#### July 2022 doc.: IEEE 802.15-22-0353-00-0thz-Inter-Carrier Interference for IEEE 802.15.3d Multiband Transmission

#### **Project: IEEE P802.15 Working Group for Wireless Speciality Networks (WSN)**

Submission Title: Inter-Carrier Interference for IEEE Std 802.15.3d Multiband Transmission

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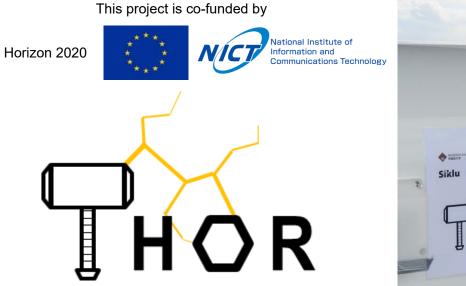
**Re:** n/a

**Abstract:** This document describes a simulation study on potential intercarrier interference when aggregating up to four channels in IEEE Std 802.15.3d

**Purpose:** Information of SC THz

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#### Inter-Carrier Interference for IEEE 802.15.3d Multiband Transmission

Influence of the transmit pulse on the bit error rate

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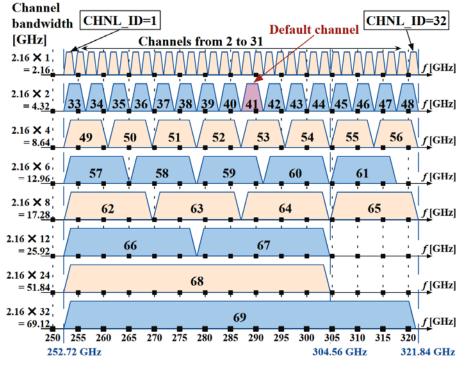
## **Multiband Transmission with IEEE 802.15.3d**

H2020 ThoR project demonstrates a multiband transmission for wireless backhaul links [1]

IEEE 802.15.3d defines channels with a bandwidth from 2.16 GHz to 69.12 GHz

Transmit power spectrak density (PSD) mask prevents intercarrier interferecen (ICI)

Which transmit pulses comply with the defined transmit spectral mask of IEEE 802.15.3d?



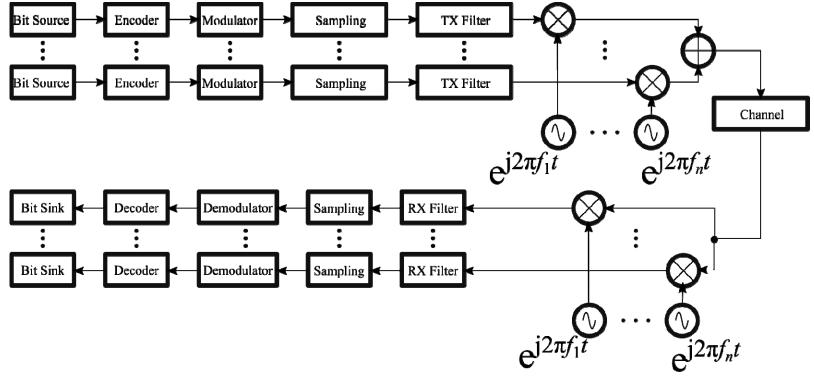
IEEE 802.15.3d channel plan [2] (© 2020 IEEE, reproduced with permission)



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## Link Level Simulations with SiMoNe

- Link level simulator in SiMoNe [3] was extended by a multi-carrier mode
- Independently configurable subcarriers can be transmitted in parallel





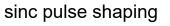
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## Spectrum of RECT and SINC pulse

