A Novel High Efficiency Power Amplifier for Envelope Detection

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Abstract— High Efficiency Power Amplifier for Envelope Detection is presented here in this paper which uses the LDMOS power amplifier to achieve high efficiency. The main objective in this work to design a power amplifier which is more efficient when subject to various kind of situations. QAM modulation with 64 point, and Additive White Gaussian Noise Channel was used here in this work. Amplitude Modulation, Phase Modulation response is plotted here to judge the performance of system designed. BER, MER analysis was separately done in respect toshow the result numerically.

Keywords—Base station power amplifier, digital predistortion, efficiency, envelope tracking, W-CDMA.

I. INTRODUCTION

Wideband Code Division multiple Access (W- CDMA) is being used by Universal Mobile Telecommunication System (UMTS) as platform of the 3rd generation cellular communication system. W-CDMA uses noise-like broadband frequency spectrum where it has high resistance to multipath fading where as this was not present in conventional narrowband signal of 2nd generation (2G) communication system.

High data rate signal transmission can be transmitted over the air by using W-CDMA system, thus enabling of multimedia rich applications such as video streams and high resolution pictures to end users. Thus, we need suitable modulation technique and error correction mechanism to be used in W-CDMA system. In 2G networks, Gaussian Minimum Shift Keying (GMSK) modulation scheme is widely used in GSM (Global System for Mobile) Communication.

The power amplifier (PA) is a key element in transmitter systems, whose main task is to increase the power level of signals at its input up to a predefined level. Power amplifier's requirements are mainly related to the absolute achievable output power levels.Many applications for power amplifier design are used in broadcast digital television, satellite and military system [1]. In most RF and microwave power amplifiers, the largest power dissipation is in the power transistor. Since the main power supply consumer is power amplifier, the low power feature is directly translated to power amplifier specifications. Moreover, due to the widespread diffusion of communication applications, the power amplifier designer has usually to trade-off among the contrasting goals of high transmitted power, lowpower consumption and highly linear operation.The resulting challenge has however heavily influenced, in the last decade, industrial, technical and research directions in the power amplifier field. From the power amplifier designer point of view, both the selection of the active devices composing the power amplifier and especially the exploration of their non-linear operation regions, to fully exploit the output power capabilities become critical [2]. Dedicated and non linear design methodologies to attain the highest available performance become therefore crucialfor successful results. Power amplifier design strongly depends on operating frequency and applications, as well as on the available device technology. For high frequency applications however, two broad power amplifier design methodologies classes are available. They are switching mode (SM) amplifier[4] and transconductance-based amplifier [5].

II. ENVELOPE TRACKING BASE STATIONAMPLIFIER

The traditional approach to linearly amplify the nonconstant envelope modulated signal is to “back off” the linear Class-A or Class-AB PA’s output power until the distortion level is within acceptable limits. Unfortunately, this lowers efficiency significantly, especially for high PAR signals. Thus, there is an inherent tradeoff between linearity and efficiency in PA design. A block diagram of the EER systems is shown in Fig. 1.

The highly efficient envelope amplifier is critical to the EER system since the total system efficiency is the product of the envelope amplifier efficiency and RF transistor drain efficiency.

The block diagram of the envelope tracking amplifier used in this work is shown in Figure 2. The W-CDMA signal is generated in the digital domain, and consists of an envelope signal, as well as I and Q RF signals. Care has been taken to ensure the proper spectral mask and a reasonable peak to average ratio (7.6 dB), which includes a decresting algorithm as well as a circularity algorithm for measurement consistency. After up-conversion, the resultant RF signal provides the input to the RF amplifier, whose supply voltage is modulated by the amplified envelope signal by the wide band and high efficiency envelope amplifier. To minimize distortion by the time delay difference between envelope and RF path, synchronization is performed by comparing the input and down-converted output signal [6].

Pre-distortion is also carried out in the digital domain in order to minimize the AM-AM and AM-PM distortion caused by the RF amplifier and envelope amplifier. Decresting (an adjustment of the peak-to-average ratio), is performed digitally on the envelope of the signal to optimize the efficiency, ACLR and EVM performance. To avoid gain collapse of RF amplifier at low drain voltages, the envelope of the signal is also detroughed (adjustment is made to the envelope signal in the vicinity of its zeros). This technique
has been used with a number of devices and a number of modulated signals [6,7]

