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doc.: IEEE 802.15-17-0038-01-003d proposal for a spectrum mask

Project: IEEE P802.15 Working Group for Wireless Personal Area Networks (WPANs)

Submission Title: Proposal for a spectrum mask

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Source: Thomas Kürner, TU Braunschweig

E-Mail: kuerner@ifn.ing.tu-bs.de

Re: n/a

Abstract: This document provides a proposal for a spectrum mask for inclusion in the draft standard IEEE 802.15.3d

Purpose: Discussion document for the TG 3d

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Proposal for a spectrum mask in IEEE P802.15.3d

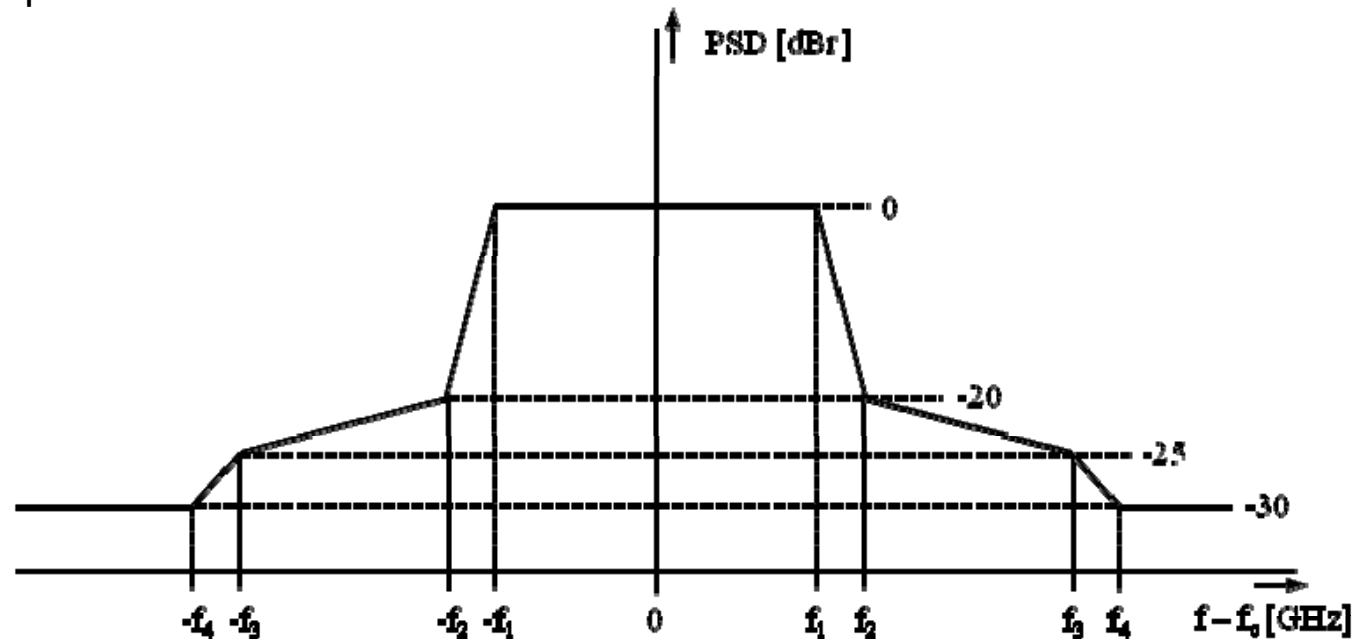
Sebastian Rey, Thomas Kürner
TU Braunschweig

Outline

- Proposed spectrum mask
- Compare the spectrum of the transmitted signal with the spectrum mask
- Compare a bandlimited signal with the spectrum mask

