The Analysis of Low Phase Nonlinearity 3.1-6 GHz CMOS Power Amplifier for UWB System

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***Abstract*—Low phase nonlinearity is important criteria in power amplifier (PA) especially in ultra-wideband system so that the output will remain original identity. Up to date there is no analysis study have been established in achieving low group delay PA in UWB technology, therefore this paper is to examined the factors that affect low phase nonlinearity in 3.1-6.0 GHz PA using two-stage amplifier with shunt resistive feedback technique for UWB system. The proposed PA adopts two stages amplifier together with inter-stage circuit to obtain adequate flatness of the gain. The shunt resistive feedback topology is used to have very wide input matching. The inductive peaking technique and Class A amplifier is adopted to obtain high gain flatness, low phase nonlinearity and linearity simultaneously. The analysis shows that the dominant factor is identified for low phase nonlinearity in UWB PA. The proposed PA achieves the average gain of 10±1 dB, S_{11}<-6dB, S_{22}< -7 dB, and phase nonlinearity of ±195.5 ps. A good linearity and power consumption are obtained. Therefore, these key performance factors of low phase nonlinearity can be applied to facilitate other researchers working in the area of power amplifier circuit design.**

***Index Terms*—Power Amplifier; CMOS; UWB; Phase Nonlinearity;**

I. INTRODUCTION

UWB technology has recently received significant attention to all researchers including academia and industry because of interesting benefit of high data rate, short distance range technology and low power. This makes UWB as fascinating technology for military and medical purposes that apply radar and information sensing [1, 2]. Multiband orthogonal frequency division multiplexing (MB-OFDM) proposal is a major solutions under consideration for UWB transceiver. MB-OFDM proposal offers each channel of 528 MHz by using 122 QPSK sub-carriers with 14 channels into five groups from 3.1–10.6 GHz as shown in Figure 1 [3, 4].

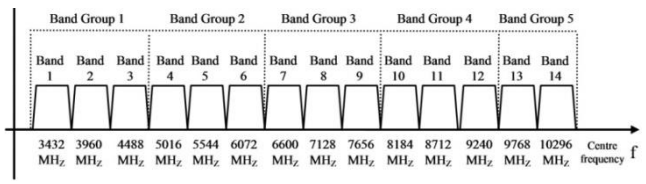

Figure 1: The band structure of MB-OFDM UWB system [4]

Group 1 and Group 2 with frequency range of 3.1 to 6.07 GHz is chosen as proposed PA [5]. The challenge in UWB module is to achieve low phase nonlinearity in power amplifier over a wide frequency band. Low phase nonlinearity is required so that the output will retain its original identity and the time domain will not become distorted especially for UWB system using impulse signal [6].

Several approaches UWB PAs have been implemented for frequency of 3.0–5.0 GHz (Group 1) [7-9], 3.0-6.0 (Group 1 to Group 2) [10, 11], 3.0–7.0 GHz (Group 1 to Group 3) [12], 5.0-10 GHz (Group 2 to Group 5) [13], 6.0–10.0 GHz (Group 4 to Group 5) [14, 15] and 3.1-10.6 GHz (Group 1 to Group 5) [16, 17]. Each of the group used different approach depending with the application. The distributed amplifier is typically used for wide frequency range and provides good linearity. However, this approach uses large area of chip and consumes high power consumption which is not suitable for UWB applications [18]. The RLC matching has the capability to offer very wideband matching but since that this approach requires many reactive element to form RLC filter that cause large area of chip [19]. The shunt feedback topology has advantage to offer flat gain and good wideband input and output matching, but high power consumption will produced [8]. In current-reused technique is one of the latest topology that used in UWB PA to have low power consumption, however it is tough to fulfil high gain with very wide frequency [12]. Another fabricated PA reported by using cascade common source topology also have shown that very wide band of 3.1 to 10.6 GHz , low phase nonlinearity, high gain, good gain flatness and small chip area were implemented and designed in PA for UWB application [11]. However, this design consumes very high power consumption up to 100 mW. Since that phase nonlinearity is one of the important criteria in power amplifier design for UWB and based on the studies mentioned above there is no analysis study have been established in achieving low phase nonlinearity power amplifier in UWB system.

This paper is to investigate the dominant factors influence in achieving minimum phase nonlinearity power amplifier from 3.1 to 6.0 GHz for UWB technology. In order to achieve phase nonlinearity, adequate and solid understanding is required on main design factors that must take into account, which include operating bandwidth, phase nonlinearity, linearity, and gain flatness for UWB. The theoretical analysis on the low phase nonlinearity is specified for UWB PA. Thus, the implementation of PA design is using 0.18µm CMOS technology has achieved average gain of S_{12}, good linearity, low phase nonlinearity, simultaneously. Also, the area of chip size is very small. The paper outline is as follows. In section II, the proposed design of UWB PA is presented. Section III, IV and V discuss the