AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

CAIRO – EGYPT

RF Front End for LTE Receiver

A Thesis

Submitted in partial fulfillment for the requirements of the degree of

Master of Science in Electrical Engineering

Electronics and Communications Engineering Department

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STATEMENT

This Thesis is submitted to Ain Shams University in partial fulfillment of the degree of Master of Science in Electrical Engineering.

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

No part of this Thesis has been submitted for a degree or a qualification at any other university or institute.

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Published Papers

1. Dalia Sadek, Abdelhalim Zekry and Heba A. Shawkey," Passive Front End for LTE TDD Transceiver ", International Journal of Computer Applications, (0975-8887), Vol. 116-No.8, pp. 6-11 April, 2015.

2. Dalia Sadek, Abdelhalim Zekry and Heba A. Shawkey, "Constructing Complete Radio Frequency Receiver for LTE TDD Transceiver ", Communications on Applied Electronics, ISSN: 2394-4714 Foundation of Computer Science, FCS, New York, USA, Volume 3– No.2, October 2015

Abstract

The development of wireless communication systems into multi-standard radio architectures that can process a multitude of frequency bands and modulation schemes has led to a growing demand for wideband receiver front-ends. To allow for portability and low cost, these new architectures also need to be compact size, low power. These requirements have made the simple architecture of the Zero IF receiver, especially attractive for this application. The design of a Zero IF receiver that comply the new standards LTE meets several challenges. The new standards take advantage of the multi carrier modulation scheme OFDM to increase spectral efficiency, which demands for higher linearity because of a non-constant signal envelope. Zero IF architectures consist of two main parts, the first part is the passive one which consists of an antenna and band pass filter and the second part which is the active part consists of Low noise amplifier, demodulator and synthesizer. The frequency spectrum allocated for an LTE range from 700MHz to 2.7GHz.

This thesis focuses on the design and implementation of zero if LTE receiver operates at band 36 TDD (1930-1990) MHz. The proposed receiver consists of two parts a passive part, an antenna and hairpin filter and an active part which is the LNA, demodulator and frequency synthesizer.

The first goal is to design and fabricate the passive components of the front end receiver which are a microstrip patch antenna with defected ground structure and a third order hairpin band pass filter. The antenna and filter are analyzed using Computer Simulation Technology (CST) Microwave Studio. The proposed devices are fabricated using FR-4 material substrate. The overall dimensions of the antenna are 43mm x36mm x1. 6mm. the antenna operates between 1923 MHz to 1990 MHz for return loss -10 dB and covers LTE network band 2 FDD mode downlink and band 36 TDD mode. The simulation results were 2.67dBi directivity and1.242dB gain with omnidirectional radiation pattern, a return loss of -31.85dB at resonant frequency 1950 MHz and 70 MHz minimum bandwidth at -10 dB return loss.

The hairpin third order band pass filter with overall dimensions 38.6mm x32.16 mm x1.6mm, center frequency of 1950 MHz and -3dB BW of 90 MHz in addition to a fractional bandwidth of 4.615%. The filter covers LTE network band 36 (TDD).

The second goal that this thesis focuses is selecting a real made off-shelf components for the active part of the front end receiver which include Low noise amplifier, IQ demodulator and frequency synthesizer.

The third goal is combine the passive part with the active part to make a complete RF front end receiver for LTE, then test and measure the whole system. Scattering parameters are measured by using the Vector Network Analyzer (VNA) E8719A. The power measurements are made using Signal Analyzer N9010A, Agilent E8267D PSG Vector Signal Generator and Spectrum Analyzer. Measurements and simulations show good agreement. The receiver front-end is covering a bandwidth (1930-1990) MHz with a noise figure 4.022 dB and IIP3 of 2.65 dBm. The measured performance of the proposed receiver is compared with other receivers to prove its validity for LTE applications.

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C_{gs}	Gate-Source Capacitance
F_i	Noise factor of the i stage
G_i	Gain of the i stage
g_i	Normalized element of filter
g_m	Transconductance
h	Height of dielectric substrate (m)
I_D	Drain Current
IIP3	Input Third Order Intercept Point
L_{Ar}	Passband return loss
L_{AS}	Stopband attenuation
OIP3	Output Third Order Intercept Point
P_{DC}	Power Delivered from the DC Power Supply
$P_{I1\text{-}dB}$	Input Referred 1-dB Compression Point (in dB)
P_{in}	Power of The Input Signal
$P_{O1\text{-}dB}$	Output Referred 1-dB Compression Point (in dB)
P_{out}	Power of The Output Signal
S_{11}	Input Return Loss
S_{12}	Reverse Isolation
S_{21}	Power Gain
S_{22}	Output Return Loss
Tan δ	Loss tangent
V_{DS}	Drain-Source Voltage
V_{gs}	Gate-Source Voltage
Z_{in}	Input Impedance
Z_0	Characteristic Impedance
β	Propagation Constant in Free Space
ε_{eff}	Relative Permittivity