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Wireless LANs

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| Proposed Text Draft on DRU |
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This document is based on the following IEEE contributions on DRU and 11bn SFD.

1. [11-23/2200r3](https://mentor.ieee.org/802.11/dcn/23/11-23-2200-03-00bn-distribution-bandwidth-of-dru.pptx): 11-23-2200-03-00bn-distribution-bandwidth-of-dru, Ross Jian Yu
2. [11-24/0468r2](https://mentor.ieee.org/802.11/dcn/24/11-24-0468-02-00bn-dru-tone-plan-for-11bn.pptx): 11-24-0468-02-00bn-dru-tone-plan-for-11bn, Shengquan Hu
3. [11-24/0477r2](https://mentor.ieee.org/802.11/dcn/24/11-24-0477-02-00bn-high-level-perspective-on-dru-follow-up.pptx): 11-24-0477-02-00bn-high-level-perspective-on-dru-follow-up, Shengquan Hu
4. [11-24/1510r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1510-02-00bn-open-issues-on-dru.pptx): 11-24-1510-02-00bn-open-issues-on-dru, Lin Yang
5. 11-24/1471r3: 11-24-1471-03-00bn-signaling-for-dru-in-trigger-frame, Eunsung Park
6. [11-24/1189r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1189-01-00bn-dru-transmission-on-frequency-subblocks-of-wide-bandwidth-ppdu.pptx): 11-24-1189-01-00bn-dru-transmission-on-frequency-subblocks-of-wide-bandwidth-ppdu, Shengquan Hu
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8. [11-24/0752r2](https://mentor.ieee.org/802.11/dcn/24/11-24-0752-02-00bn-stf-design-consideration-for-dru.pptx): 11-24-0752-02-00bn-stf-design-consideration-for-dru, Lin Yang
9. [11-24/1188r2](https://mentor.ieee.org/802.11/dcn/24/11-24-1188-02-00bn-global-csd-index-assignment-for-dru-stf-transmission-in-11bn.pptx): 11-24-1188-02-00bn-global-csd-index-assignment-for-dru-stf-transmission-in-11bn, Shengquan Hu
10. [11-24/1097r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1097-01-00bn-thoughts-on-uhr-ltf-for-dru.pptx): 11-24-1097-01-00bn-thoughts-on-uhr-ltf-for-dru, Eunsung Park
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12. [11-24/1901r0](https://mentor.ieee.org/802.11/dcn/24/11-24-1901-00-00bn-dru-ltf-sequence-design-for-40mhz-dbw.pptx): 11-24-1901-00-00bn-dru-ltf-sequence-design-for-40mhz-dbw, Chenchen LIU
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15. [11-24/1489r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1489-01-00bn-signaling-for-dru-transmission.pptx): 11-24-1489-01-00bn-signaling-for-dru-transmission, Shengquan Hu
16. [11-24/0736r1](https://mentor.ieee.org/802.11/dcn/24/11-24-0736-01-00bn-preamble-and-pe-transmission-in-ppdu-using-dru.pptx): 11-24-0736-01-00bn-preamble-and-pe-transmission-in-ppdu-using-dru, using DRU, Yapu Li
17. [11-24/1856r1](https://mentor.ieee.org/802.11/dcn/24/11-24-1856-01-00bn-tone-distribution-in-dru-with-puncturing-follow-up.pptx): 11-24-1856-01-00bn-tone-distribution-in-dru-with-puncturing-follow-up, Yan Xin

# 38.3.2 Subcarrier and resource allocation

# 38.3.2.1 Tone Plan for DRUs

The UHR PHY subcarrier frequency spacing used in Distributed-tone RU (DRU) tone plan is identical to EHT PHY subcarrier frequency spacing defined in Clause 36 (Extreme High Efficiency (EHT) PHY specification).

The DRUs defined for UHR UL TB PPDU transmission are 26-tone DRU, 52-tone DRU, 106-tone DRU, 242-tone DRU, and 484-tone DRU.

Distribution bandwidth defined for UHR UL TB PPDU transmission are 20 MHz, 40 MHz, 60 MHz and 80 MHz.

The 26-tone DRU, 52-tone DRU, and 106-tone DRU are used in 20 MHz distribution bandwidth. 26-tone DRU, 52-tone DRU, 106-tone DRU, and 242-tone DRU are used in 40 MHz distribution bandwidth. 52-tone DRU, 106-tone DRU, 242-tone DRU, and 484-tone DRU are used in 80 MHz distribution bandwidth.

The maximum number of DRUs in the 20 MHz, 40 MHz, 80 MHz UHR PPDU formats is defined in Table 38-x.

An UHR UL TB PPDU using OFDMA transmission can carry a mixture of 26-, 52-, 106-, 242-, and 484-

tone DRUs.

**Table 38-x—Maximum number of DRUs for each distribution bandwidth**

|  |  |  |  |
| --- | --- | --- | --- |
| DRU Type | Distribution BW20 | Distribution BW40 | Distribution BW80 |
| 26-tone DRU | 9 | 18 | N/A |
| 52-tone DRU | 4 | 8 | 16 |
| 106-tone DRU | 2 | 4 | 8 |
| 242-tone DRU | N/A | 2 | 4 |
| 484-tone DRU | N/A | N/A | 2 |

DRU tone plans on distribution bandwidth 20 MHz and 40 MHz are designed by using 26-tone DRUs as basic building blocks, (80MHz TBD), the hierarchical tone structure as regular RUs (RRUs) is preserved for DRU.

A 26-tone DRU consists of 24 data subcarriers and 2 pilot subcarriers. The positions of the pilots for the 26-

tone DRU are defined in 38-TBD. The locations of the 26-tone DRUs are fixed as defined in Table 38-x and Table 38-x.

A 52-tone DRU consists of 48 data subcarriers and 4 pilot subcarriers. The positions of the pilots for the 52-

tone DRU are defined in 38-TBD. The locations of the 52-tone DRUs are fixed as defined in Table 38-x, Table 38-x and Table 38-x.