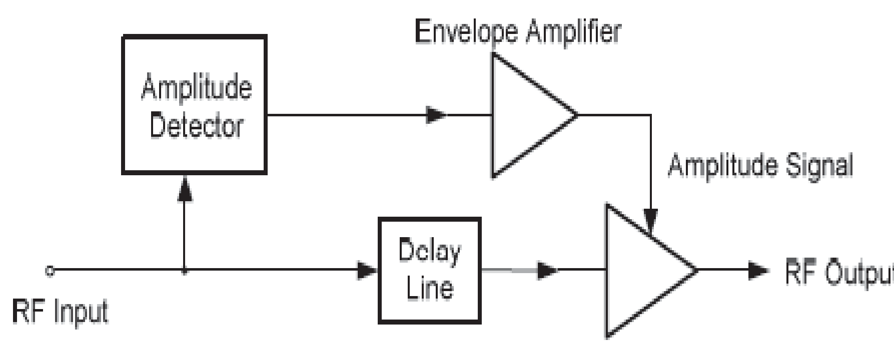

Fig 1. EER System

Wide Band High Efficiency Envelope Amplifier used in this work, which is shown in Figure 3, comprises a linear stage to provide a wide band voltage source and, in parallel, a switching stage to provide an efficient current supply. The output voltage of the envelope amplifier follows the input envelope signal with help of an operational amplifier. The current is supplied to the drain of RF amplifier from both the linear stage and the switching stage through the current feedback which senses the current flowing out ofthe linear stages and turns on/offthe switch [8].

The linear stage provides the difference between the desired output current and the current provided by the switching stage, such that the overall error is minimized. This Vdd amplifier isbeing used for a wide range of applications, resulting in a slight reduction in efficiency.

Measurement ofthe high voltage envelope amplifier used in this work shows average drain efficiency around 64% with a W-CDMA signal, a peak drain voltage of 29.4 V, an RMS (root-mean-square) value of 12.4 V. Therefore, it is suitable for the base station power amplifier using high breakdown voltage LDMOS devices. The efficiency ofthe Vdd amplifier could be improved by selecting components that are more precisely selected for this application.

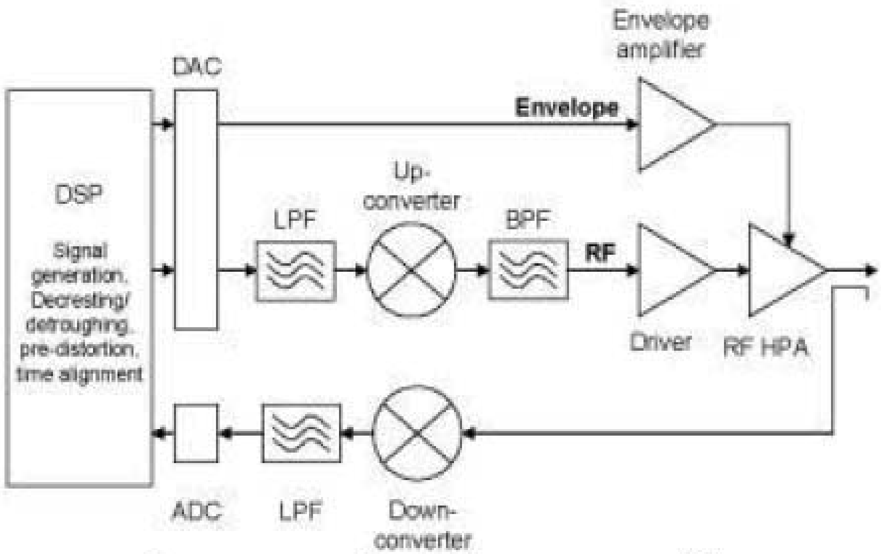

Fig 2. Base Station High Power Amplifier

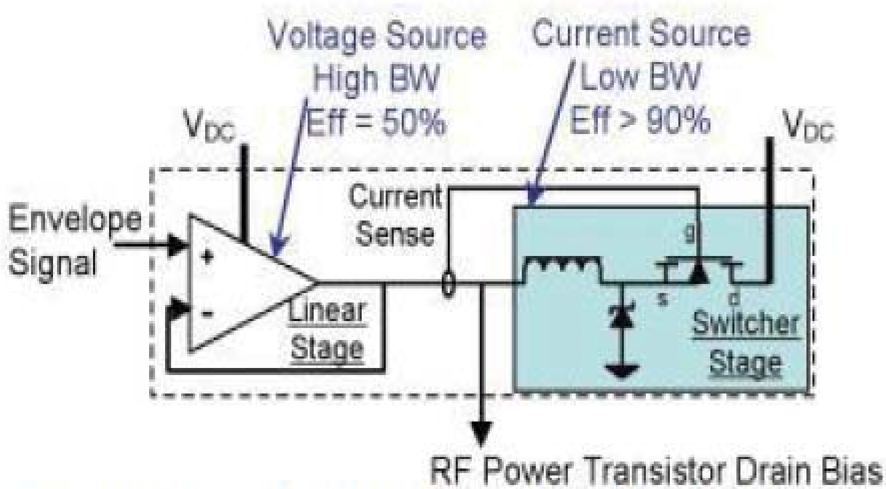

Fig 3. Wide Band High Efficiency Envelope Amplifier.

