AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electronics and Communications Engineering Department

CMOS Design of a 60GHz Receiver Front End

A Thesis

Submitted in Partial Fulfillment of the Requirements For the Degree of Master of Science in Electrical Engineering

(Electronics and Communications Engineering)

Submitted By
Eng. Nehad Ahmed Mohamed Mostafa Mansour

Supervised By
Prof. Adel E. El-Hennawy
Prof. Hassan Ahmed El Ghitani
Dr. Mohamed Mohamed El Nozahi
Cairo – Egypt

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جامعة عين شمس
كلية الهندسة
Ain Shams University
Faculty of Engineering
Electronics and Communications Department

Name: Nehad Ahmed Mohamed Mansour
Thesis Title: CMOS Design of a 60GHz Front End Receiver
Degree: Master of Science in Electrical Engineering
Department: Electronics and Communications Engineering

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Curriculum Vitae

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Date of Birth: 1 January 1983

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Date of Degree: June 2005

Statement

This dissertation is submitted to the Faculty of Engineering, Ain Shams University for the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis was carried out by the author at the Electronics and Communications Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualification at any other university or institution.

Name: Nehad Ahmed Mohamed Mansour

Signature:

Date:

To my dear parents, Siada Thakeb, Ahmed Mansour, and Nevine Ghourab.
To my beloved husband, Ahmed Samir.
To my adorable children, Nour and Karim.
To my lovely sister, Gihad Mansour.
To my dear friend, Rana Aly.

With all my love and gratitude

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Name: Nehad Ahmed Mohamed Mansour

Thesis Title: CMOS Design of a 60GHz Receiver Front End

Degree: Master of Science dissertation, faculty of Engineering, Ain Shams University, 2014

Abstract

In this Thesis, a survey on different RF front end receivers is carried out. And, the two basic building blocks; LNA and Mixer; of the front end receiver are designed. The Mixer is designed using the Conventional Single Balanced Gilbert Cell Mixer topology. A new matching network and design methodology for the matching network is proposed for the inductively generated LNA. The new matching network leads to the minimum possible *NF* of the conventional LNA. The theory and the optimization algorithm were demonstrated in this thesis. The new methodology depends on a developed theory in which the single ended LNA is divided into two identical parallel half sections, and the final output is the sum of these two sections. The matching network is then viewed as a phase shifter with an optimum phase to cancel the noise of the other section.

Designing the matching network to give total noise phase shift between the two outputs equal 180°, with approximately equal amplitudes, resulting in nearly zero noise signal at the output of the adder stage causing what is called destructive addition to the generated noise signal at the output of the whole new LNA block. Leaving the signal pass through same paths to have same phase and same amplitude at the inputs of the adder stage, resulting in constructive addition to the input signal. Thus, the noise figure of the LNA block can be easily enhanced. The achieved noise figure is lower than the traditional architecture by 1.1 dB using the same technology node of 130 nm CMOS technology operating at the same frequency.

The design for both the mixer and the LNA was carried out using 130 nm TSMC design kit and a supply voltage of 2 volts. The newly proposed methodology is the first approach at this specific frequency of operation; 60GHz; that performs noise cancellation. The obtained *NF* is the best reported when compared to similar designs using the 130 nm technology node.

Key words:

RF receiver architectures, monolithic image reject filter, inductive degenerated common source low noise amplifier, single balanced gilbert cell mixer, noise figure enhancement, phase shifting, millimeter wave.

Contents