A 52-tone DRU consists of tones of two corresponding 26-tone DRUs. For example, 52-tone DRU1 consists of tones of 26-tone DRU1 and DRU2.

A 106-tone DRU consists of 102 data subcarriers and 4 pilot subcarriers. The positions of the pilots for the 106-

tone DRU are defined in 38-TBD. The locations of the 106-tone DRUs are fixed as defined in Table 38-x, Table 38-x and Table 38-x.

A 106-tone DRU consists of tones of two corresponding 52-tone DRUs and two extra tones. For example, 106-tone DRU1 consists of tones of 52-tone DRU1, 52-tone DRU2, and two extra tones.

A 242-tone DRU consists of 234 data subcarriers and 8 pilot subcarriers. The positions of the pilots for the 242-

tone DRU are defined in 38-TBD. The locations of the 242-tone DRUs are fixed as defined in Table 38-x, Table 38-x and Table 38-x.

A 242-tone DRU consists of tones of two corresponding 106-tone DRUs, one 26-tone DRUs, and four extra tones. For example, 242-tone DRU1 consists of tones of 106-tone DRU1, 106-tone DRU2, 26-tone DRU5, and four extra tones.

A 484-tone DRU consists of 468 data subcarriers and 16 pilot subcarriers. The positions of the pilots for the 484-

tone DRU are defined in 38-TBD. The locations of the 106-tone DRUs are fixed as defined in Table 38-x, Table 38-x and Table 38-x.

A 484-tone DRU consists of tones of two corresponding 242-tone DRUs. For example, 484-tone DRU1 consists of tones of 242-tone DRU1 and DRU2.

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| **Table 38-x Data and pilot subcarrier indices for Distributed-tone RUs (DRU)  in a 20 MHz UHR TB PPDU** |
| **DRU type** | **DRU index and subcarrier range** |
| 26-tone DRUi=1:9 | DRU1[-120:9:-12, 6:9:114] | DRU2[-116:9:-8, 10:9:118] | DRU3[-118:9:-10, 8:9:116] | dRU4[-114:9:-6, 12:9:120] | dRU5[-112:9:-4, 5:9:113] |
| DRU6[-119:9:-11, 7:9:115] | DRU7[-115:9:-7, 11:9:119] | DRU8[-117:9:-9, 9:9:117] | dRU9[-113:9:-5, 4:9:112] |  |
| 52-tone DRUi=1:4 | DRU126-tone [DRU1, DRU2] | DRU226-tone [DRU3, DRU4] |  |
| DRU326-tone [DRU6, DRU7] | DRU426-tone [DRU8, DRU9] |  |
| 106-tone DRUi=1:2 | DRU126-tone [DRU1~4], [-3, 3] | DRU226-tone [DRU6~9], [-2, 2] |  |

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| **Table 38-x Data and pilot subcarrier indices for Distributed-tone RUs (DRU)  in a 40 MHz UHR TB PPDU** |
| **DRU type** | **DRU index and subcarrier range** |
| 26-tone DRUi=1:18 | DRU1[-242:18:-26, 10:18:226] | DRU2[-233:18:-17, 19:18:235] | DRU3[-238:18:-22, 14:18:230] | DRU4[-229:18:-13, 23:18:239] | DRU5[-225:18:-9, 27:18:243] | DRU6[-240:18:-24, 12:18:228] |
| DRU7[-231:18:-15, 21:18:237] | DRU8[-236:18:-20, 16:18:232] | DRU9[-227:18:-11, 25:18:241] | DRU10[-241:18:-25, 11:18:227] | DRU11[-232:18:-16, 20:18:236] | DRU12[-237:18:-21, 15:18:231] |
| DRU13[-228:18:-12, 24:18:240] | DRU14[-234:18:-18, 18:18:234] | DRU15[-239:18:-23, 13:18:229] | DRU16[-230:18:-14, 22:18:238] | DRU17[-235:18:-19, 17:18:233] | DRU18[-226:18:-10, 26:18:242] |
| 52-tone DRUi=1:8 | DRU1[-242:9:-17, 10:9:235] | DRU2[-238:9:-13, 14:9:239] | DRU3[-240:9:-15, 12:9:237] |
| DRU4[-236:9:-11, 16:9:241] | DRU5[-241:9:-16, 11:9:236] | DRU6[-237:9:-12, 15:9:240] |
| DRU7[-239:9:-14, 13:9:238] | DRU8[-235:9:-10, 17:9:242] |  |
| 106-tone DRUi=1:4 | DRU126-tone [DRU1~4], [-8,5] | DRU226-tone [DRU6~9], [-6,7] | DRU326-tone [DRU10~13], [-7,6] |
| DRU426-tone [DRU15~18], [-5,8] |  |  |
| 242-tone DRUi=1:2 | DRU1106-tone [DRU1~2],26-tone DRU5, [-244,-4,3,9] | DRU2106-tone [DRU3~4],26-tone DRU14, [-243,-3,4,244] |  |