III. IMPLEMENTATION AND RESULTS

Implementation of the designed power amplifier is done using the MATLAB 7.8.0. Implementation done in the following stage:

1. Signal Generated in Digital Domain
2. Signal modulated using 64 QAM
3. Signal passed through an AWGN channel 15 db SNR
4. Received Signal via High efficiency power amplifier is plotted.
5. AM/ PM response of resultant signal is plotted.
6. BER, MER calculated.

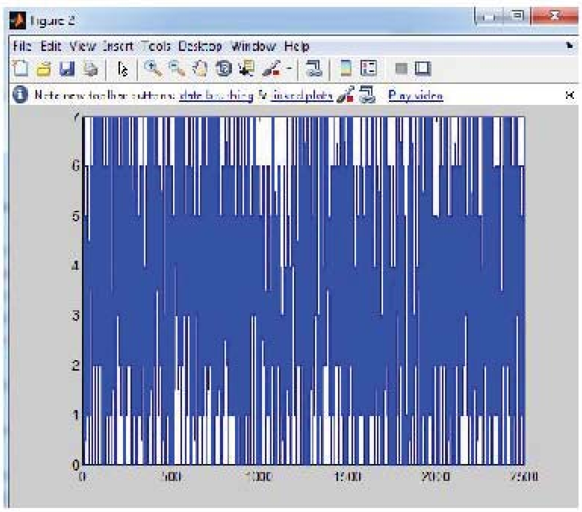

Fig 1 Digital Generated Data

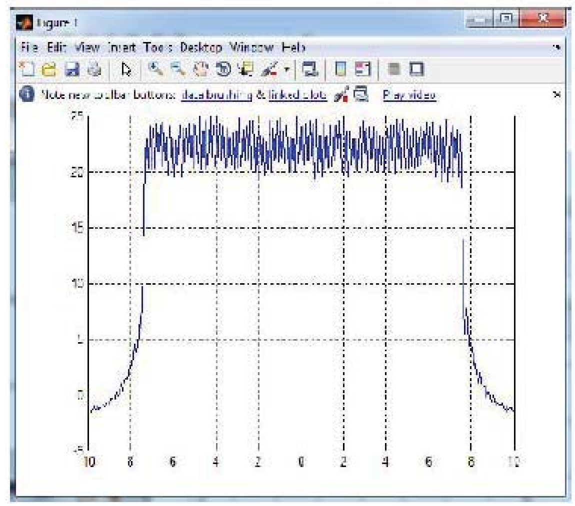

Fig 4 Received Plot of signal after amplifier

