR ELR PPDU)](#_bookmark105).For further clarifications on all values of this field, refer to [Table 38-B (Combination of](#_bookmark103) [UL/DL and PPDU Type And Compression](#_bookmark103) [Mode field)](#_bookmark103). |
|  | B2-B10 | TBD | TBD | TBD. |
|  | B11-B15 | Number Of UHR-SIG Symbols | 5 | Indicates the number of UHR-SIG symbols. Set to a value that is the number of UHR-SIG symbols minus 1. |
|  | B16–B19 | CRC | 4 | CRC for bits 0–41 of the U-SIG field. Bits 0– 41 of the U-SIG field correspond to bits 0–25 of the U-SIG-1 field followed by bits 0–15 of the U-SIG-2 field. The CRC computation uses the same polynomial as that in 27.3.11.7.3 (CRC computation). |
|  | B20–B25 | Tail | 6 | Used to terminate the trellis of the convolutional decoder. Set to 0. |

**Table 38-B Combination of UL/DL and PPDU Type And Compression Mode field**

|  |  |
| --- | --- |
| **U-SIG fields** | **Description** |
| **UL/DL** | **PPDU Type And Compression Mode** | **UHR PPDU format** | **UHR-SIG present?** | **RU Allocation subfields present?** | **ELR-MARK and ELR-SIG present?** | **Total number of User fields in MU PPDU or transmitters in TB PPDU or ELR PPDU** | **Note** |
| 0 (DL) | 0 | UHR MU | Yes | Yes | No | ≥ 1 | DL OFDMA (including non-MU-MIMO and MU-MIMO). |
|  | 1 | UHR MU | Yes | No | No | 1 | UHR SU transmission that is not addressed to an AP. |
|  | 2 | UHR MU | Yes | No | No | > 1 | DL non-OFDMA MU-MIMO. |
|  | 3 | UHR ELR | No | No | Yes | 1 | UHR ELR transmission that is not addressed to an AP. |

**Table 38-B Combination of UL/DL and PPDU Type And Compression Mode field (*continued*)**

|  |  |
| --- | --- |
| **U-SIG fields** | **Description** |
| **UL/DL** | **PPDU Type And Compression Mode** | **UHR PPDU format** | **UHR-SIG present?** | **RU Allocation subfields present?** | **ELR-MARK and ELR-SIG present?** | **Total number of User fields in MU PPDU or transmitters in TB PPDU or ELR PPDU** | **Note** |
| 1 (UL) | 0 | UHR TB | No | No | No | ≥ 1 | UL OFDMA or UL non-OFDMA (including non-MU-MIMO and MU-MIMO). |
|  | 1 | UHR MU | Yes | No | No | 1  | UHR SU transmission that is addressed to an AP. |
|  | 2 | – | – | – | – | – | Validate. |
|  | 3 | UHR ELR | No | No | Yes | 1 | UHR ELR transmission that is addressed to an AP. |

The U-SIG field includes an indication of a coordinated beamforming (COBF) transmission.

The U-SIG field for a UHR TB PPDU contains the fields listed in Table 38-C (U-SIG field of a UHR TB PPDU).

**Table 38-C U-SIG field of a UHR TB PPDU**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two parts of U-SIG** | **Bit** | **Field** | **Number of bits** | **Description** |
| U-SIG-1 | B0–B2 | PHY Version Identifier | 3 | Differentiate between different PHY clauses.Set to 1 for UHR.Values 2–7 are Validate.NOTE—Set to 0 for EHT (see 36.3.12.7.2). |
|  | B3–B5 | Bandwidth | 3 | Set to 0 for 20 MHz.Set to 1 for 40 MHz.Set to 2 for 80 MHz.Set to 3 for 160 MHz.Set to 4 for 320 MHz-1.Set to 5 for 320 MHz-2.See definition of 320 MHz-1 and 320 MHz-2 in [36.3.24.2 (Channelization for 320 MHz](#_bookmark328) [channel)](#_bookmark328).Values 6 and 7 are Validate. |
|  | B6 | UL/DL | 1 | Set to 1 to indicate that the PPDU is addressed to the AP. |
|  | B7–B12 | BSS Color | 6 | An identifier of the BSS.Set to the TXVECTOR parameter BSS\_COLOR. |
|  | B13–B19 | TXOP | 7 | If the TXVECTOR parameter TXOP\_DURATION is UNSPECIFIED, set to 127 to indicate the absence of duration information.If the TXVECTOR parameter TXOP\_DURATION is an integer value, set to a value less than 127 to indicate duration information for NAV setting and protection of the TXOP as follows:If the TXVECTOR parameter TXOP\_DURATION is less than 512, set to 2x**⎣**(TXOP\_DURATION)/8**⎦**.Otherwise, set to 2x**⎣**(TXOP\_DURATION-512)/128**⎦+**1. |
|  | B20–B25 | TBD | TBD | TBD. |