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| **Table 38-x Data and pilot subcarrier indices for Distributed-tone RUs (DRU)  in a 80 MHz UHR TB PPDU** |
| **DRU type** | **DRU index and subcarrier range** |
| 52-tone DRUi=1:16 | DRU1[-483:36:-51, 17:36:449],[-467:36:-35, 33:36:465] | DRU2[-475:36:-43, 25:36:457],[-459:36:-27, 41:36:473] | DRU3[-479:36:-47, 21:36:453],[-463:36:-31, 37:36:469] | DRU4[-471:36:-39, 29:36:461],[-455:36:-23, 45:36:477] |
| DRU5[-477:36:-45, 23:36:455],[-461:36:-29, 39:36:471] | DRU6[-469:36:-37, 31:36:463],[-453:36:-21, 47:36:479] | DRU7[-481:36:-49, 19:36:451],[-465:36:-33, 35:36:467] | DRU8[-473:36:-41, 27:36:459],[-457:36:-25, 43:36:475] |
| DRU9[-482:36:-50, 18:36:450],[-466:36:-34, 34:36:466] | DRU10[-474:36:-42, 26:36:458],[-458:36:-26, 42:36:474] | DRU11[-478:36:-46, 22:36:454],[-462:36:-30, 38:36:470] | DRU12[-470:36:-38, 30:36:462],[-454:36:-22, 46:36:478] |
| DRU13[-476:36:-44, 24:36:456],[-460:36:-28, 40:36:472] | DRU14[-468:36:-36, 32:36:464],[-452:36:-20,48:36:480] | DRU15[-480:36:-48, 20:36:452],[-464:36:-32, 36:36:468] | DRU16[-472:36:-40, 28:36:460],[-456:36:-24, 44:36:476] |
| 106-tone DRUi=1:8 | DRU152-tone [DRU1~2],  [-495, 485] | DRU252-tone [DRU3~4],[-491, 489] | DRU352-tone [DRU5~6],[-489, 491] | DRU452-tone [DRU7~8],[-493, 487] |
| DRU552-tone [DRU9~10],[-494, 486] | DRU652-tone [DRU11~12],[-490,490] | DRU752-tone [DRU13~14],[-488,492] | DRU852-tone [DRU15~16],[-492,488] |
| 242-tone DRUi=1:4 | DRU1[-499:4:-19, 17:4:497] | DRU2[-497:4:-17, 19:4:499] |
| DRU3[-498:4:-18, 18:4:498] | DRU4[-496:4:-16, 20:4:500] |
| 484-tone DRUi=1:2 | DRU1[-499:2:-17, 17:2:499] | DRU2[-498:2:-16, 18:2:500] |

For a DRU distributed over a frequency subblock of wider bandwidth PPDU, the DRU subcarrier indices are defined by the Equation 38-x:

$k\_{DRU\\_l} =  k\_{DRU}+ K\_{shift}\left(l\right)$ 38-x

where

*KDRU:*  DRU subcarrier indices from DRU tone plan Table 38-x1, Table-x2, and Table-x3 for an DRU on distribution bandwidth 20 MHz, 40 MHz, and 80 MHz

*KDRU\_l:*  DRU subcarrier indices on *l-th* frequency subblock

*Kshift(l):* constant shift value defined in Table-y

*l:*  frequency subblock index of subblock size 20 MHz, 40 MHz, and 80MHz on PPDU bandwidth 80 MHz, 160 MHz, and 320 MHz

**Table 38-y Constant shift value *Kshift* for DRU on a frequency subblock of wide bandwidth**

|  |  |  |  |
| --- | --- | --- | --- |
| **Frequency Subblock Size** | **CBW80** | **CBW160** | **CBW320** |
| 20MHz | [-380,-133,132,379] | [-892,-645,-380,-133,132,379,644,891] | [ -1916,  -1669, -1404, -1157,  -892, -645, -380,-133, 132, 379, 644, 891, 1156, 1403, 1668, 1915] |
| 40MHz | [-256, 256] | [-768,-256,256,768] | [-1792,-1280,-768,-256,256,768,1280,1792] |
| 80MHz | NA | [-512,512] | [-1536,-512,512,1536] |

# 38.3.15.7 Pilot Subcarriers

DRU only use 4x UHR-LTF. The number of pilot tones for DRU is the same as the same size RRU with 4x or 2x UHR-LTF. The pilot subcarrier indices for the DRU Data field and UHR-LTF field OFDM symbols are defined in 38.3.13.11.2 (Pilots subcarriers in DRU).

## 38.3.15.7.x Pilots subcarriers in DRU

11bn supports hierarchical pilot structure for DRU. Pilot locations of a larger DRU is a subset of pilot locations of smaller component DRUs within the same distribution BW (DBW).

For a user transmitting on the i-th 26/52/106-tone DRU in 20MHz DBW, the pilot subcarriers shall be inserted in subcarriers k∈ *KdRxx\_i*, where *KdRxx\_i* is given by the i-th pilot index set in the row of given DRU size of Table 1 (Pilot indices for dRU transmission over 20MHz).

**Table 1: Pilot indices for DRU transmission over 20MHz**

|  |
| --- |
| **Pilot indices for DRU transmission over 20MHz** |
| DRU size | *KdRxx\_i* |
| DRU26, i = 1:9 | {-111 15}, {-89 37}, {-100 26}, {-78 48},{-67 59}, {-56 70}, {-34 92}, {-45 81},{-23 103} |
| DRU52, i = 1:4 | {-111 -89 15 37}, {-100 -78 26 48}, {-56 -34 70 92}, {-45 -23 81 103} |
| DRU106, i = 1:2 | {-111 -78 15 48}, {-56 -23 70 103} |

For a user transmitting on the i-th 26/52/106/242-tone DRU in 40MHz DBW, the pilot subcarriers shall be inserted in subcarriers k∈ *KdRxx\_i*, where *KdRxx\_i* is given by the i-th pilot index set in the row of given DRU size of Table 2 (Pilot indices for dRU transmission over 40MHz).

**Table 2: Pilot indices for DRU transmission over 40MHz**

|  |
| --- |
| **Pilot indices for DRU transmission over 40MHz** |
| DRU size | *KdRxx\_i* |
| DRU26, i = 1:18 | {-224 28}, {-125 127}, {-202 50}, {-103 149},{-81 171}, {-114 138}, {-213 39}, {-92 160},{-191 61}, {-169 83}, {-70 182}, {-147 105}, {-48 204}, {-180 72}, {-59 193}, {-158 94}, {-37 215}, {-136 116} |
| DRU52, i = 1:8 | {-224 -125 28 127}, {-202 -103 50 149}, {-213 -114 39 138}, {-191 -92 61 160}, {-169 -70 83 182}, {-147 -48 105 204}, {-158 -59 94 193}, {-136 -37 116 215}  |
| DRU106, i = 1:4 | {-224 -103 28 149}, {-213 -92 39 160}, {-169 -48 83 204}, {-158 -37 94 215} |
| DRU242, i = 1:2 | {-224 -213 -103 -92 28 39 149 160}, {-169 -158 -48 -37 83 94 204 215}  |

For a user transmitting on the i-th 52/106/242/484-tone DRU in 80MHz DBW, the pilot subcarriers shall be inserted in subcarriers k∈ *KdRxx\_i*, where *KdRxx\_i* is given by the i-th pilot index set in the row of given DRU size of Table 3 (Pilot indices for dRU transmission over 80MHz).