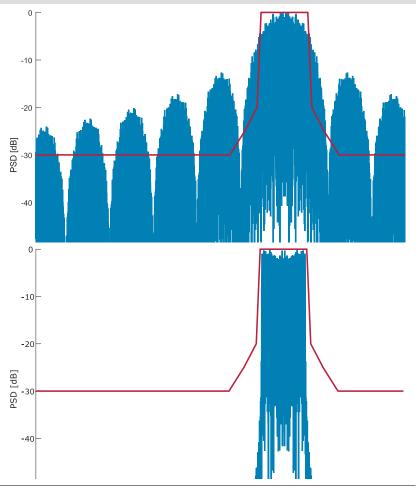
2.16 GHz channel, 1.76 GBd symbol rate

rectangular pulse shaping

- High inter-carrier interference
- IEEE 802.15.3d transmit spectral mask in red



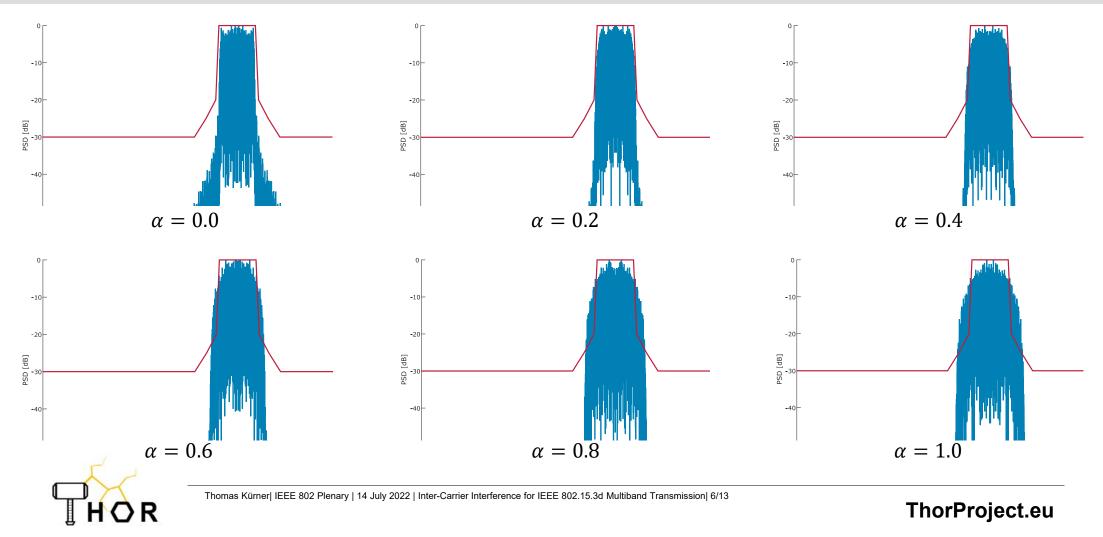
- Pulse duration corresponds to 128 times of the symbol duration
- No practical use





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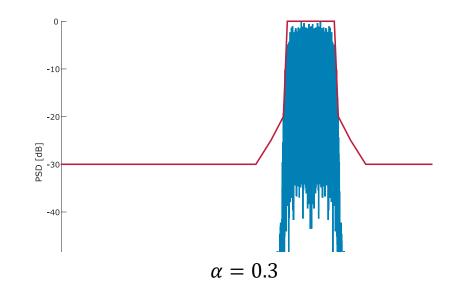
## Spectrum of RRC pulse with different roll-off factor $\alpha$



## Spectrum of RRC pulse with different roll-off factor $\alpha$

 $\alpha > 0.3$  does not comply with the power spectrum masks anymore

How does the transmit pulse affect the bit error rate?

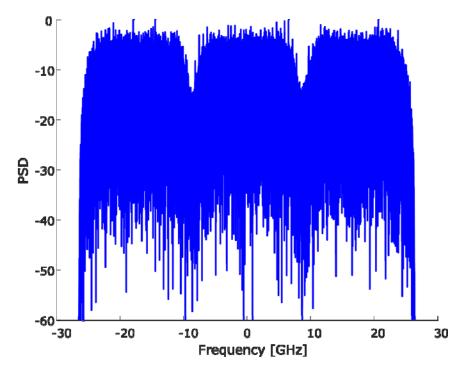




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## **Multiband configuration**

