**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | TFD of NB CCA for assisting UWB channel access |
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| Re: | Contribution to IEEE 802.15.4ab  |
| Abstract |  |
| Purpose | This submission proposes text to for the IEEE Std 802.15.4ab specification framework document.  |
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*… …*

*In the following, the original text of IEEE 802.15.4-2020 is shown in blue whereas the proposed add-on texts are shown in black.*

**10.2.8 Clear channel assessment (CCA)**

**… …**

An HRP UWB PHY shall implement one CCA Mode 1 through CCA Mode 4 or one of the following methods:

… …

* *CCA Mode 5: HRP UWB preamble sense based on the SHR of a frame.* CCA shall report a busy medium upon detection of a preamble symbol as specified in 15.2.6. An idle channel shall be reported if no preamble symbol is detected up to a period not shorter than the maximum packet duration plus the maximum period for acknowledgment.
* *CCA Mode 6: HRP UWB preamble sense based on the packet with the multiplexed preamble as specified in 15.6.* CCA shall report a busy medium upon detection of a preamble symbol as specified in 15.2.6.
* *CCA Mode 7: UWB medium access coupled with CCA of narrow-band assisted PHY (NBA-PHY) as specified in Clause X.* Transmission of NB radio and NB CCA conducted by the coupled NBA-PHY are used to indicate the UWB-PHY medium access status. NB CCA shall report a busy UWB medium upon detection of the NB radio as specified in Clause X.

**… …**

***Clause X* O-QPSK PHY for NB CCA for assisting UWB channel access**

To use CCA mode 7 as defined in 10.2.8, a compliant device should contain a UWB PHY and a coupled NBA-PHY that are operated with a same or synchronized clock. One out of the next two O-QPSK PHYs can be used as the NBA-PHY for NB CCA for assisting UWB channel access. The first is the O-QPSK PHY operated at UNII-3 band or UNII-5 (if UNII-3 is not available, e.g., Japan) band as defined in NBA TFD. The second is the O-QPSK PHY operated at 915 MHz band as defined in Clause 21 of IEEE 802.15.4-2020 using the chosen parameters given in X.1. Use of the above two O-QPSK PHYs depends on local regulations.

X.1 O-QPSK at 915 MHz band

The channelization parameters of O-QPSK PHY operated at 915 MHz band are as follows.

* Frequency band: 902.1 – 927.9 MHz
* Channel spacing: 0.2 MHz
* Total number of channels: 129
* Center frequency: $f\_{k}=f\_{0}+k×0.2, \left(k=0, 1, \cdots ,128\right)$ [MHz]

$f\_{0}=902.2$ [MHz]

Among different combinations of parameters of O-QPSK at 915 MHz band in Clause 21 of IEEE 802.15.4-2020, the modulation diagram shown in Figure. X-1 as well as the coding and spreading parameters given in Table X-1 are chosen for NBA PHY for NB CCA for assisting UWB channel access.



Figure X-1 Modulation diagram

Table X-1 Coding and Spreading parameters

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Chip rate** **(kchips/s)** | **Spreading mode** | **coding** |
| SHR | 1000 | (64, 1)-DSSS | BDE |
| PHR | 1000 | (16, 1)0/1-DSSS | BDE and rate ½ FEC+interleaver |
| PSDU | 1000 | (16, 1)0/1-DSSS |

The following half-sine pulse shape is chosen as modulation pulse shape.

 $\begin{array}{c}p\left(x\right)=\left\{\begin{array}{c}sin\left(\frac{πt}{2T\_{c}}\right), \&0\leq t<2T\_{c}\\0 , \&otherwise\end{array}\right.\#\left(X-1\right)\end{array}$

All other parameters except for the above are the same as those defined in Clause 21 of IEEE 802.15.4-2020.

X.2 NB CCA for UWB channel access

When a compliant device intends to access a UWB channel, it shall perform NB CCA using the NBA-PHY against a NB channel[[1]](#footnote-1) which is paired with the intended UWB channel. The listening duration for NB CCA shall be at least 9us. The ED Threshold (EDT) level is proportional to the device’s maximum configured transmit power (Pmax) :

For Pmax ≤ 14 dBm: EDT = -75 dBm/MHz

For 14 dBm < Pmax ≤ 24 dBm: EDT = -85 dBm/MHz + (24 dBm - Pmax)

For Pmax ≥ 24 dBm: EDT = -85 dBm/MHz

The EDT levels defined above are absolute levels that apply at all times. When a compliant device obtains channel access right and intends to send UWB signal at a UWB channel, it should also send a NB signal at a single NB channel which is paired with the intended UWB channel to declare UWB medium occupancy. UWB channel $i$ ($i=0, 1, 2, \cdots , 15$ ) of Table 10-9 is respectively paired to NB channels using the following formulas, where the channel orders are adjusted so that the two NB channels paired to UWB ch5 and ch9 have maximum frequency separation.