**Table 3: Pilot indices for DRU transmission over 80MHz**

|  |
| --- |
| **Pilot indices for DRU transmission over 80MHz** |
| DRU size | *KdRxx\_i* |
| DRU52, i = 1:16 | {-447 -359 53 141}, {-403 -315 97 185}, {-227 -139 273 361}, {-183 -95 317 405}, {-425 -117 75 383}, {-381 -73 119 427}, {-337 -249 163 251}, {-293 -205 207 295}, {-194 -106 306 394}, {-150 -62 350 438}, {-370 -282 130 218}, {-326 -238 174 262}, {-260 -172 240 328}, {-216 -128 284 372}, {-392 -84 108 416}, {-436 -348 64 152}  |
| DRU106, i = 1:8 | {-403 -315 97 185}, {-227 -139 273 361}, {-381 -117 119 383}, {-293 -205 207 295}, {-150 -62 350 438}, {-326 -238 174 262}, {-260 -172 240 328}, {-348 -84 152 416} |
| DRU242, i = 1:4 | {-403 -315 -227 -139 97 185 273 361}, {-381 -293 -205 -117 119 207 295 383}, {-326 -238 -150 -62 174 262 350 438}, {-348 -260 -172 -84 152 240 328 416}  |
| DRU484, i = 1:2 | {-403 -381 -315 -293 -227 -205 -139 -117 97 119 185 207 273 295 361 383}, {-348 -326 -260 -238 -172 -150 -84 -62 152 174 240 262 328 350 416 438} |

The pilot mapping $P\_{n}^{k}$ for the subcarrier *k* for symbol *n* for DRUshall be the same as for RRU that is specified in from Equation (27-101) to Equation (27-105) in 27.3.12.13 (Pilot subcarriers).

# 38.3.14.10 UHR-STF

# 38.3.14.10.1 UHR-STF for DRUs

The same UHR-STF sequences are used in UHR TB PPDUs for both UHR DRU and UHR RRU. For a DRU with a given distribution bandwidth (DBW) transmitted in a UL TB PPDU, UHR-STF sequence depends on the PPDU BW, the occupied STF tones are the same as that of the largest RRU corresponding to the distribution BW within the PPDU BW.

For a 20 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-STF for DRU is given by Equation (38-xx1)

*UHRS*-120:8:120 = *HES*-120:8:120 (38-xx1)

where *HES*-120:8:120 is defined in Equation (27-28).

For a 40 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-STF for DRU is given by Equation (38-xx2).

*UHRS*-248:8:248 = *HES*-248:8:248  (38-xx2)

where *HES*-248:8:248 is defined in Equation (27-30).

For an 80 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-STF for DRU is given by Equation (38-xx3), when DBW is 80MHz.

*UHRS*-504:8:504 = *HES*-504:8:504 (38-xx3)

where HES-504:8:504 is defined in Equation (27-32).

For an 160 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-STF is given by Equation (38-xx4).

*UHRS*-1016:8:1016 = *HES*-1016:8:1016 (38-xx4)

where *HES*-1016:8:1016 is defined in Equation (27-34).

For a 320 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-STF is given by Equation (38-xx5).

*UHRS*-2040:8:2040 = *EHTS*-2040:8:2040 (38-xx5)

where *EHTS*-2040:8:2040 is defined in Equation (36-34).

When transmitting a DRU with a given DBW in a UHR TB PPDU:

* The PPDU BW determines which UHR-STF sequence is used
* The DBW determines which tones in the UHR-STF field are modulated. Let *KSTF*,242,*n*, *KSTF*,484,*n* and *KSTF*,996,*n* be the set of UHR-STF tones modulated when transmitting the *n-*th 242-tone, 484-tone and 996-tone RRU lowest in frequency, respectively, in a *WP* MHz UHR TB PPDU (*WP* ≥ DBW). Then, *KSTF*,242,*n* is the set of UHR-STF tones that are modulated when transmitting a DRU with DBW of 20 MHz located in the *n-*th lowest 20 MHz within the UHR TB PPDU. *KSTF*,484,*n* is the set of UHR-STF tones that are modulated when transmitting a DRU with DBW of 40 MHz located in the *n-*th lowest 40 MHz within the UHR TB PPDU. *KSTF*,996,*n* is the set of UHR-STF tones that are modulated when transmitting a DRU with DBW of 80 MHz located in the *n-*th lowest 80 MHz within the UHR TB PPDU.

The maximum DBW is 80 MHz in 80 MHz, 160 MHz, and 320 MHz UHR TB PPDUs. DRUs with DBW of 20 or 40MHz are allowed within each 80 MHz frequency subblock.

# 38.3.14.10.2 Global CSD for DRU transmission

Global CSD is used for DRU UHR-STF transmission to solve unintentional beamforming issue. It is applied in each distribution BW. For each DRU user, a unique CSD index will be assigned according to its DRU index to minimize CSD collision.

DRU transmission reuses the existing 8 CSD table (Table 21-11 – Cyclic shift values for the VHT modulated fields of a PPDU) for the global CSD allocation.

Like per stream global CSD in UL MU-MIMO, global CSD index for each DRU assignment can be defined based on DRU index. For a DRU assignment in a distribution BW, it is assigned with a global CSD start index i. If number of streams (Nss) for this DRU is larger than 1, then it will use CSD [mod(i-1:i+Nss-2,8)+ones(1,Nss)] for each stream.