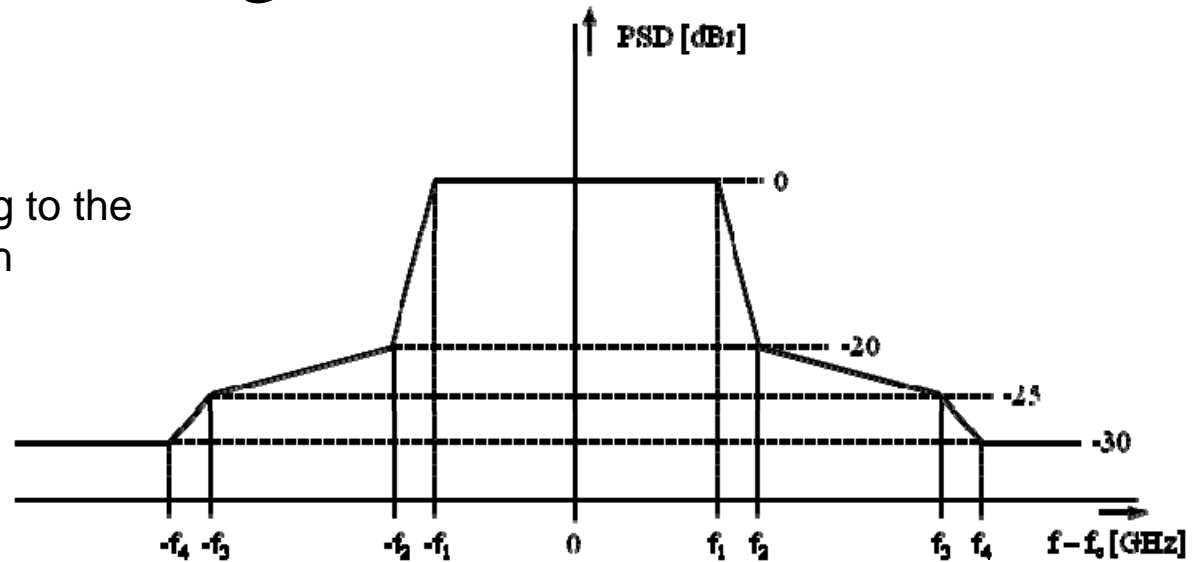
Definition of a generic PSD mask

- Defining a spectrum mask is a regulatory task.
- Currently, no mask available
- A generic mask is proposed following the concept of TG3e with bandwidth-specific parameters



Definition of a generic PSD mask

- Proposal:
 - Adapt f_1 according to the channel bandwidth
 - $f_2 = f_1 + a$
 - $f_3 = f_1 + b$
 - $f_4 = f_1 + c$



- Comparison with 3e and 3c:
 - $f_1 = 0.94 \text{ GHz} = \text{bandwidth}/2 - 0.14 \text{ GHz} = 2.16 \text{ GHz}/2 - 0.14 \text{ GHz}$
 - Proposal : $f_1 = \text{bandwidth}/2 - 0.14 \text{ GHz}$ for each possible bandwidth
 - $f_2 = 1.1 \text{ GHz} = f_1 + a = f_1 + 0.16 \text{ GHz}$
 - $f_3 = 1.6 \text{ GHz} = f_1 + b = f_1 + 0.66 \text{ GHz}$
 - $f_4 = 2.2 \text{ GHz} = f_1 + c = f_1 + 1.26 \text{ GHz}$

What does the spectrum look like?

