ITU Kaleidoscope 2016

ICTs for a Sustainable World

PAPR Reduction in SC-FDMA via a Novel Combined Pulse-Shaping Scheme

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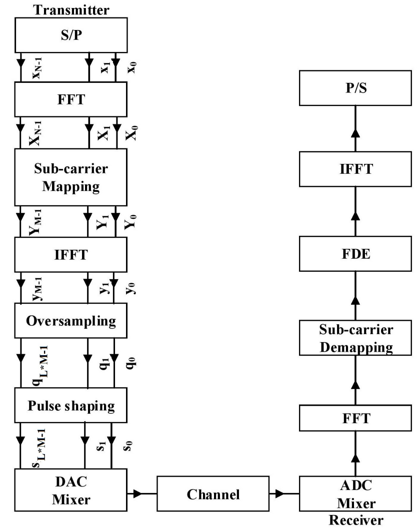
Introduction

Introduction

- OFDM
- SC-FDMA
- Sub-Carrier Mapping
- PAPR Reduction
  - Linear
  - Non-Linear
- Our Pulse Shaping Scheme

SC-FDMA

SC-FDMA



$$PAPR = \frac{\max\limits_{0 \le k \le M \times L-1} |s_k|^2}{E\{|s_k|^2\}}$$

Nyquist-I Pulse Shaping

Nyquist-I Pulse Shaping

- Nyquist-I Pulse Shaping
- Different Versions of Nyquist-I Pulse Shaping
  - Raised Cosine
  - Root Raised Cosine
  - Parametric Linear Pulses
  - Parametric Exponential Pulses
  - Parametric Linear Combination Pulses

Proposed Pulse Shaping Scheme

Proposed Pulse Shaping Scheme I

- Combination of K pulse shaping methods

$$h(t) = \sum_{i=1}^{K} a_i h_i(t)$$

$$\text{s. t.} \quad \sum_{i=1}^{K} a_i = 1$$

- Solving the problem for $K = 3$
- Optimization problem

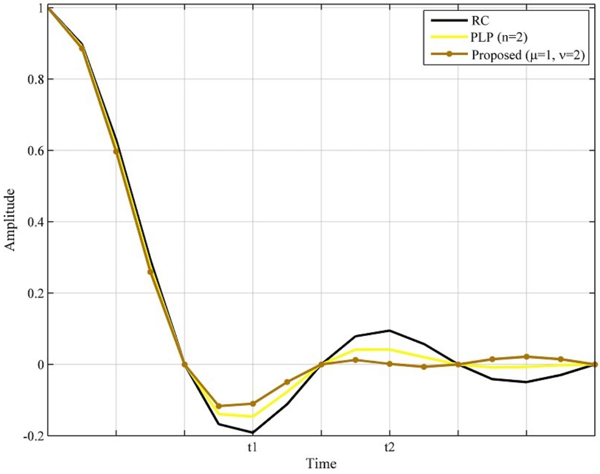
$$\min_{\mu,\nu} \quad |h(t_1)| \times |h(t_2)|$$

$$\text{s. t.} \quad |h(t_1)| > |h(t_2)|$$

where

$$h(t) = \mu h_{\mathrm{PEP}}(t) + \nu h_{\mathrm{PLP}(2)}(t) + (1-\mu-\nu)\, h_{\mathrm{PLP}(1)}(t)$$

Proposed Pulse Shaping Scheme II



Impulse response of RC, modified PLP and our scheme.

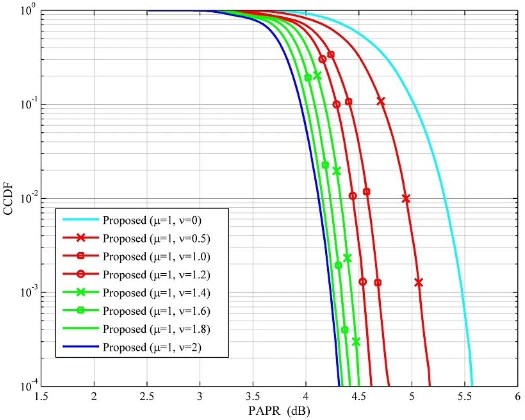
Simulation Results

Simulation Results I

Simulation Parameters

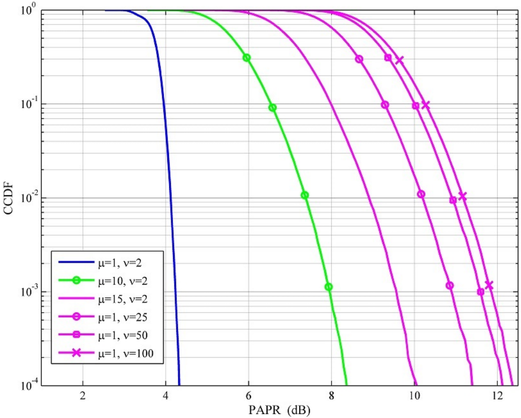
Parameter	Value
No. of subcarriers	512
No. of used subcarriers	128
Sampling frequency	10 MHz
Oversampling factor	4
Roll-off factor (α)	0.22
Sub-carrier mapping	interleaved