# 38.3.14.10.3 Global CSD index assignment for DRU STF transmission

For DRU UHR-STF transmission, DRU index based global CSD start index assignment defined in Tables 38-yy1-yy3 shall be followed for distribution BW of 20MHz, 40MHz, and 80MHz, respectively.

**Table 38-yy1: Global CSD starting index for DBW20**

|  |  |
| --- | --- |
| DRU size | Global CSD starting index for DBW20 |
| DRU26, i=1:9 | {1,2,3,4,5,5,6,7,8} |
| DRU52, i=1:4 | {2,4,6,8} |
| DRU106, i=1:2 | {3,7} |

**Table 38-yy2: Global CSD starting index for DBW40**

|  |  |
| --- | --- |
| DRU size | Global CSD starting index for DBW40 |
| DRU26, i=1:18 | {1,5,2,6,3,3,7,4,8,1,5,2,6,7,3,7,4,8} |
| DRU52, i=1:8 | {1,2,3,4,5,6,7,8} |
| DRU106, i=1:4 | {2,4,6,8} |
| DRU242, i=1:2 | {3,7} |

**Table 38-yy3: Global CSD starting index for DBW80**

|  |  |
| --- | --- |
| DRU size | Global CSD starting index for DBW80 |
| DRU52, i=1:16 | {1,5,2,6,3,7,4,8,1,5,2,6,3,7,4,8} |
| DRU106, i=1:8 | {1,2,3,4,5,6,7,8} |
| DRU242, i=1:4 | {2,4,6,8} |
| DRU484, i=1:2 | {3,7} |

# 38.3.14.11.1 UHR-DLTF for DRUs

The DRU UHR-DLTF field provides a means for the receiver to estimate the channel between the set of constellation mapper outputs and the receive chains. For DRU with a given distribution bandwidth (DBW) transmitted in a UHR TB PPDU, UHR-DLTF sequence depends on the DBW.

In hyybrid RRU and DRU transmission. the RRU LTF follows the exact same rule as if there is no DRU.

For DRUs in UHR TB PPDU with BW of 80/160/320MHz, the maximum DBW is 80 MHz.

For BW of 160MHz or 320MHz each 80MHz segment uses the same UHR-DLTF defined for 80MHz.

DRUs with DBW of 20 or 40MHz are allowed within each 80 MHz frequency subblock in cases where the 80MHz is either punctured or non-punctured but split as 20+20+40 or 40+20+20.

In a 20 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-DLTF located on subcarriers [-122:122] is given by Equation (38-xx1)

*UHR-DLTF-122,122* = (38-xx1)

{ 0, 0, -1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1, -1, +1, -1, -1, -1, -1, +1, -1,

 -1, +1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, -1, +1, +1, -1, +1, -1, +1, +1, -1,

 +1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, +1, +1, -1, +1, -1,

 +1, -1, +1, -1, -1, +1, -1, +1, +1, +1, +1, -1, +1, +1, -1, +1, -1, -1, -1, +1, +1,

 -1, +1, -1, -1, +1, -1, -1, -1, -1, -1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, +1,

 -1, +1, +1, -1, +1, +1, -1, +1, -1, +1, -1, +1, -1, -1, +1, -1, 0, 0, 0, -1, +1, -1,

 +1, -1, -1, +1, -1, -1, -1, +1, -1, +1, -1, -1, -1, +1, +1, +1, -1, +1, -1, -1, -1,

 -1, -1, -1, -1, -1, -1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, +1, +1, +1, +1, +1,

 -1, -1, +1, -1, -1, +1, +1, -1, -1, -1, -1, +1, -1, +1, +1, -1, -1, +1, +1, +1, -1,

 -1, +1, -1, -1, -1, -1, +1, -1, +1, +1, -1, -1, +1, -1, +1, +1, -1, +1, +1, -1, +1,

 +1, -1, +1, +1, -1, +1, -1, +1, -1, -1, +1, +1, -1, -1, -1, -1, +1, +1, +1, -1, -1,

 -1, -1, +1, -1, -1, -1, +1, +1, +1, -1, +1, 0, 0 }

In a 40 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-DLTF located on subcarriers [-244:244] is given by Equation (38-xx2)

*UHR-DLTF-244:244*=

{-1 1 -1 -1 -1 1 -1 -1 1 1 1 -1 1 1 1 1 1 1 1 -1 -1 1 1 -1 1 -1 -1 1 1 -1 -1 1 -1 1 -1 1 1 -1 1 1 1 1 -1 -1 1 -1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 1 1 -1 1 -1 -1 1 -1 1 -1 1 -1 1 1 1 1 1 1 -1 1 -1 -1 1 -1 -1 -1 -1 1 -1 -1 -1 1 -1 -1 1 -1 -1 -1 -1 -1 1 -1 1 -1 1 -1 1 1 -1 -1 -1 1 1 -1 -1 1 1 -1 -1 1 -1 1 -1 1 -1 1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 1 1 1 1 1 1 -1 -1 1 -1 -1 1 -1 -1 -1 -1 1 1 -1 -1 1 -1 1 -1 1 -1 -1 1 -1 1 1 1 1 1 1 1 1 -1 -1 1 -1 -1 1 -1 1 1 -1 1 1 1 1 1 -1 1 1 1 -1 1 -1 1 1 -1 -1 -1 -1 1 -1 -1 1 -1 1 1 1 -1 -1 -1 -1 1 -1 -1 1 1 -1 1 1 1 1 1 1 1 1 1 -1 1 1 1 1 -1 -1 1 -1 1 -1 1 -1 0 0 0 0 0 -1 -1 -1 -1 1 -1 1 -1 -1 1 -1 1 1 -1 -1 1 1 -1 1 1 1 -1 1 1 -1 1 1 -1 -1 -1 -1 1 -1 -1 -1 -1 -1 1 1 -1 1 1 1 -1 -1 -1 -1 -1 -1 -1 -1 1 -1 -1 1 -1 1 1 1 -1 1 -1 1 -1 -1 -1 -1 1 -1 1 1 -1 1 1 1 -1 -1 -1 -1 -1 1 1 -1 1 1 1 1 -1 -1 -1 1 1 1 1 -1 -1 1 -1 -1 -1 -1 1 -1 1 -1 -1 1 -1 -1 -1 -1 -1 1 -1 1 -1 1 1 1 -1 -1 1 -1 1 1 -1 -1 -1 1 -1 1 -1 1 -1 -1 -1 1 1 1 -1 -1 -1 -1 1 1 1 -1 1 -1 1 1 1 -1 -1 -1 1 1 1 1 -1 -1 1 1 -1 1 -1 -1 1 1 -1 1 -1 -1 -1 1 1 1 -1 1 1 -1 1 -1 1 -1 -1 1 1 1 1 -1 1 -1 1 1 1 1 -1 -1 -1 -1 -1 1 -1 -1 -1 -1 1 1 1 1 -1 -1 1 1 -1 1 1 1 1 -1 1 -1 1 1 -1 1 1 -1 -1 -1 -1 -1 1 -1 1 1 1 -1 -1 1 -1}

