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" On the Intelligent Components Geometry Design of a Variant of "

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میر مجتبی میرصالحی

دبیر کمیته علمی کنفرانس

On the Intelligent Components Geometry Design of a Current Reuse Folded Cascode Concurrent Dual-band CMOS LNA

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Abstract: *In this paper, an optimized design procedure based on evolutionary algorithms for automatic synthesis of a current reuse folded cascode dual-band concurrent fully integrated low-noise amplifiers (LNA) targeted to 802.16d @ 3.5GHz and 802.11b, g @ 2.4GHz standards is discussed. Algorithm is intended to compute the circuit elements geometry and bias levels capable of maintaining the best level of gain, input matching, output matching and power consumption. The genetic algorithm optimization engine is developed in MATLAB environment and performance evaluation in 0.18µm RF CMOS TSMC technology is ceded to HSPICE. Results indicate that the automated scheme well renders the desired circuit in an acceptable computation time, otherwise, either tremendous manual trial and errors or an astronomical cycles of exhaustive search is required.*

Keywords: Genetic algorithm, Concurrent dual-band LNA, Input/output matching, Low-noise amplifier.

1. Introduction

In response to the growing demand for multiprotocol wireless communication units, efforts for reduction of size, integration of circuits and automatic design for lowering cost has gained tremendous attention. In this respect, four techniques have been adopted: 1) A cost inefficient parallel mode 2) A non-concurrent switched mode [1, 2]. 3) An LNA with a wideband input [3]. 4) A concurrent multiband input circuit [3] which its cost increasing could be minimal if an appropriate design is implemented. The typical savings in concurrent LNA are die area (25%) and power consumption (40%) compared with the parallel LNA approach [3]. Several fully integrated concurrent dual band LNA topologies such as cascode [3], folded cascode [1] and their variants are under investigations.

The LNA components are often calculated using approximate equations assuming idealness of the elements, hence, a significant shift in theoretical and simulation results are generally observed [4]. Due to the sensitivity of circuit to parasitic elements and lack of accurate models for integrated passive elements, many trial and error attempts in reaching to an acceptable result are also inevitable. The design ordeal can be circumvented by an automated procedure, which can increase efficiency in both circuit performance and time consumption [5]. Evolutionary algorithms are prime choices for intelligent handling of the automatic search task. Either the entire design or the manual trial and error part can be left for them.

There are plenty of research papers studying the application of intelligent methods in circuit design. Design of a single band LNA using GA for exploration in search space and Levenberg–Marquardt method for exploitation has been detailed in [6]. A simulation-based analog circuit synthesis methodology using evolutionary algorithms has been elaborated in [7]. Dual band input matching using Particle Swarm Optimization (PSO) is the subject of investigation in [8]. In [4] there is a switched dual band LNA design by employing a PSO based output circuit exploration. A study on circuit component sizing using differential evolution has been investigated in [9].

In this paper, intelligent automatic design of a fully integrated 0.18 m CMOS concurrent folded cascode dual-band LNA operating at 2.4GHz for IEEE 802.11b/g (WLAN) and 3.5GHz for IEEE 802.16d (WiMAX) is elaborated. The GA is implemented using MATLAB and circuit performance evaluation is conducted by employing the well-known circuit simulation tool, HSPICE that has been integrated into the program. The subject of optimization is the geometry, rather than the value, of the LNA circuit elements such as inductances, resistances, transistors as well as biasing conditions under specific problem constraints. The results indicate that the automated algorithm yields circuits with performance comparable or even better than those have already been published while the speed of design is increased.

In section 2, GA optimization is briefly reviewed. Section 3 yields the result of the GA optimization and the performance of the underlying circuits. Finally, conclusion comes in section 4.

2. GA-based Optimization Engine

2.1 Genetic Algorithm [10]

GA is an intelligent global search optimization algorithm that mimics the natural genetic evolution. The typical GA algorithm constitutes the following steps: