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Peak to Average Power Reduction Technique in OFDM System

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Abstract: ***In this paper, OFDM based on Software-Defined Radio (GNU Radio) to reducing the peak to average power ratio is developed and tested. Orthogonal frequency-division multiplexing (OFDM) is a method of encoding digital data on multiple carrier frequencies. OFDM has developed into a popular scheme for wideband digital communication, whether wireless or over copper wires, used in applications such as digital television and audio broadcasting, DSL Internet access wireless networks and 4G mobile communications. In this proposed design a weight is imposed on each discrete OFDM signal via a certain kind of a band limited signal, and an OFDM signal formed with the weighted discrete data is then considered before a high power amplifier (HPA), whereas the original signal can be recovered completely at the receiver side using weighted OFDM scheme & we doing it using to be implementing on Blade RFx40 SDR platform and the performance is going to be analyzed. BladeRFx40 is a Software Defined Radio (SDR) platform designed to enable a community of hobbyists and professionals to explore and experiment with the multidisciplinary facets of RF communication.***

Keywords: OFDM, DSL, DMT, FDM, SDR

1. Introduction

OFDM is one of the many multicarrier modulation techniques, which provides high spectral efficiency, low implementation complexity, less vulnerability to echoes and non – linear distortion. Due to these advantages of the OFDM system, it is vastly used in various communication systems. But the major problem one faces while implementing this system is the high peak – to – average power ratio of this system. A large PAPR increases the complexity of the analog – to – digital and digital – to – analog converter and reduces the efficiency of the radio frequency (RF) power amplifier.

Thus, the power efficiency of the HPA is seriously limited to avoid nonlinear distortion; otherwise, the high PAPR results in significant performance degradation. Because of the practical importance of this problem, a number of algorithms for reducing the high PAPR have been developed, such as clipping and filtering (C&F) [1]–[3]; coding [4]–[7]; adaptive symbol selection, such as selected mapping; partial transmit sequence and interleaving [8]–[10]; tone reservation/injection [11], [12]; active signal constellation extension [13], companding [14]–[16]; and others. In this paper, a PAPR reduction scheme based on a weighted OFDM signal is proposed to reduce the PAPR without distortion in removing the weight at the receiver side.

2. System Model

Orthogonal Frequency Division Multiplexing (OFDM) is an efficient method of data transmission for high speed communication systems. Here, we provide the weighted OFDM signal, where the weight is derived from a suitable band limited signal having no zero on the real line. In this weighted OFDM method with modified weight, the time duration needed to transmit the weighted OFDM signal is the same as the time duration for the original OFDM signal. Moreover, the original discrete data can be recovered completely at the receiver side with additional 2N complex multiplications of computational complexity without extra cost in transmission. The weighted OFDM scheme was introduced in where the Gaussian function, sine function, and some other functions were used as weighted functions. Consider a weighted discrete data to form a weighted OFDM signal, which is defined on the same time interval as the original OFDM signal.

3. Block Diagram

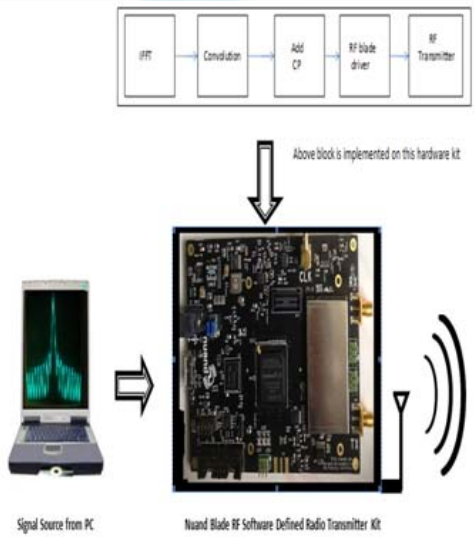

Figure 1: OFDM using Blade RFx40 SDR Platform Transmitter Block Diagram

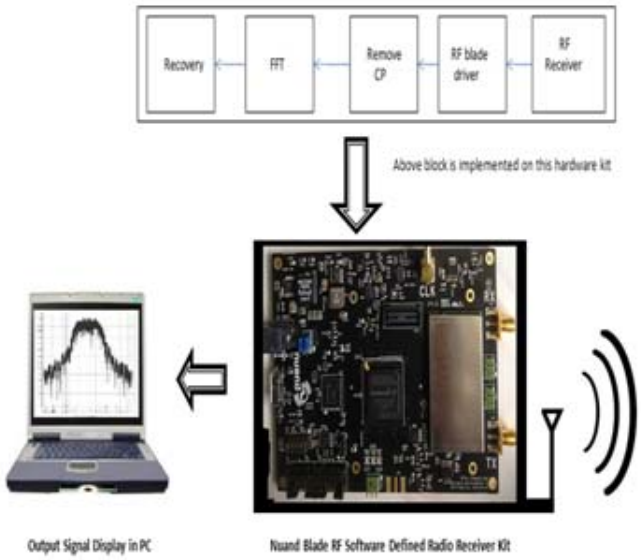

Figure 2: OFDM using Blade RFx40 SDR Platform Receiver Block Diagram

The inverse fast Fourier transform (IFFT) is then applied to these modulated signals. A cyclic prefix (CP) whose length is greater than the delay spread of the channel is inserted to mitigate the effects of the inter symbol interference (ISI). After PAPR reduction, it should be implemented using blade RF and GNU radio. At the receiver, the reverse operations are performed. The given signal is transformed using frequency to time domain. The result from transformation is passed on for the removing cyclic prefix. After PAPR reduction, it should be implemented using blade RF& applying fast Fourier transform (FFT) to transform the time domain signal to frequency domain.

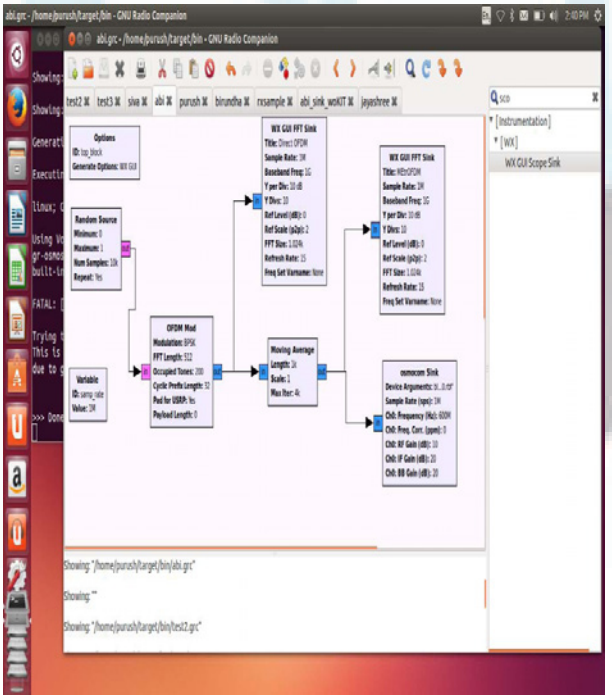

Figure 3: Basic Transmitter Block executed in SDR Platform

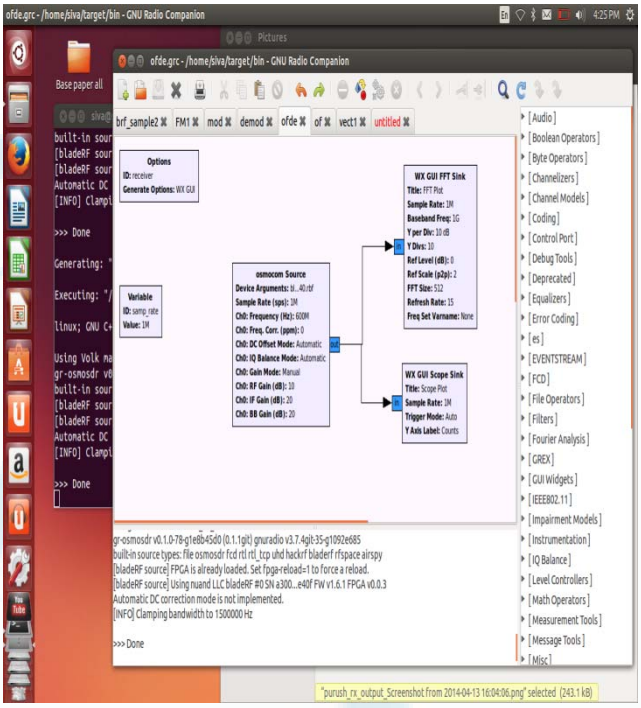

Figure 4: Basic Receiver Block executed in SDR Platform

4. Implementation of SDR for PAPR

A. Software Defined Radio

Software Radio (SR) is where all the signal manipulations and processing works in radio communication are done in software instead of hardware. In software radio, analog to digital converter (ADC) process is directly done after the antenna.ADC will digitize the electromagnetic wave captured by the antenna and pass it to the baseband processor for further process; demodulation, channel coding, source coding and etc. In general, Software Defined Radio (SDR) is defined as a software based communication platform which characteristics can be reconfigured and modified to perform different functions at different times.

B. GNU Radio

GNU Radio is an open source software toolkit which consists of signal processing blocks library and the glue to tie these blocks together for building and deploying software defined radios. The signal processing blocks are written in C++ while python is used as a scripting language to tie the blocks together to form the flow graph. SWIG is use as the interface compiler which allows the integration between C++ and Python language. USRP digitized the inflow data from the air and passing to GNU Radio through over the USB interface.

C. Universal Software Radio Peripheral

Universal Software Radio Peripheral (USRP) is a flexible low-cost platform for software defined radios developed by Matt Ettus [2]. USRP consists of two main boards; the

daughter board and the mother board. The mother board consists of four 12-bit Analog to Digital converter (ADC) with sampling rate up to 64 MS/s, four 14-bit Digital to Analog Converter (DAC) with speed up to 128 MS/s, two Digital up Converter (DUC) to up convert the baseband signal to 128 MS/s before translating them to the selected output frequency, a programmable USB 2.0 controller for communication between USRP and GNU Radio and an FPGA for implementing four Digital Down Converter (DDC) and high rate signal processing. It is capable to simultaneously transmit and receive signal in real time due to fully coherent in all sampling clocks and local oscillator.

D. Altera Cyclone IV FPGA

Altera's Cyclone® IV FPGA family extends the Cyclone FPGA series leadership in providing the market's lowest cost, lowest power FPGAs, and now with a transceiver variant. Ideal for high-volume, cost-sensitive applications, Cyclone IV FPGAs enable you to meet increasing bandwidth requirements while lowering costs. The family includes:

- Cyclone IV GX FPGAs with up to eight integrated 3.125-Gbps transceivers
- Cyclone IV E FPGAs for a wide spectrum of general logic applications

E. ARM Processor

The ARM processor has been specifically designed to be small to reduce power consumption and extend battery operation essential for applications such as mobile phones and personal digital assistants (PDAs). ARM has incorporated hardware debug technology within the processor so that software engineers can view what is happening while the processor is executing code. With greater visibility, software engineers can resolve issues faster, which has a direct effect on the time to market and reduce overall development costs. The ARM core is not a pure RISC architecture because of the constraints of its primary application—the embedded system. In some sense, the strength of the ARM core is that it does not take the RISC concept too far. In today's systems the key is not raw processor speed but total effective system performance and power consumption.

F. Hardware - BLADERF X40

Figure 5: Nuand tool kit Tx/Rx

The blade RF x40 is a low-cost USB 3.0 Software Defined Radio. The 40KLE option makes the blade RF the essential low-cost RF transceiver kit for both hobbyists, and RF enthusiasts.

5. Results

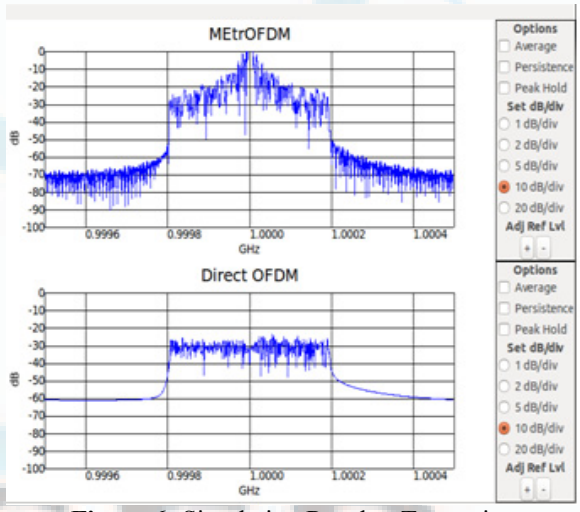

Figure 6: Simulation Result – Transmitter

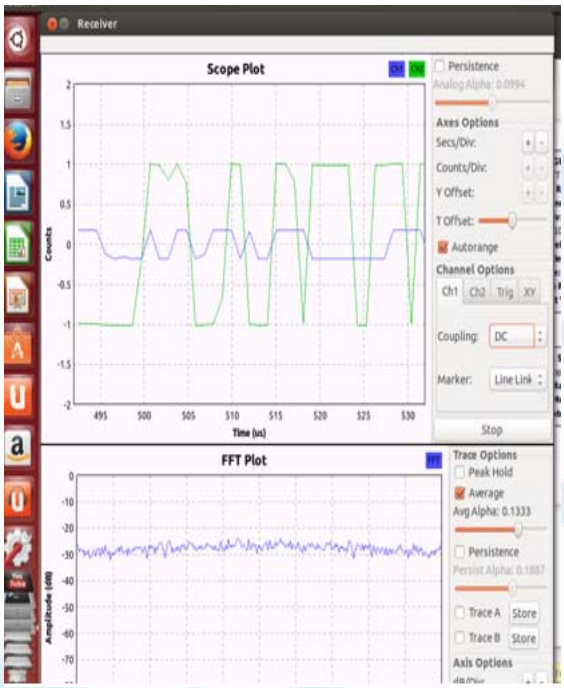

Figure 7: Simulation Result – Receiver

6. Conclusion

A weighted OFDM scheme has been proposed for system performance and reduces the peak to average power ratio, but schemes achieving a good balance between complexity and performance are yet to be developed. Software Defined Radio is bound to bring about a technological revolution for the current wireless communication system. Excellent software GNU Radio and outstanding hardware USRP family products composed of a combination of ease of use, saving time, low cost but powerful Software Defined Radio platform.

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