In an 80 MHz UHR TB PPDU transmission, the frequency domain sequence for UHR-DLTF located on subcarriers [-500:500] is given by Equation (38-xx3)

*UHR-DLTF-500,500* = (38-xx3)

{ 0, -1, +1, -1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, +1, -1, +1, -1,

+1, -1, +1, -1, +1, +1, -1, -1, +1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, +1, +1, -1, +1, +1,

+1, +1, -1, -1, +1, +1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, +1, -1, -1,

+1, -1, -1, -1, +1, -1, +1, +1, -1, -1, -1, -1, -1, -1, -1, -1, -1, -1, +1, +1, +1, -1, -1, +1, +1,

-1, +1, -1, -1, -1, +1, -1, +1, +1, +1, +1, -1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1,

-1, +1, +1, -1, +1, -1, -1, -1, +1, +1, -1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1, -1, -1, -1, +1,

+1, +1, -1, -1, +1, +1, -1, +1, +1, +1, +1, -1, -1, +1, +1, -1, -1, +1, -1, -1, +1, +1, -1, +1, -1,

-1, -1, +1, -1, +1, -1, -1, -1, +1, -1, +1, -1, -1, -1, -1, +1, +1, -1, -1, -1, +1, -1, +1, +1, -1,

+1, -1, +1, -1, +1, -1, -1, -1, +1, +1, +1, +1, +1, -1, -1, -1, +1, -1, +1, +1, -1, -1, -1, +1, -1,

-1, +1, +1, +1, +1, -1, -1, -1, +1, -1, -1, -1, -1, +1, +1, -1, -1, -1, -1, -1, -1, +1, +1, +1, +1,

+1, +1, +1, +1, +1, +1, -1, +1, +1, -1, +1, -1, +1, -1, -1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1,

+1, -1, +1, -1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, +1, -1, +1, -1, -1, -1, +1, -1, -1, -1,

+1, -1, -1, +1, -1, -1, -1, -1, +1, +1, +1, -1, +1, -1, +1, +1, -1, -1, +1, +1, -1, -1, +1, -1, +1,

-1, -1, -1, -1, -1, -1, +1, -1, -1, +1, -1, -1, -1, -1, -1, -1, -1, +1, -1, +1, +1, +1, +1, +1, +1,

-1, -1, +1, +1, +1, +1, -1, -1, -1, -1, +1, +1, +1, +1, -1, -1, -1, -1, -1, +1, +1, -1, +1, +1, -1,

-1, +1, -1, +1, -1, +1, +1, -1, -1, -1, -1, +1, +1, +1, +1, +1, -1, -1, +1, -1, +1, -1, -1, +1, -1,

+1, +1, -1, +1, -1, +1, -1, -1, +1, +1, -1, +1, -1, -1, -1, -1, -1, -1, -1, -1, +1, -1, +1, +1, +1,

-1, -1, +1, -1, -1, -1, -1, +1, -1, +1, +1, +1, -1, +1, +1, +1, -1, -1, -1, +1, +1, +1, +1, -1, +1,

-1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1, -1, -1, +1, -1, -1, +1, -1, -1, -1, +1, -1, -1, +1, -1,

-1, +1, +1, +1, -1, -1, -1, +1, +1, +1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,

 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, +1, -1, -1, -1, -1, +1, -1, +1, -1, +1, -1,

-1, +1, -1, +1, -1, -1, +1, +1, -1, +1, +1, -1, +1, -1, +1, +1, -1, +1, -1, +1, +1, +1, -1, +1, +1,

-1, -1, -1, +1, +1, -1, -1, -1, +1, +1, -1, +1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, +1, -1,

+1, +1, +1, -1, +1, -1, +1, -1, +1, -1, +1, +1, -1, -1, -1, -1, -1, -1, +1, +1, -1, -1, +1, +1, +1,

+1, -1, -1, +1, +1, +1, -1, +1, +1, -1, -1, -1, +1, +1, +1, -1, -1, +1, -1, +1, +1, -1, -1, -1, -1,

+1, -1, -1, -1, -1, -1, +1, -1, -1, -1, -1, -1, +1, +1, +1, +1, -1, -1, -1, -1, +1, +1, -1, +1, -1,

-1, +1, +1, +1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1, -1, +1, +1, +1, -1, +1, +1, -1, +1, +1, -1,

+1, +1, +1, -1, -1, -1, -1, +1, -1, +1, +1, +1, +1, -1, +1, -1, +1, -1, -1, +1, +1, +1, -1, +1, -1,

-1, +1, +1, -1, -1, +1, -1, +1, +1, -1, -1, +1, +1, +1, +1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1,

