**IEEE P802.15**

**Wireless Personal Area Networks**

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| Project | IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs) | |
| Title | Proposed pulse shape text changes for HRP UWB PHY | |
| Date Submitted | 25 February 2020 | |
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| Re: | Contribution to TG4z for IEEE 802.15.4z regarding pulse shape | |
| Abstract | Contribution to TG4z amendment of IEEE Std 802.15.4-2015 | |
| Purpose | This submission proposes text to for the 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 / INTRODUCTION:**

We proposed a pulse shape mask for improved ranging performance in 15-19-0443-01-004z, which was integrated into D3 of 802.15.4z but later reduced to a simple paragraph in D4 that has remained unchanged trough into D6.

Now a comment submitted into the SA ballot recirculation # 1 and contribution 15-20-0084-00-004z have opened up the topic for reconsideration.

The following outlies our view of this topic and goes on to propose text changes to the 4z draft corresponding to this view.

**OUR VIEW:**

We still are of the view that a the precursor free pulse is the best, but recognise that there is an implementation out there with precursors, and so see a merit in knowing the pulse shape at least as in the shape of its precursors so that a receiver could use that information to ignore the precursors and get a better first path estimation, a key metric for an *enhanced ranging device* (ERDEV), or at the very least know that the estimate may be errored and report the FoM accordingly.

With that in mind we propose to specify a shape constraint for the pulse precursors and a mask constraining the precursor free pulse, and additionally a means to communicate or identify which is being employed in the TX to allow appropriate RX measures to be implemented if possible.

The appropriate text changes to the draft are captured below….

**16.4.5 Baseband impulse response**

***Change the text of P802.15.4z-D6 as shown:***

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

To help with interoperability in ranging scenarios, it is recommended that the RDEV supports a mode in which the transmitted pulse exhibits minimum precursor energy. In Figure 16-13, the middle pulse has precursors while the left-hand pulse has no precursors. Note that this is not suggesting that either of these particular pulses are recommended.

***And, insert the following new text, table and figure after the above D6 paragraph:***

It is further recommended that some method, e.g. an out-of-band means or some upper layer message, is used to indicate whether an ERDEV's transmitter is employing a minimum precursor pulse or a pulse with precursors. This information might be used by receiving ERDEVs to improve the accuracy of their RMARKER arrival estimates of the reported FoM value.

In this case where the transmitted pulse follows the mathematical formula of the reference root raised cosine pulse r(t) the constraint should be a roll-off factor of beta=0.45, and a deviation less than 1 % over the critical pulse span as per the equation:

|p(t) – r(t, beta=0.45)| / max(|r(t)|) < 0.01, for all t = -3.5 ns to 0 ns, where 0 ns is the pulse peak amplitude.

Or, where the transmitted pulse follows the minimum precursor pulse recommendation the transmitted pulse shape *p(t)* should be constrained by the time domain mask of Figure 1. Where: the risetime, *Tr*, is defined as the time taken for the amplitude of the pulse to go from 10 % to 90 % of the first peak amplitude, and the maximum *Tr* is less than or equal to the value given for the channel number in Table 1; 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 does not exceed this first peak amplitude, at any point, by more than 5 %, and 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.



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

**Table 1—Recommended maximum pulse risetime**

|  |  |
| --- | --- |
| **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 |

***[END]***