**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) |
| Title | Text to address comment id r1-0900 |
| Date Submitted | 19 September 2019 |
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| Re: | Contribution to TG4z for IEEE 802.15.4z to address the indicated LB161 comment  |
| Abstract | Contribution to TG4z amendment of IEEE Std 802.15.4-2015 |
| Purpose | This submission is intended to address the indicated LB161 comment on draft 2 of the 802.15.4z amendment. This text herein is intended to be as ready as possible to integrate into IEEE Std 802.15.4z draft amendment to IEEE Std 802.15.4.  |
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| EXTRA NOTE(s): This submission provides text intended to be ready to integrate directly into the 802.15.4z draft. |

**BACKGROUND:**

Comment ID: **r1-0820** (as nominated in 15-19-0397).

Comment: 802.15.4z HRP PHY should not use the reference pulse designed for 802.15.4a. The reference pulse should not have a pre-cursor and instead, the minimum phase version of this pulse should be used. Definition from 802.15.4a allows for constructions of pulses which have too high pre-cursors which could result in inaccurate ranging measurement (reduced distance) and possibly having consequences for "enhanced/authenticated ranging".

Discussion:

For ranging, determining the arrival time of the signal as accurately as possible is a key goal. In general, this is done by estimating a channel impulse response which is essentially the transmitted pulse as shaped and distorted by the channel. In the case of non-line-of-sight channels the direct path is typically attenuated and may be substantially weaker than some of the reflected paths. A key performance metric then is the ability to detect the attenuated direct first path signals that arrive earlier that the stronger reflected signals. A pulse shape that has pre-cursers is problematical because the reflected precursors can mask the weaker attenuated first path signal. The solution is simple, use a pulse shape without such precursors.

This contribution provides a recommended pulse shape for UWB PHY RDEV usage, specifying the time domain mask in the text along with a table to cover the various HRP UWB PHY channel bandwidths and an associated figure showing the mask and some compliant example pulses. As specified the recommendation will allow detection of weak first paths up to 35 dB more attenuated than a subsequent echo path.

This submission provides (on the next page) text with accompanying editorial instructions intended to be ready to integrate directly into the 802.15.4z draft.

**16.4.5 Baseband impulse response**

***Insert at the end of subclause 16.4.5 the following text and figure:***

For accurate ranging performance it is recommended that the transmitted pulse shape *p(t)* be constrained by the time domain mask specified in Figure 1. The risetime of the pulse, *Tr*, is defined as the time taken for the amplitude of the pulse to go from 10 % to 90 % of the first peak amplitude. The first peak amplitude is defined as the maximum amplitude of the pulse before it first drops more than 1.25 % below any previous amplitude. The pulse amplitude should not exceed this first peak amplitude, at any point, by more than 5 %. Before the pulse amplitude reaches +10 % it should not drop below -1.25 % of the first peak amplitude, i.e., it should not go negative by more than this amount with respect to the first peak amplitude. The maximum *Tr* should be equal to the value given for the channel number in Table 1 the following table.

**Table 1—Recommended maximum pulse risetime**

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| --- | --- |
| **Channel Number**  | **Maximum Pulse risetime, *Tr*****(ns)** |
| {0:3, 5:6, 8:10, 12:14} | 2.00 |
| 7 | 0.92 |
| {4, 11} | 0.75 |
| 15 | 0.74 |



**Figure 1—Recommended time domain mask for the HRP UWB PHY pulse**

***[END]***