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Digital Predistortion of Power Amplifier using Quadratic Rotation Method

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***Abstract*---In this paper, the task of design and implementation of digital pre-distortion technique has been divided into two parts. The behavioural model of power amplifier has been developed and digital predistorters module has been developed. AM-AM characterstics for the proposed model is presented and power spectral density (PSD) have been considered as the major parameters to check the performance and modelling accuracy. Parameter estimation and their automatic adjustment is a key issue in adaptive digital predistorter design.**

***Keywords*--- Adjacent channel leakage ratio, error vector magnitude, power spectral density, Quadrature Rotation.**

I. INTRODUCTION

With the rapid enlargement of new technologies during the last decades, the demand of complex algorithms to work in real-time applications has increased considerably. For attaining the real time expectations and to assure the stability and accuracy of the systems the application of numerical methods and matrix decompositions have been studied as a trade-off between complexity, accuracy and stability. Matrix inversion is one the most important operations in signal processing and is present in many areas such as positioning systems, wireless communications[1]. The computation of a matrix inverse grows in exponent with the matrix dimension and can introduce errors and instabilities in the system. Consequently, it is worthy to study all the existing methods to accelerate the computation and assure the stability of the operation. These methods developed during the last decades rely on matrix decompositions to reduce complexity. These decompositions include QR Decomposition, SVD, and LU Decomposition [2]. QR Decomposition is the most widely used since assures stability and have less complexity. The stability and accuracy of these methods are analyzed analytically and the complexity is studied in terms of

operations and level of parallelism. This paper presnts the QR Decomposition method DPD of power amplifier.

II. QR DECOMPOSITION

QR decomposition is one of the most important operations in linear algebra. It can be used to find matrix inversion, to solve a set of simulations equations or in numerous applications in scientific computing. It represents one of the relatively small numbers of matrix operation primitive from which a wide range of algorithms can be realized[3][4]. QR decomposition is an elementary operation, which decomposes a matrix into an orthogonal and a triangular matrix. QR decomposition of a real square matrix A is a decomposition of A as A = Q×R, where Q is an orthogonal matrix ($Q^T \times Q = I$) and R is an upper triangular matrix [5][6]. And we can factor m x n matrices (with $m \geq n$) of full rank as the product of an m x n orthogonal matrix where QT × Q = I and an n x n upper triangular matrix. There are different methods which can be used to compute QR decomposition. The techniques for QR decomposition are

Gram-Schmidt orthonormalization method, Householder reflections, and the Givens rotations.

III. RESULTS AND DISCUSSIONS

The results presented which are obtained using QRD algorithms. On the basis of AM-AM characteristics of PA, AM-AM characteristics of DPD, AM-PM characteristics of PA, power spectrum analysis of PA and power spectrum analysis of DPD the calculations are obtained for WiMAX signal. The simplicity of the proposed system has been evaluated on the basis of degree and length of memory polynomial. ACLR and EVM has been measured of the proposed system. The ACLR values are measured at Lower (-10MHz),

Lower (-5MHz), Upper (+5MHz) and Upper (+10MHz). To validate these algorithms for PA linearization using box oriented memory polynomial DPD technique, the device under test is taken as a wideband PA working at 2 GHz-2.7 GHz band. The test signal is generated using Agilent System Vue software. The parameters of WiMAX signal taken for experimental setup are listed in Table 1.