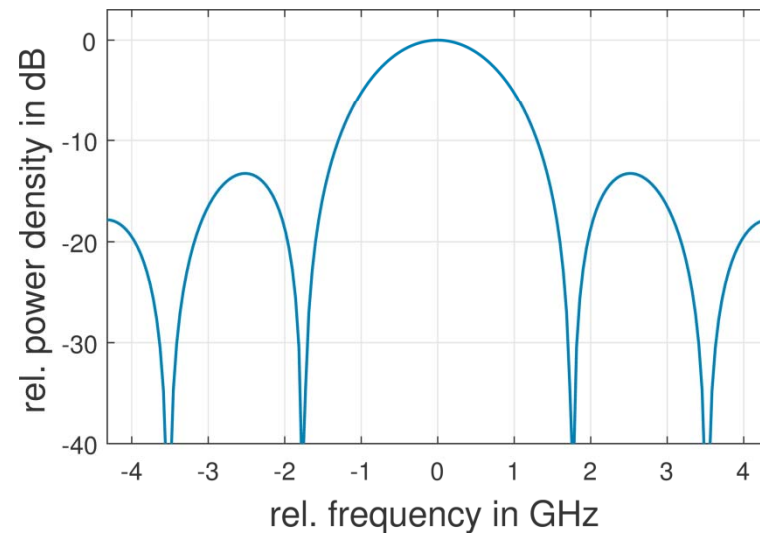
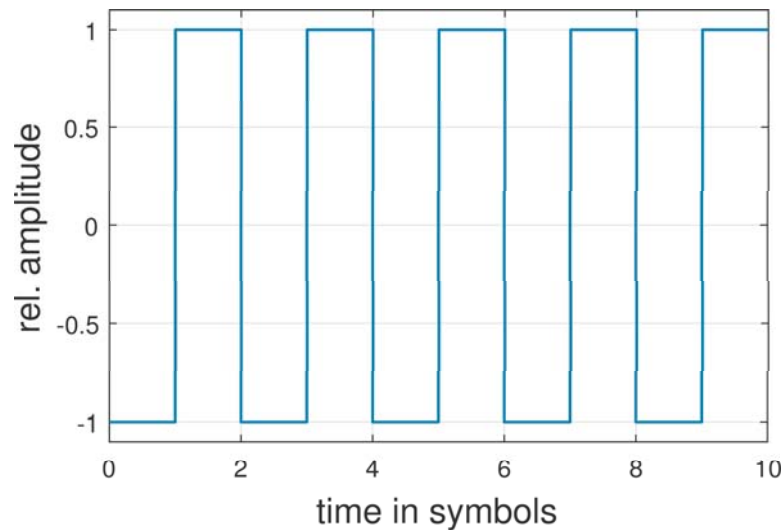
The data signal $s(t)$ can be described as a rectangular sequence of symbols

- Assuming ideal operation of ideal hardware (infinite bandwidth)
- (in the following the signal is illustrated for a BPSK with the symbols „-1“ and „1“. The argumentation also holds for higher order modulations)
- Worst case of max. bandwidth for continuous change from “-1” to “1” and back again.
- Bit rate on the radio channel is $R_c=1.760$ GSymbols/s for a 2.16 GHz channel

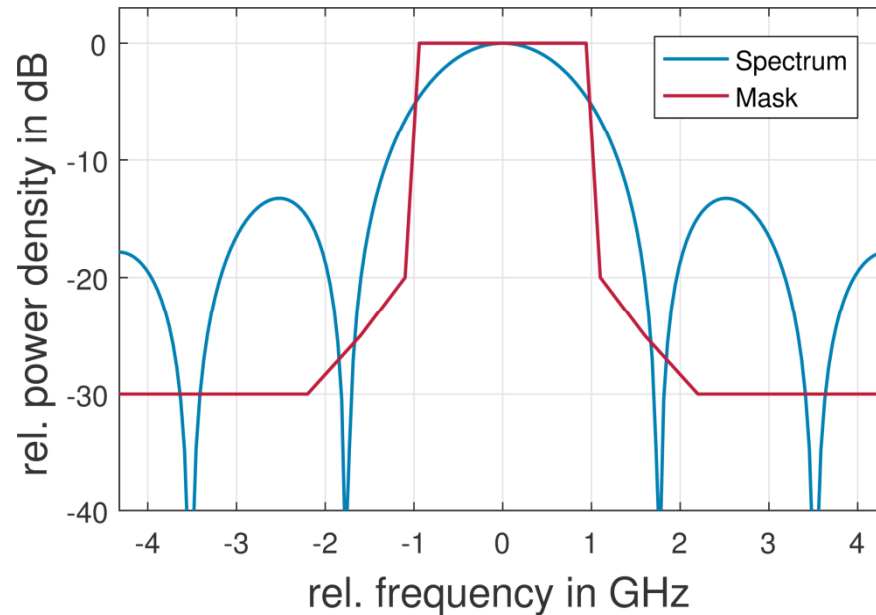
What does the spectrum look like?