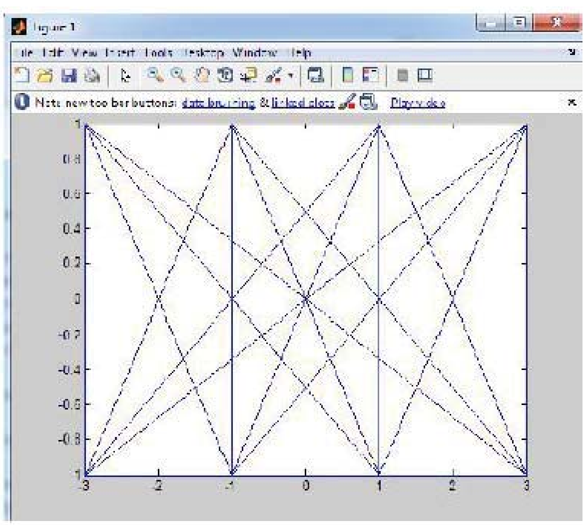

Fig 2. QAM Modulated Data

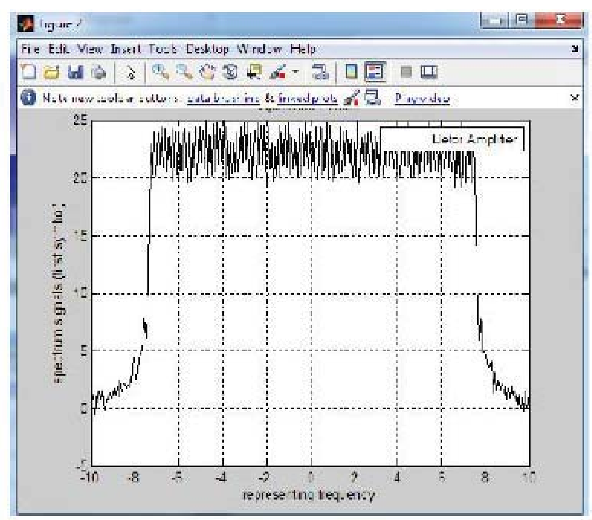

Fig 5 Received Signal Plot before amplifier

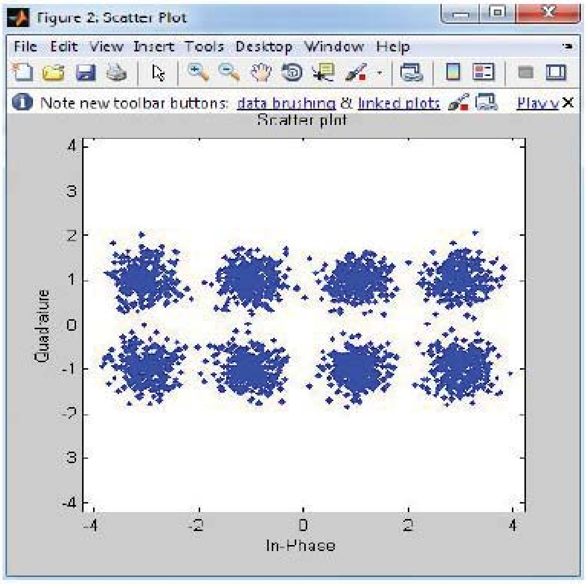

Fig 3. Scatter Plot of In phase AWGN pass signal

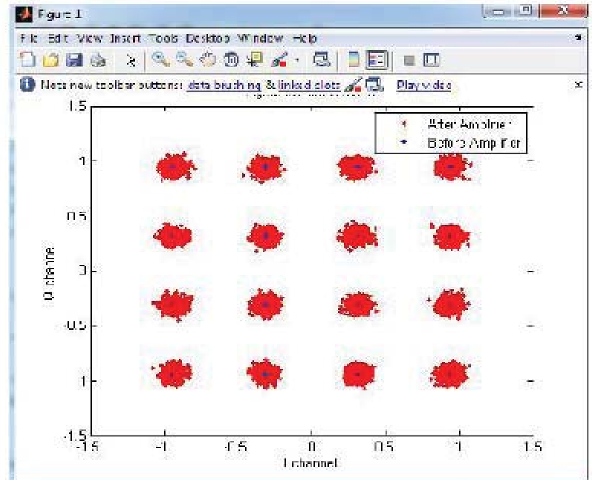

Fig 6 Signal constellation of received signal

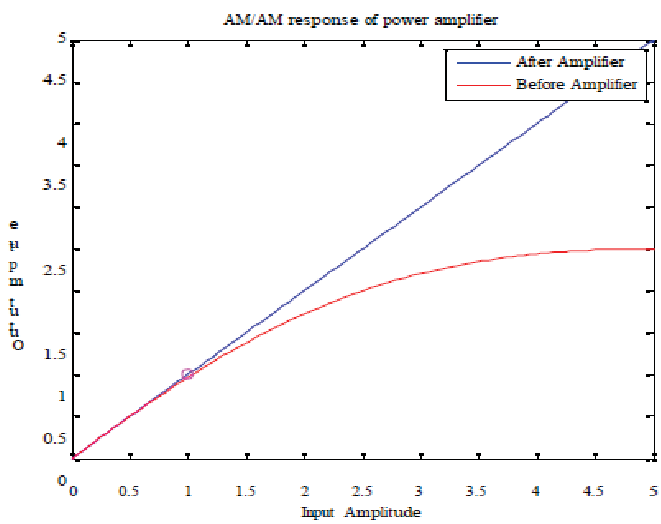

Fig 7. AM/PM response of received signal

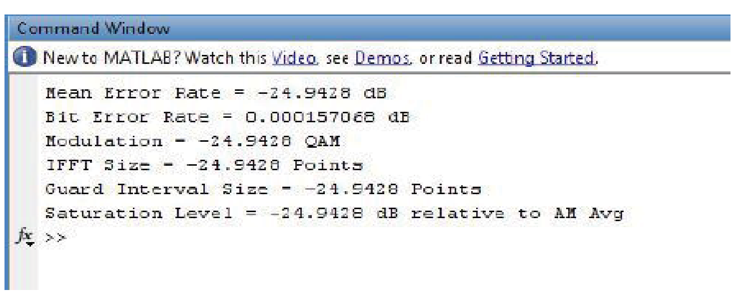

Fig 8. MER, BER Analysis shown in command window

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