Simulation Results I



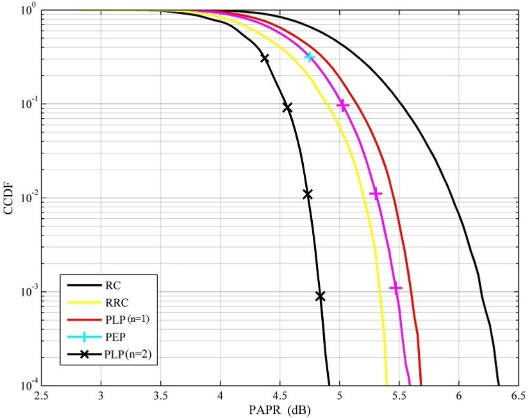
CCDF of PAPR for SC-IFDMA with QPSK for $\mu = 1$ and $\nu \in [0, 2]$.

Simulation Results II



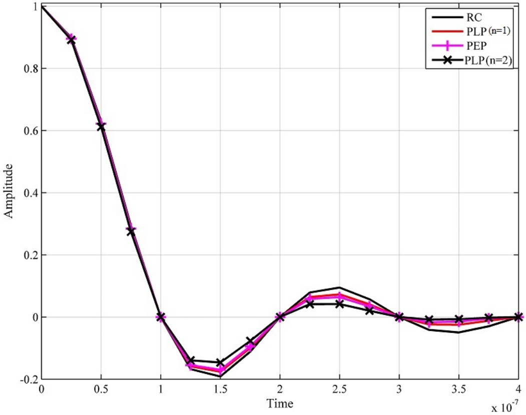
CCDF of PAPR for SC-IFDMA with QPSK for $\mu = 1$ and $\nu \in [2, 100]$

Simulation Results III



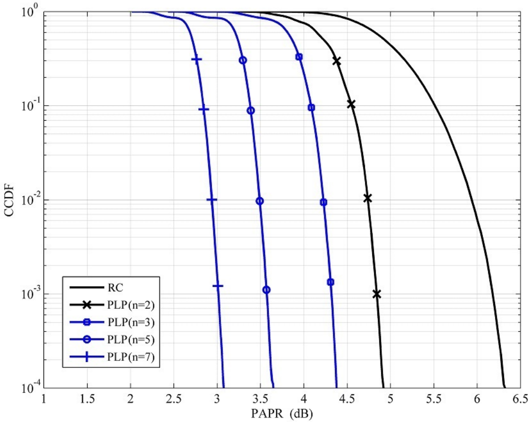
CCDF of PAPR for SC-IFDMA with QPSK via different schemes.

Simulation Results IV



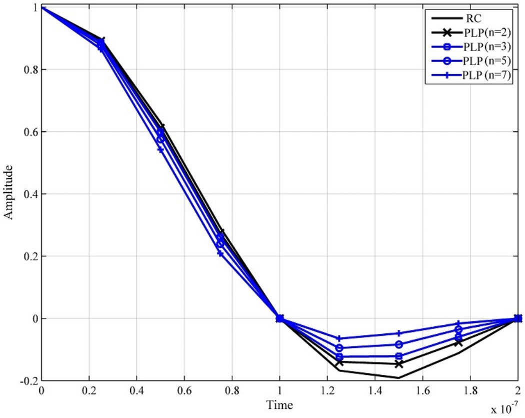
Impulse response of RC, PLP, PEP and modified PLP schemes.

Simulation Results V



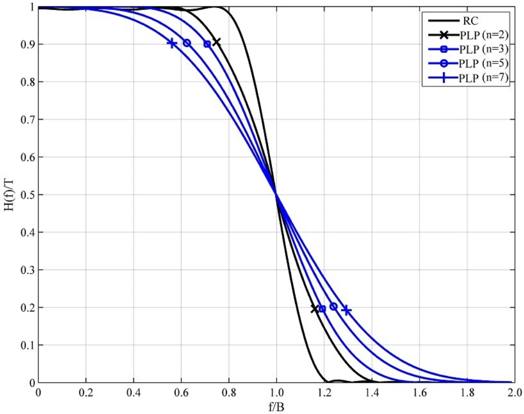
CCDF of PAPR for SC-IFDMA with QPSK via RC and modified PLP.