**Table 38-C U-SIG field of a UHR TB PPDU (*continued*)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two parts of U-SIG** | **Bit** | **Field** | **Number of bits** | **Description** |
| U-SIG-2 | B0–B1 | PPDU Type And Compression Mode | 2 | Set to 0 for a TB PPDU. Value 2 is Validate.NOTE—A value of 1 indicates a UHR SU transmission. Refer to [Table 38-A (U-SIG field](#_bookmark105) [of a UHR MU PPDU)](#_bookmark105). A value of 3 indicates an ELR PPDU. Refer to [Table 38-D (U-SIG field](#_bookmark105) [of a UHR ELR PPDU)](#_bookmark105).For further clarifications on all values of this field, refer to [Table 38-B (Combination of](#_bookmark103) [UL/DL and PPDU Type And Compression](#_bookmark103) [Mode field)](#_bookmark103). |
|  | B2-B15 | TBD | TBD | TBD. |
|  | B16–B19 | CRC | 4 | CRC for bits 0–41 of the U-SIG field. Bits 0– 41 of the U-SIG field correspond to bits 0–25 of the U-SIG-1 field followed by bits 0–15 of the U-SIG-2 field. The CRC computation uses the same polynomial as that in 27.3.11.7.3 (CRC computation). |
|  | B20–B25 | Tail | 6 | Used to terminate the trellis of the convolutional decoder. Set to 0. |

The U-SIG field for a UHR ELR PPDU contains the fields listed in Table 38-D (U-SIG field of a UHR ELR PPDU).

**Table 38-D U-SIG field of a UHR ELR PPDU**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two parts of U-SIG** | **Bit** | **Field** | **Number of bits** | **Description** |
| U-SIG-1 | B0–B2 | PHY Version Identifier | 3 | Differentiate between different PHY clauses.Set to 1 for UHR.Values 2–7 are Validate.NOTE—Set to 0 for EHT (see 36.3.12.7.2). |
|  | B3–B5 | Bandwidth | 3 | Set to 0 for 20 MHz.Values 1-7 are Validate. |
|  | B6 | UL/DL | 1 | Indicates whether the PPDU is sent in UL or DL. Set to the TXVECTOR parameter UPLINK\_FLAG.A value of 1 indicates the PPDU is addressed to an AP.A value of 0 indicates the PPDU is addressed to a non-AP STA.NOTE—In 5 GHz band or 6 GHz band, the value is always set to 1. |
|  | B7–B12 | BSS Color | 6 | An identifier of the BSS.Set to the TXVECTOR parameter BSS\_COLOR. |
|  | B13–B19 | TXOP | 7 | If the TXVECTOR parameter TXOP\_DURATION is UNSPECIFIED, set to 127 to indicate the absence of duration information.If the TXVECTOR parameter TXOP\_DURATION is an integer value, set to a value less than 127 to indicate duration information for NAV setting and protection of the TXOP as follows:If the TXVECTOR parameter TXOP\_DURATION is less than 512, set to 2x**⎣**(TXOP\_DURATION)/8**⎦**.Otherwise, set to 2x**⎣**(TXOP\_DURATION-512)/128**⎦+**1. |
|  | B20–B24 | Disregard | 5 | Set to all 1s and treat as Disregard. |
|  | B25 | Validate | 1 | Set to 1 and treat as Validate. |