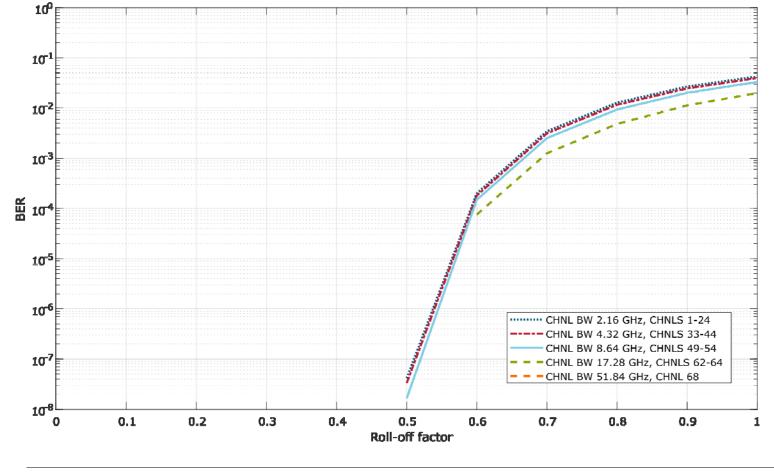
- Channel IDs 1-24, 33-44, 49-54, 62-64, 68
- Subcarrier symbol rates 1.76 GBd, 3.52 GBd, 7.04 GBd, 14.08 GBd, 42.24 GBd
- 16-QAM modulation
- No channel coding
- Perfect channel without AWGN
- RRC pulse with different roll-off factors
- 10 Mbit transmitted



Exemplary PSD of CHNL IDs 62-64



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#### **Bit error rate from inter-carrier interference**

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## **Bit error rate**

ROF / CHNL BW	2.16 GHz	4.32 GHz	8.64 GHz	17.28 GHz	51.84 GHz
0	0	0	0	0	0
0.1	0	0	0	0	0
0.2	0	0	0	0	0
0.3	0	0	0	0	0
0.4	0	0	0	0	0
0.5	$4.15 \cdot 10^{-8}$	$3.31 \cdot 10^{-8}$	$1.64 \cdot 10^{-8}$	0	0
0.6	$2.01\cdot 10^{-4}$	$1.81 \cdot 10^{-4}$	$1.49 \cdot 10^{-4}$	$7.55 \cdot 10^{-5}$	0
0.7	$3.5 \cdot 10^{-3}$	$3.1 \cdot 10^{-3}$	$2.5 \cdot 10^{-3}$	$1.3 \cdot 10^{-3}$	0
0.8	$1.3 \cdot 10^{-2}$	$1.2 \cdot 10^{-2}$	$9.3 \cdot 10^{-3}$	$4.8 \cdot 10^{-3}$	0
0.9	$2.7 \cdot 10^{-2}$	$2.5 \cdot 10^{-2}$	$2.0 \cdot 10^{-2}$	$1.1 \cdot 10^{-2}$	0
1.0	$4.3 \cdot 10^{-2}$	$4.0 \cdot 10^{-2}$	$3.3 \cdot 10^{-2}$	$2.0 \cdot 10^{-2}$	0



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## Conclusion

- Transmit spectral mask prevents inter-carrier interference
- Root-raised cosine with roll-off factor < 0.3 agrees with the transmit spectral mask</li>
- Roll-off-factors > 0.4 lead to inter-carrier interference



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### References

#### [1] https://thorproject.eu/

[2] V. Petrov, T. Kürner and I. Hosako, "IEEE 802.15.3d: First Standardization Efforts for Sub-Terahertz Band Communications toward 6G," in IEEE Communications Magazine, vol. 58, no. 11, pp. 28-33, 2020.

[3] J. M. Eckhardt, C. Herold, B. K. Jung, N. Dreyer and T. Kürner, ``Modular link level simulator for the physical layer of beyond 5G wireless communication systems," Radio Science, vol. 57, no. 2, e2021RS007395, 2022.



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# Thank you for your attention! ご清聴ありがとうございました



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Horizon 2020



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