- The spectrum is the fourier transform of the signal with a sinc shape
- Power density is normalized to 0 dB (b=1)

$$s(t) = \text{rect}\left(\frac{t}{T}\right) \quad \mathcal{F}\{s(t)\} = S(f) \quad S(f) = b \cdot \text{sinc}(\pi \cdot T \cdot f) \quad T = \frac{1}{R_c}$$



Comparison with spectrum mask



- Spectrum is too wide
- (The lines connecting f2, f3 and f4 look almost like one single line)
- Filtering of the signal required

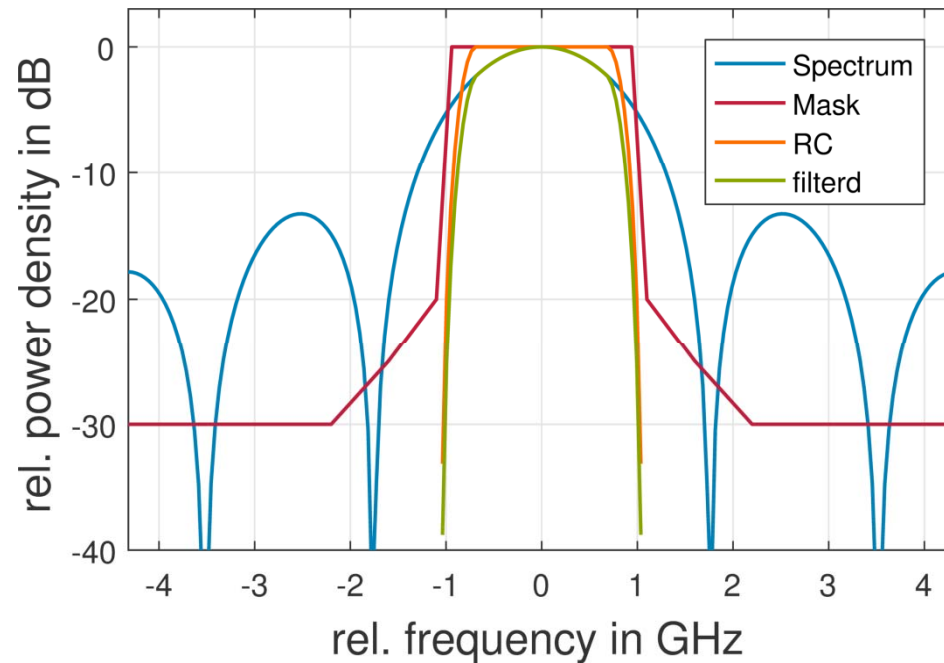
Transfer function of a raised cosine filter

- Given chip rate, e.g. $R = 1.76$ GSymbols/s for 2.16 GHz channel
- Symbol duration $T = \frac{1}{R}$
- Roll-off factor e.g. $\beta = 0.22$

$$H(f) = \begin{cases} T & |f| \leq \frac{1-\beta}{2T} \\ \frac{T}{2} \left[1 + \cos \left(\frac{\pi T}{\beta} \left[|f| - \frac{1-\beta}{2T} \right] \right) \right] & \frac{1-\beta}{2T} < f < \frac{1+\beta}{2T} \\ 0 & \text{otherwise} \end{cases}$$