Simulation Results VI



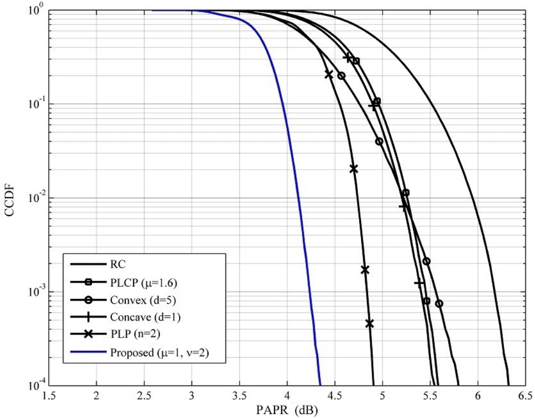
Impulse response of the RC and modified PLP schemes.

Simulation Results VII



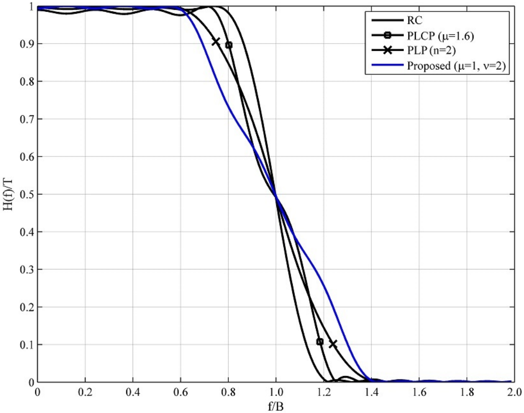
Frequency response of RC and modified PLP schemes.

Simulation Results VIII



CCDF of PAPR for SC-IFDMA with QPSK different schemes.

Simulation Results IX



Frequency response of RC, PLCP, modified PLP, and our schemes.

Simulation Results I

Required time to generate a transmit string in different pulse shaping schemes (parallel filters)

Pulse Shaping	SC-IFDMA	
	QPSK(μs)	16QAM(μs)
RC	643.74	720.79
RRC	644.73	722.58
PLP	637.06	718.92
PEP	643.56	717.96
PP ($n = 2$)	637.44	719.50
PLCP ($\mu = 1.6$)	687.09	755.12
Proposed ($\mu = 1$ and $\nu = 2$)	710.26	774.42

Simulation results I

Required time to generate a transmit string in different pulse shaping schemes (combined filters)

Pulse Shaping	SC-IFDMA	
	QPSK(μs)	16QAM(μs)
RC	643.74	720.79
RRC	644.73	722.58
PLP	637.06	718.92
PEP	643.56	717.96
PP ($n = 2$)	637.43	719.50
PLCP ($\mu = 1.6$)	637.39	719.23
Proposed ($\mu = 1$ and $\nu = 2$)	645.31	720.59

Simulation results

Average values and variances of PAPR for different pulse shaping schemes

Pulse Shaping	QPSK		16QAM		64QAM	
	β	σ^2	β	σ^2	β	σ^2
RC	4.45	0.11	5.49	0.32	5.76	0.32
RRC	3.53	0.05	5.02	0.14	5.55	0.14
PLP	3.93	0.07	5.21	0.25	5.54	0.25
PEP	3.77	0.07	5.12	0.24	5.48	0.24
PP ($n = 2$)	3.10	0.04	4.81	0.15	5.27	0.18
PLCP ($\mu = 1.6$)	3.70	0.08	5.09	0.23	5.45	0.23
Convex ($d = 5$)	3.90	0.16	4.99	0.23	5.39	0.21
Concave ($d = 1$)	3.64	0.08	5.04	0.25	5.42	0.22
Proposed	2.34	0.02	4.41	0.08	5.09	0.10

Conclusions

Conclusions

- We proposed a novel pulse shaping scheme to reduce PAPR in SC-FDMA systems, and compared its performance with other existing schemes via simulation
- The PAPR in our scheme is 2.11 dB, 1.08 dB, and 0.67 dB less than those in RC pulse shaping for QPSK, 16-QAM and 64-QAM respectively.

Thank You