

Non Rectangular Time Windowing Analysis for IEEE 802.11 OFDM System

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Introduction

- This contribution examines the potential error caused by the non-rectangular window included in the OFDM standard.
- It is observed that phase rotation and spreading of the constellation points results after ideal demodulation.
- This error can impact synchronization, modulation error measurements and data decoding unless mitigated.

Short Training Signal Windowed

- Draft Standard’s defining equations includes windowing

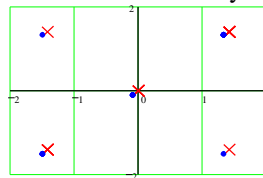
$$r_{SHORT2}(t) = w_{SHORT2}(t) \sum_{k=-N_s/2}^{N_s/2} S_k \exp(j2\pi k \Delta_f t)$$

$$w_{SHORT2}(t) = \begin{cases} \sin^2\left(\frac{\beta}{2}(0.5 + t/T_{tr})\right) & \left(-\frac{T_{tr}}{2} < t < \frac{T_{tr}}{2}\right) \\ 1 & \left(\frac{T_{tr}}{2} < t < T_{SHORT2} - \frac{T_{tr}}{2}\right) \\ \sin^2\left(\frac{\beta}{2}(0.5 - (t - T_{SHORT2})/T_{tr})\right) & \left(T_{SHORT2} - \frac{T_{tr}}{2} < t < T_{SHORT2} + \frac{T_{tr}}{2}\right) \end{cases}$$

- A transition time, defined as T_{tr} , is said to be “about” 100 nsec. In fact, earlier draft versions, imply relationship to the rolloff parameter of the raised cosine window.
 - The rolloff parameter, β , can be related to two FFT samples. With respect to the 4 μ sec OFDM symbol,
 - Letting $\beta = 2/64$ indicates that $\beta T = 100$ nsec exactly, where $T = 3.2 \mu$ sec, is the active symbol duration.

Windowed vs Ideal Short Symbol

- Applying the window transition causes dispersion from the ideal rectangular time window, after ideal demodulation.
 - Single 16 point short symbol
 - Error from ideal approximately, -22.8 db (following standard’s MER equation)
 - T_{short} length commensurate with short symbol length



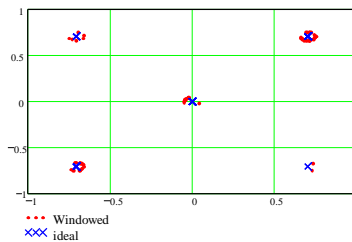
✕✕ Ideal
•• Windowed

January 1999

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Windowed Long training Symbol with GI

- Long training symbol windowed shows less dispersion
 - since impact of non unity multiplication applies to relatively less of the signal
 - 80 symbols long + windowing
 - Long training symbol can be viewed as a QPSK data symbol
 - Error approximately -25.4 db



Submission

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Observations

- Greater effect on shorter symbols
- Above examples are for QPSK
 - Impact anticipated to be greater for more dense constellations
- Error
 - Can bias synchronization estimates
 - Close to modulation error requirements of -18 or -21 db for QPSK and potentially make them not realizable

Submission

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Recommendation

- Current references to windowing in the standard are described as informative only and used for convenience
 - The convenience is not necessary as appending time intervals over which a definition is valid is the usual format
- Remove references to current time windowing. Benefits include
 - Allows for closer alignment with BRAN
 - Eliminates confusion
 - Avoids potential for signal degradation due to this cause.