TABLE 1 PARAMETERS OF WIMAX SIGNAL

Parameter	**Value**
Carrier Frequency	2.4 and 2.45 GHz
Bandwidth	10 MHz
FFT size	512
Modulation	64-QAM
Coding Rate	3/4
Data Subcarriers	200
Pilot Carriers	8
Guard Interval	1/4
DL Frame Time	100 micro seconds

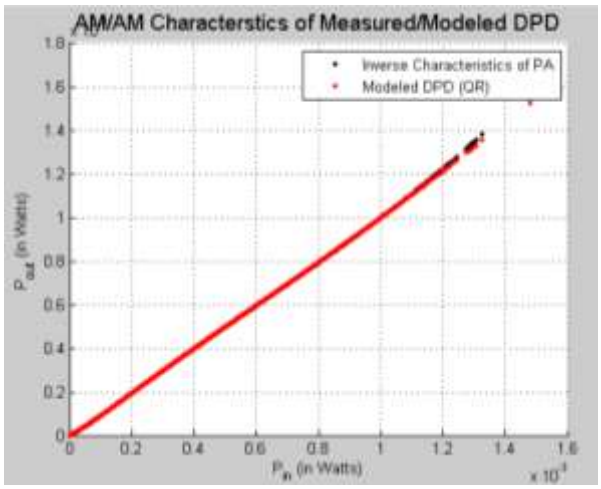

Fig. 1 Inverse AM/AM characteristics of PA

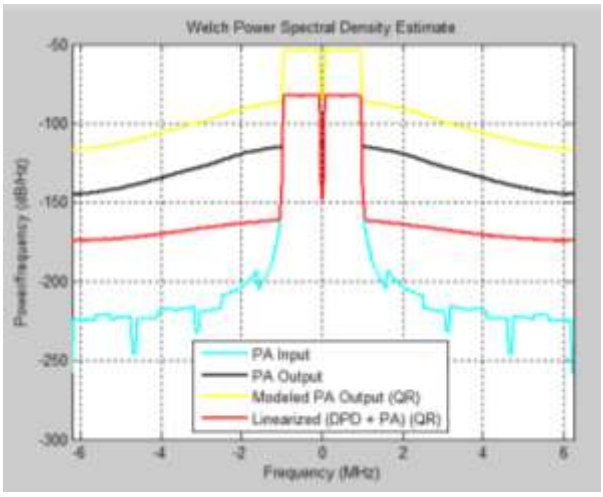

Fig. 2 Power Spectral Density DPD/PA modelled using QR algorithm

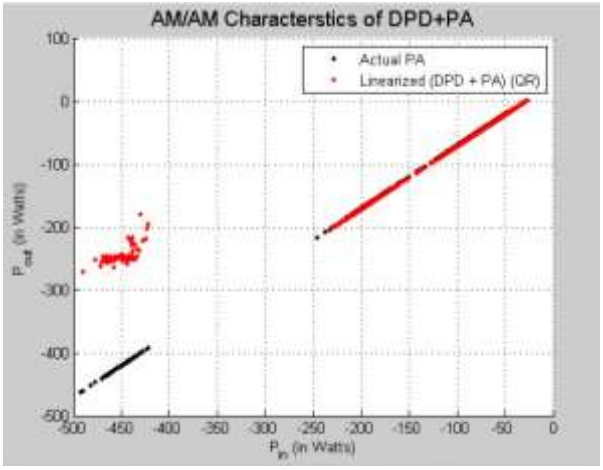

Fig. 3 Linearized Characteristics using QR Algorithm

Figure 1 to 3 shows the inverse AM-AM characteristics, power spectral density and linearized characteristics of actual PA and DPD. To validate the performance of the QR and algorithm in PA modelling using the memory

polynomial model value of memory length and the nonlinearity order has been taken. Figure1 and Figure 2 shows the AM-AM characteristics and Power Spectral Density DPD/PA modeled using QR algorithm respectively of actual PA and proposed PA model. The results show the accuracy of the PA modeling in terms of AM-AM characteristics.

IV CONCLUSION

Parameter estimation and their automatic adjustment is a key issue in adaptive digital predistorter design. The selection of the minimization algorithm, the development of objective function and the error function plays an important role in design accuracy of adaptive digital predistorter. The evaluation of the system is done by generating different graphs for Inverse AM/AM characteristics and Power Spectral Density DPD. The system shows the linerised characteristics when QR Algorithm is utlizesd

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