**Table 38-D U-SIG field of a UHR ELR PPDU (*continued*)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Two parts of U-SIG** | **Bit** | **Field** | **Number of bits** | **Description** |
| U-SIG-2 | B0–B1 | PPDU Type And Compression Mode | 2 | Set to 3 for an ELR PPDU.If the UL/DL field is set to 1, value 2 is Validate.NOTE—If the UL/DL field is set to 0, a value of 0 indicates a DL OFDMA transmission, a value of 1 indicates a UHR SU transmission and a value of 2 indicates a non-OFDMA DL MU-MIMO transmission. If the UL/DL field is set to 1, a value of 1 indicates a UHR SU transmission. Refer to [Table 38-A (U-SIG field](#_bookmark105) [of a UHR MU PPDU)](#_bookmark105). If the UL/DL field is set to 1, a value of 0 indicates a TB PPDU. Refer to [Table 38-C (U-SIG field](#_bookmark105) [of a UHR TB PPDU)](#_bookmark105).For further clarifications on all values of this field, refer to [Table 38-B (Combination of](#_bookmark103) [UL/DL and PPDU Type And Compression](#_bookmark103) [Mode field)](#_bookmark103). |
|  | B2-B12 | STA-ID | 11 | Set to a value of the TXVECTOR parameter STA-ID (see 35.11.1.1 (STA\_ID)). |
|  | B13-B15 | ELR Validate | 3 | Set to a value of 7.Values 0-6 are Validate. |
|  | B16–B19 | CRC | 4 | CRC for bits 0–41 of the U-SIG field. Bits 0– 41 of the U-SIG field correspond to bits 0–25 of the U-SIG-1 field followed by bits 0–15 of the U-SIG-2 field. The CRC computation uses the same polynomial as that in 27.3.11.7.3 (CRC computation). |
|  | B20–B25 | Tail | 6 | Used to terminate the trellis of the convolutional decoder. Set to 0. |

#### 38.3.14.7.3 Encoding and modulation

For a UHR MU PPDU, UHR TB PPDU and UHR ELR PPDU, the U-SIG field shall use the same encoding and modulation process as that of the U-SIG field in an EHT MU PPDU and EHT TB PPDU, as described in 36.3.12.7.3 (Encoding and modulation).

The time domain waveform for the U-SIG field of a UHR MU PPDU and a UHR TB PPDU, transmitted on transmit chain $i\_{TX}$, shall be as specified in Equations (36-20) and (36-21), respectively, where the parameters $∆\_{F,Pre-EHT}$ and $T\_{GI,Pre-EHT}$ in both equations and $η\_{Pre-EHT}$ in Equation (36-21) shall be replaced by their UHR counterparts, $∆\_{F,Pre-UHR}$, $T\_{GI,Pre-UHR}$ and $η\_{Pre-UHR}$, respectively.

For the U-SIG field in a UHR ELR PPDU, the BPSK constellation point assigned to the *k*-th data subcarrier of the *n*-th symbol is denoted as $d\_{k,n}$. The time domain waveform for the U-SIG field of a UHR ELR PPDU, transmitted on transmit chain $i\_{TX}$, shall be as specified in Equation (38-E).

$r\_{U-SIG}^{i\_{TX}}\left(t\right)=\frac{1}{\sqrt{N\_{TX}∙N\_{U-SIG}^{Tone}}}\sum\_{n=0}^{1}w\_{T\_{SYML}}\left(t-nT\_{SYML}\right)η\_{UHR-ELR, U-SIG}\sum\_{k=-28}^{28}\left(γ\_{k,20}\left(D\_{k,n}+p\_{n+2}P\_{k}\right)exp\left(j2πkΔ\_{F,Pre-UHR}\left(t-nT\_{SYML}-T\_{GI,Pre-UHR}-T\_{CS}^{i\_{TX}}\right)\right)\right)$ (38-E)

where

η UHR-ELR, U-SIG is 1.

$γ\_{k,20}=1$ is defined as in 21.3.7.5 (Definition of tone rotation).

$$D\_{k,n}=\left\{\begin{matrix}0,&k=0, \pm 7, \pm 21\\d\_{M\_{20}\left(k\right),n},&otherwise\end{matrix}\right.$$

$$M\_{20}\left(k\right)=\left\{\begin{matrix}\begin{matrix}k+28, -28\leq k\leq -22\\k+27, -20\leq k\leq -8\end{matrix}\\\begin{matrix}k+26, -6\leq k\leq -1\\k+25, 1\leq k\leq 6 \end{matrix}\\\begin{matrix}k+24, 8\leq k\leq 20\\k+23, 22\leq k\leq 28\end{matrix}\end{matrix}\right.$$

$P\_{k}$ and $p\_{n}$ are defined in 17.3.5.10 (OFDM modulation).

Other variables in Equation (38-E) are defined in 38.3.12 (Timing-related parameters) and 38.3.13 (Mathematical description of signals).

**Text to be adopted ends here.**

**References:**

1. [11-24-0171r21](https://mentor.ieee.org/802.11/dcn/24/11-24-0171-21-00bn-tgbn-motions-list-part-1.pptx): 11-24-0171-21-00bn-tgbn-motions-list-part-1, Alfred Asterjadhi (Qualcomm Inc.)