+1, -1, -1, +1, +1, -1, -1, +1, +1, +1, +1, -1, -1, +1, +1, +1, -1, -1, -1, -1, -1, -1, +1, +1, +1,

+1, -1, -1, -1, +1, +1, +1, -1, -1, +1, +1, +1, -1, +1, -1, +1, -1, +1, -1, -1, +1, -1, +1, -1, +1,

-1, +1, +1, +1, +1, -1, +1, +1, -1, -1, -1, -1, +1, -1, -1, +1, -1, -1, +1, -1, -1, -1, -1, +1, -1,

+1, -1, +1, -1, -1, -1, +1, -1, +1, -1, -1, -1, -1, -1, -1, -1, -1, -1, +1, -1, -1, -1, +1, +1, +1,

+1, +1, +1, -1, -1, +1, -1, +1, -1, -1, +1, -1, +1, -1, -1, +1, -1, +1, +1, +1, +1, +1, -1, -1, -1,

-1, +1, +1, +1, -1, -1, +1, +1, +1, +1, +1, +1, +1, -1, -1, +1, +1, -1, -1, +1, +1, -1, -1, -1, +1,

+1, -1, +1, +1, -1, -1, +1, -1, -1, -1, -1, +1, -1, +1, +1, -1, -1, +1, +1, -1, -1, +1, +1, -1, +1,

-1, -1, -1, +1, +1, +1, -1, +1, -1, +1, -1, -1, +1, -1, -1, +1, -1, +1, -1, +1, +1, -1, +1, -1, -1,

-1, -1, +1, +1, -1, +1, +1, +1, -1, +1, +1, +1, +1, +1, +1, -1, -1, -1, +1, -1, -1, -1, -1, -1, -1,

+1, -1, -1, -1, -1, -1, +1, +1, -1, +1, -1, +1, +1, -1, -1, -1, -1, -1, +1, -1, -1, +1, +1, +1, -1,

-1, +1, +1, -1, +1, -1, +1, -1, +1, +1, +1, +1, -1, -1, -1, -1, -1, +1, -1, -1, -1, +1, -1}

# 38.3.3 Transmission of DRU

Distributed tone RUs (DRU) are defined in UHR to overcome PSD limitations and boost the transmit power by spreading its tones in a certain distribution bandwidth (DBW). A DRU transmission is allowed only in an OFDMA UHR TB PPDU to maximize the power boost gain of each DRU and UL MU MIMO is disallowed for a DRU transmission. Also, the maximum number of spatial streams allowed in a DRU transmission is two.

For a 20MHz TB PPDU, the DBW is 20MHz only.

For a 40MHz TB PPDU, the DBW is 40MHz only.

For a 80MHz frequency subblock without preamble puncturing, the DBW can be 20 MHz or 40MHz or 80MHz.

For an 80 MHz UHR TB PPDU without preamble puncturing, two DBW modes combining two 20 MHz DBWs and one 40 MHz DBW are allowed. One mode is that 20 MHz DBWs are applied to the lowest and the second lowest 20 MHz subchannels and 40 MHz DBW is applied to the highest 40 MHz subchannel. The other mode is that 20 MHz DBWs are applied to the highest and the second highest 20 MHz subchannels and 40 MHz DBW is applied to the lowest 40 MHz subchannel. In these DBW modes, 20 MHz and 40 MHz DRU tone plans (see 38.3.3.3 Tone Plan for DRU) are used for 20 MHz and 40 MHz DBWs, respectively, by applying constant tone shifts (see 38.3.3.3 Tone Plan for DRU) to align tone indices.

For an 80 MHz UHR TB PPDU with 20 MHz preamble puncturing, a DBW mode combining one 20 MHz DBW and one 40 MHz DBW is allowed depending on the location of the punctured 20 MHz subchannel. If the lowest 20 MHz subchannel is punctured, 20 MHz and 40 MHz DBWs are applied to the second lowest 20 MHz subchannel and the highest 40 MHz subchannel, respectively. If the second lowest 20 MHz subchannel is punctured, 20 MHz and 40 MHz DBWs are applied to the lowest 20 MHz subchannel and the highest 40 MHz subchannel, respectively. If the second highest 20 MHz subchannel is punctured, 20 MHz and 40 MHz DBWs are applied to the highest 20 MHz subchannel and the lowest 40 MHz subchannel, respectively. If the highest 20 MHz subchannel is punctured, 20 MHz and 40 MHz DBWs are applied to the second highest 20 MHz subchannel and the lowest 40 MHz subchannel, respectively. In these DBW modes, 20 MHz and 40 MHz DRU tone plans (see 38.3.3.3 Tone Plan for DRU) are used for 20 MHz and 40 MHz DBWs, respectively, by applying constant tone shifts (see 38.3.3.3 Tone Plan for DRU) to align tone indices.

For an 80 MHz UHR TB PPDU with the highest 20 MHz preamble puncturing, 60 MHz DBW is allowed and the 60 MHz DRU tone plan (see 38.3.3.3 Tone Plan for DRU) is used.

For a 160 MHz UHR TB PPDU and a 320 MHz UHR TB PPDU, in a certain 80 MHz frequency subblock without preamble puncturing, 80 MHz DBW is allowed and the 80 MHz DRU tone plan (see 38.3.3.3 Tone Plan for DRU) is used by applying constant tone shifts (see 38.3.3.3 Tone Plan for DRU) to align tone indices.