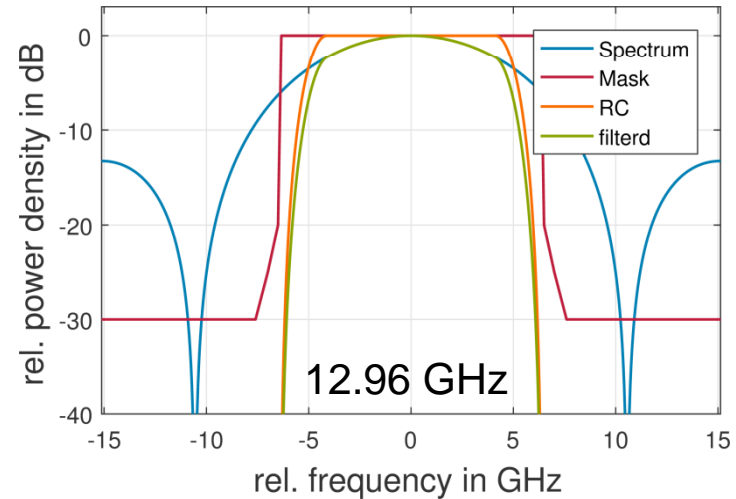
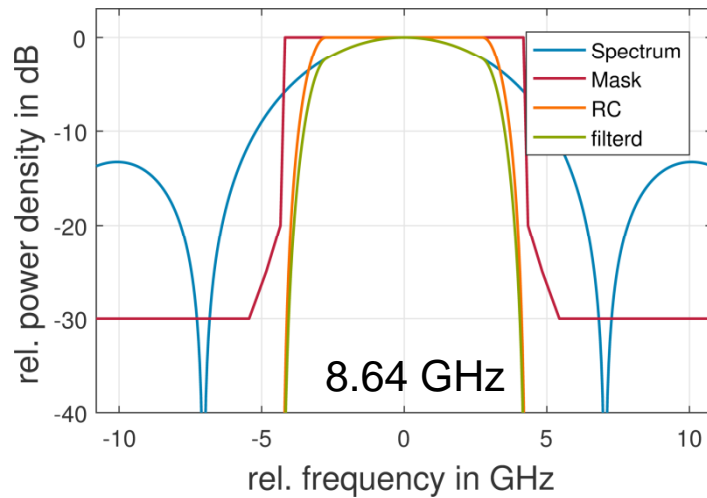
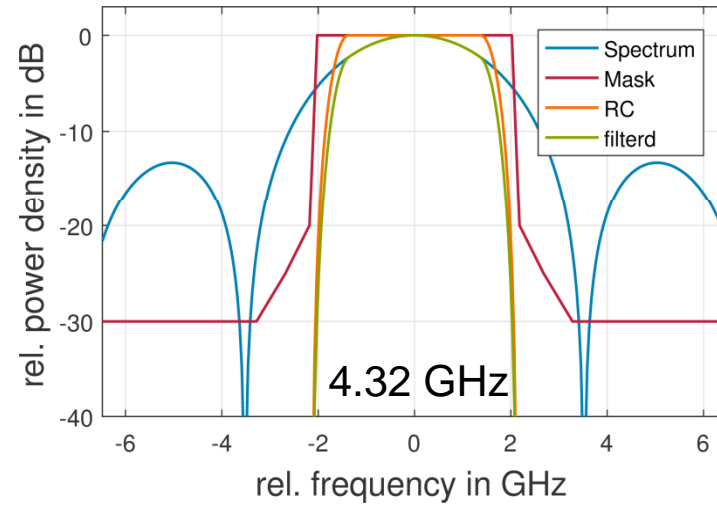
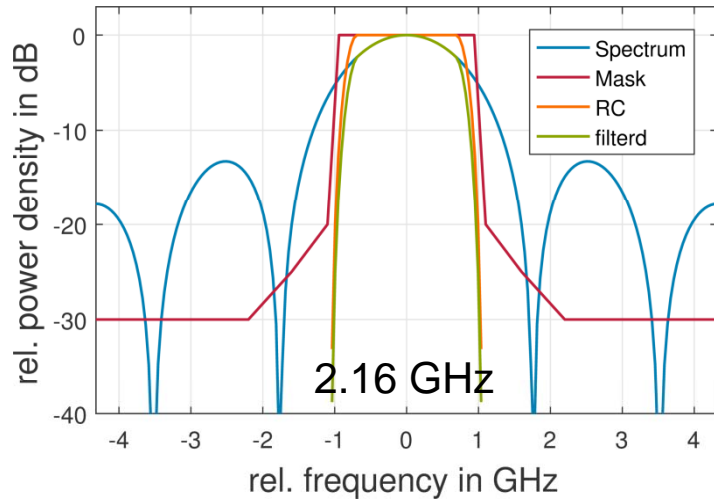
- In the following $H(f)$ is normalized so that the passband is 0 dB.

Comparison with the PSD mask



Multiplication of the filter transfer function (RC) with the signal spectrum fulfills the spectrum mask.

Comparison with the PSD mask



Comparison with the PSD mask