* UNII-3 band

$$\begin{array}{c}\left\{\begin{matrix}\begin{matrix}f\_{i+j×16}=5726.25+i×2.5+j×40;&0\leq i\leq 8\\f\_{i+j×16}=5726.25+(i+4)×2.5+j×40;&9\leq i\leq 11\\f\_{i+j×16}=5726.25+(i-3)×2.5+j×40;&12\leq i\leq 15\end{matrix}&j=0, 1, 2\end{matrix}\right.\#\left(X-2\right)\end{array}$$

* UNII-5 band[[2]](#footnote-2)

$$\begin{array}{c}\left\{\begin{matrix}\begin{matrix}f\_{i+j×32}=5993.75+(i+76)×2.5+j×80;&0\leq i\leq 8\\f\_{i+j×32}=5993.75+(i+80)×2.5+j×80;&9\leq i\leq 11\\f\_{i+j×32}=5993.75+(i+73)×2.5+j×80;&12\leq i\leq 15\end{matrix}&j=0, 1, 2, \cdots ,5\end{matrix}\right.\#\left(X-3\right)\end{array}$$

* 915 MHz band

$$\begin{array}{c}\left\{\begin{matrix}\begin{matrix}f\_{i+j×16}=902.2+i×0.2+j×3.2;&0\leq i\leq 8\\f\_{i+j×16}=902.2+(i+4)×0.2+j×3.2;&9\leq i\leq 11\\f\_{i+j×16}=902.2+(i-3)×0.2+j×3.2;&12\leq i\leq 15\end{matrix}&j=0, 1, 2, \cdots ,7\end{matrix}\right.\#\left(X-4\right)\end{array}$$

where, *j* represents the number of channel groups. There are respectively 3 groups at UNII-3 band, 6 groups at UNII-5 band, and 8 groups at 915 MHz band. Each group consists of 16 NB channels. Selection of groups depends on availability of local regulation and on the order of group number. If multiple groups are allowed, then the smallest one shall be used., Only one group is used for NB CCA. Details of pairing between UWB channels and NB channels are given in Table X-2.

Table X-2 Channel pairing between UWB channels and NB channels

|  |  |  |  |
| --- | --- | --- | --- |
| UWB channel number (Table 10-9) | Channel number @UNII-3 band($j=0, 1, 2$) | Channel number @UNII-5 band[if UNII-3 is not available due to regulatory constraints]($j=0, 1, 2, \cdots ,5$) | Channel number @915 MHz band($j=0, 1, 2, \cdots ,7$) |
| 0 | $$f\_{0+j×16} $$ | $$f\_{76+j×32}$$ | $$f\_{0+j×16}$$ |
| 1 | $$f\_{1+j×16}$$ | $$f\_{77+j×32}$$ | $$f\_{1+j×16}$$ |
| 2 | $$f\_{2+j×16}$$ | $$f\_{78+j×32}$$ | $$f\_{2+j×16}$$ |
| 3 | $$f\_{3+j×16}$$ | $$f\_{79+j×32}$$ | $$f\_{3+j×16}$$ |
| 4 | $$f\_{4+j×16}$$ | $$f\_{80+j×16}$$ | $$f\_{4+j×16}$$ |
| 5 | $$f\_{5+j×16}$$ | $$f\_{81+j×32}$$ | $$f\_{5+j×16}$$ |
| 6 | $$f\_{6+j×16}$$ | $$f\_{82+j×32}$$ | $$f\_{6+j×16}$$ |
| 7 | $$f\_{7+j×16}$$ | $$f\_{83+j×32}$$ | $$f\_{7+j×16}$$ |
| 8 | $$f\_{8+j×16}$$ | $$f\_{84+j×32}$$ | $$f\_{8+j×16}$$ |
| 9 | $$f\_{13+j×16}$$ | $$f\_{89+j×32}$$ | $$f\_{13+j×16}$$ |
| 10 | $$f\_{14+j×16}$$ | $$f\_{90+j×32}$$ | $$f\_{14+j×16}$$ |
| 11 | $$f\_{15+j×16}$$ | $$f\_{91+j×32}$$ | $$f\_{15+j×16}$$ |
| 12 | $$f\_{9+j×16}$$ | $$f\_{85+j×32}$$ | $$f\_{9+j×16}$$ |
| 13 | $$f\_{10+j×16}$$ | $$f\_{86+j×32}$$ | $$f\_{10+j×16}$$ |
| 14 | $$f\_{11+j×16}$$ | $$f\_{87+j×32}$$ | $$f\_{11+j×16}$$ |
| 15 | $$f\_{12+j×16}$$ | $$f\_{88+j×32}$$ | $$f\_{12+j×16}$$ |

The minimum NB CCA sending duration for assisting UWB medium access is 24 NB symbols. The UWB medium occupancy start time is declared by sending the NB signal pattern (start-time pattern) shown in Figure. X-2. The UWB medium occupancy end time is declared by sending the NB signal pattern (end-time pattern) shown in Figure. X-3.



Figure X-2 Start-time pattern of UWB channel occupancy



Figure X-3 END-time pattern of UWB channel occupancy

Transmission of start-time pattern should start at the same time, within 1us, as transmission of UWB signal at the pairing UWB channel. Transmission of end-time pattern should end at the same time, within 1us, as the pairing UWB transmission. If a compliant device sensed the start-time pattern, it shall not further contend for channel access until it senses the end-time pattern. If a compliant device senses the end-time pattern, it can start or resume contending for the channel.

**References**

[1] Draft ETSI EN 303687 v1.0.0 (2022-04) 6GHz WAS/RLAN; Harmonised Standard for access to radio spectrum

1. Under ETSI standard, the CCA shall be performed over a 20 MHz bandwidth, where the center frequency of the 20 MHz channel is given by fc = 5 935 + (nch × 20) MHz where nch is an integer and 1 ≤ nch ≤ 24 [1]. [↑](#footnote-ref-1)
2. The NB channels are selected to avoid the preferred scanning channel (PSC) Wi-Fi channels at 6 GHz. [↑](#footnote-ref-2)