For a 160 MHz UHR TB PPDU and a 320 MHz UHR TB PPDU, in a certain 80 MHz frequency subblock with 20 MHz preamble puncturing, a DBW mode combining one 20 MHz DBW and one 40 MHz DBW is allowed depending on the location of the punctured 20 MHz subchannel. If the lowest 20 MHz subchannel of the 80 MHz frequency subblock is punctured, 20 MHz and 40 MHz DBWs are applied to the second lowest 20 MHz subchannel and the highest 40 MHz subchannel, respectively, in the 80 MHz frequency subblock. If the second lowest 20 MHz subchannel of the 80 MHz frequency subblock is punctured, 20 MHz and 40 MHz DBWs are applied to the lowest 20 MHz subchannel and the highest 40 MHz subchannel, respectively, in the 80 MHz frequency subblock. If the second highest 20 MHz subchannel of the 80 MHz frequency subblock is punctured, 20 MHz and 40 MHz DBWs are applied to the highest 20 MHz subchannel and the lowest 40 MHz subchannel, respectively, in the 80 MHz frequency subblock. If the highest 20 MHz subchannel of the 80 MHz frequency subblock is punctured, 20 MHz and 40 MHz DBWs are applied to the second highest 20 MHz subchannel and the lowest 40 MHz subchannel, respectively, in the 80 MHz frequency subblock. In these DBW modes, 20 MHz and 40 MHz DRU tone plans (see 38.3.3.3 Tone Plan for DRU) are used for 20 MHz DBWs and 40 MHz DBW, respectively, by applying constant tone shifts (see 38.3.3.3 Tone Plan for DRU) to align tone indices.

For a 160 MHz UHR TB PPDU and a 320 MHz UHR TB PPDU, in a certain 80 MHz frequency subblock with the highest 20 MHz preamble puncturing, 60 MHz DBW is allowed and the 60 MHz DRU tone plan (see 38.3.3.3 Tone Plan for DRU) is used by applying constant tone shifts (see 38.3.3.3 Tone Plan for DRU) to align tone indices.

For a 160 MHz UHR TB PPDU and a 320 MHz UHR TB PPDU, in a certain 80 MHz frequency subblock with 40 MHz preamble puncturing, 40 MHz DBW is allowed in the non-punctured 40 MHz subchannel of the 80 MHz frequency subblock and 40 MHz DRU tone plan (see 38.3.3.3 Tone Plan for DRU) is used by applying constant tone shifts (see 38.3.3.3 Tone Plan for DRU) to align tone indices.

For a 160 MHz UHR TB PPDU and a 320 MHz UHR TB PPDU, a hybrid mode where DRUs and Regular RUs (RRUs) are simultaneously used in one UHR TB PPDU is allowed. For a UHR TB PPDU with the hybrid mode, either DRU or RRU are used within each 80 MHz frequency subblock and DRUs and RRUs are not mixed within a certain 80 MHz frequency subblock. The minimum RRU size is 242 in the hybrid mode.

The smallest size of a DRU is 26 and the largest size of a DRU is 106 in the 20MHz distribution BW. The smallest size of a DRU is 26 and the largest size of a DRU is 242 in the 40MHz distribution BW. The smallest size of DRU is 52 and the largest size of a DRU is 484 in the 80MHz distribution BW.

**9.3.1.22 Trigger frame format**

The UHR variant Common Info field is defined in Figure 9-90x (UHR variant Common Info field format).

B0

B3

Trigger Type

UL Length

More TF

CS Required

GI and HE/EHT-LTF/UHR-LTF Type/TXS Mode

Reserved

Number of HE/EHT-LTF /UHR-LTF Symbols

UL BW

B4

B15

B16

B17

B18

B19

B20

B21

B22

B23

B25

Bits:

4

12

1

1

2

2

1

3

B27

B35

B37

B52

Reserved

LDPC Extra Symbol Segment

AP Tx Power

PE Disambiguity

UL Spatial Reuse

Reserved

Pre-FEC Padding Factor

Bits:

1

1

6

2

1

1

16

1

HE/EHT P160

Special User info Field Flag

1

B54

B54

B56

B62

B63

B59

B60

B55

DRU/RRU Indication

Reserved

UHR Reserved

Bits:

4

3

1

variable

Trigger Dependent Common Info

B53

B36

B28

B33

B34

B26

 Figure 9-90x⎯ UHR variant Common Info field format

The DRU/RRU Indication subfield indicates whether distributed RU (DRU) or regular RU (RRU) transmission is solicited in each 80 MHz frequency subblock. The format of DRU/RRU Indication subfield is defined in Figure 9-90y (DRU/RRU Indication subfield format). If UL BW is 80 MHz, then B1-B3 in the DRU/RRU Indication subfield are reserved. If UL BW is 160 MHz, then B2-B3 in the DRU/RRU Indication subfield are reserved. To solicit a UHR TB PPDU using DRU transmission in an 80 MHz frequency subblock, the corresponding bit in the DRU/RRU Indication subfield is set to 1. Otherwise, it is set to 0.

B0

B2

DRU/RRU Indication for the lowest 80 MHz frequency subblock

DRU/RRU Indication for the second lowest 80 MHz frequency subblock

DRU/RRU Indication for the second highest 80 MHz frequency subblock

DRU/RRU Indication for the highest 80 MHz frequency subblock

B3

B1

1

1

1

1

Bits:

Bits:

 Figure 9-90y⎯ DRU/RRU Indication subfield format

9.3.1.22.x UHR variant User Info field

If the RU Allocation of the User Info field indicates the assigned RU is located in an 80 MHz frequency subblock where DRU transmission is solicited, the SS Allocation subfield of the UHR variant User Info field for DRU transmission is further divided into three subfields to indicate DRU distribution BW and the spatial streams of the solicited UHR TB PPDU, as shown in Figure 9-90z (SS Allocation subfield format of a UHR variant User Info field for DRU transmission)

B3

B2

B1

B0

2

2

Reserved

B4

1

Bits:

Number of Spatial Streams

DRU Distribution BW

Figure 9-90z⎯ SS Allocation subfield format of a UHR variant User Info field for DRU transmission

The DRU Distribution BW subfield is encoded as follows:

⎯ 0 for distribution BW 20 MHz

⎯ 1 for distribution BW 40 MHz

⎯ 2 for distribution BW 80 MHz

⎯ 3 Reserved

The Number of Spatial Streams subfield indicates the number of spatial streams, and is set to the number of spatial streams minus 1.