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A New Approach to Design Wide Band Power Amplifiers by Compensating Parasitic Elements of Transistors

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***Abstract*—This paper presents an analytical approach to compensate parasitic elements of transistors over a wide frequency band. By absorbing parasitic elements, an output matching network can be realized by a conventional real to real impedance transformer. This technique is a general procedure which is adopted to design, simulate and implement a wide band power amplifier (WPA) with commercial packaged GaN transistors. Continuous wave signal excitation in frequency band from 600 to 2800 MHz demonstrates excellent power utilization factor with output power higher than 40 dBm, drain efficiency (DE) between 56.2% to 82.6 % corresponding to power added efficiency (PAE) of 52.6% to 81.6% respectively. Simple analytical design strategy with excellent performance suggests this method as a promising way to design WPAs for modern communication systems.**

***Keywords*—wide band power amplifier (WPA), parasitic elements, compensator, output matching network, communication systems.**

1. INTRODUCTION

Due to the capability of frequency spectrum sharing, high data rate and large channel capacity, ultra wide band communication systems have found many interests in recent years [1], [2]. Power amplifier is an important component at such systems where their features like efficiency, output power and gain affect system performance strongly. To reduce cost, complexity and life time limitations in base and mobile stations, wide band and high efficiency power amplifiers are essential. To improve frequency performance of power amplifiers many researches have been carried out. Distributed amplifier is a promising approach to extend frequency bandwidth [3]-[5]. However this technique employs multiple transistors which adds manufacturing complexity and cost to the design and leads to low power added efficiency and relatively low gain.

Fig.1 illustrates a simple model of a power amplifier with a single active device. The transistor is modeled by an ideal current source shunted by an output capacitance denoted by C_{out}. Due to this capacitance, optimal load impedance for maximum output power and high efficiency is not constant in the operating frequency bandwidth. Therefore variable optimum load impedance is a bottleneck for designing wide band power amplifiers (WPA) with a single transistor.

To mitigate this problem, a usual approach is optimization of a specific topology over the whole frequency bandwidth [6]-[10]. Indeed, a matching structure is selected and then according to the load pull data, a CAD optimization over the entire frequency band is applied. Since load pull data differ for different transistors, this method based on CAD optimization cannot be considered as a general procedure to design WPAs.

Real frequency technique is a favorable approach to match a variable complex impedance to a fixed real impedance over a wide frequency bandwidth [11]. This method has been studied extensively in recent years to design WPAs [12], [13], wide band Doherty [14] and continuous mode power amplifiers [15].

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