/ 70 2018-19

CMOS Realization of Electronically tunable Grounded Inductor Application Band Pass Amplifier Design for Noise Minimization in RF System

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Abstract— **We present grounded Inductor based band-pass Amplifier to minimize the noise with the degenerative feedback resistance technique in common source and common gate configuration of MOS Transistor.The thermal noise of the proposed MOS Transistor architecture is reduced noise by using input feedback stage with a degeneration resistor in the common source and common gate configuration. RF Band Pass Amplifier which has grounded inductor, low-noise amplifiers (LNA) and An Radio Frequency (RF) band-pass filter (BPF) for proposed RF System to minimize the noise with .18µm as well as CMOS 90 nm technology. The quality factor obtained at maximum resonant frequency which are 4.0 - 4.4 at 3.849 GHz respectively.The tuning frequency range at 3.43 GHz- 3.849 GHz, and the band pass filter parameters yield total power consumption of 0.81mW - 1.46 mW, at low noise figure of 4.2 dB - 5.4 dB with the low noise sensitivity 3.10µm-3.13µm . The inductors are simulated by active elements namely Voltage Differencing Voltage transconductance Amplifier (VDVTA) and Gyrator C are key features in Radio Frequency Integrated Circuits.**

Keywords— **Radio Frequency (RF), Band-Pass Filter (BPF), Low-Noise Amplifiers (LNA), Voltage Differencing Voltage transconductance Amplifier (VDVTA).**

I. Introduction

In the past few decade spiral inductor simulated architectures using MOS transistors [1][2][3][4][5][7][9] can be found in the literature higher noise, nonlinearity and power consumption are the major disadvantages of spiral inductors due to the fact that these circuits are realized using active building blocks which have higher noise. Thermal noise reduction has been successfully implemented in LNA circuits by removing the noise of their input MOS transistors [6][7]. In this paper, noise minimization is applied to grounded inductor configuration with Gyrator-C as well as VDVTA configuration, and its noise is reduced using the degenerative resistive feedback. Noise minimization allows grounded inductors to be used in such applications as front-end active RF band pass filter in receivers and also to design low-phase noise oscillators [8][12][13]17].

The demand of integrated circuit is ever increasing the advancement of CMOS technology. The inductor has mo major role in RF system design such as voltage controlled oscillator, low noise amplifier, matching active network, filter power supply noise reduction etc. The block diagram of proposed of RF Band Pass Amplifier is shown in fig 1[9][10][11].The last few decade researcher work on inductor based on some recently active building blocks namely OP-Amp, OTA, CCII, OTRA, CFOA, CDTA, VDIBA and gyrator-C etc. VDVTA and Gyrator-C based CMOS grounded inductor is recent research topic because of its electronically tunable, compactness and the major advantage of grounded inductor over passive counterpart is it's electronically tunability. Nevertheless, most of spiral inductor has certain drawbacks as high power consumption, large noise, poor linearity all these are inherent in grounded inductor circuit. The Gallium Arsenide (GaAs), Metal Semiconductor Field-Effect Transistor (MESFET) and bipolar technologies are the alternative techniques to realize an grounded inductor but the CMOS grounded inductor has presented the greatest advantages towards the inexpensive chip design as the enhancement of the integrated circuit technologies; the usage of passive inductors is degrading due to their large chip area, low-quality factor, and less tenability. Mainly the inductor is the major chip area consuming element [5][10][14][16]; the higher the inductance required, the higher the chip area.

The inductor has more important role in RF system design such as voltage, power consumption and size.

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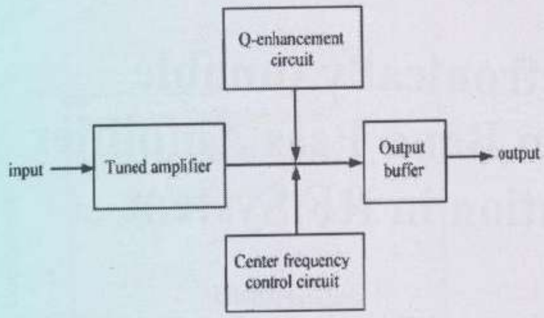

Fig. 1. Block Diagram of Proposed Band Pass Amplifier with VDVTA and Gyrator-C Based Band Pass Filter

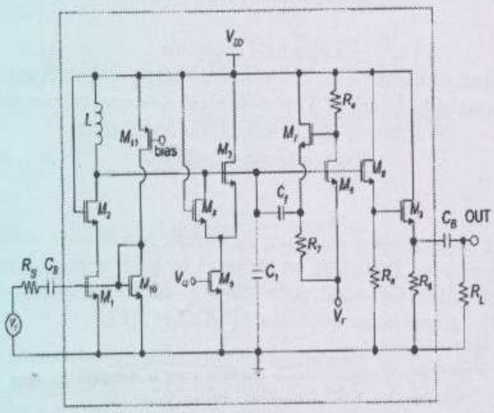

Fig. 2. Proposed Band Pass Amplifier Circuit with Degenerative load for RF System

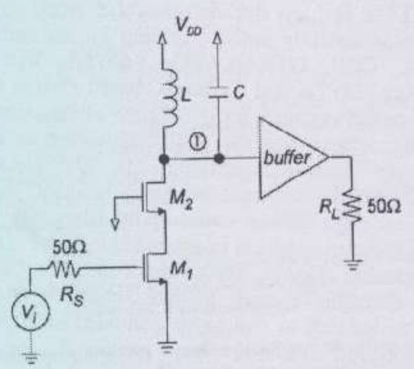

Fig. 3. Inductor Application Based Ideal Band Pass Amplifier for RF Circuit

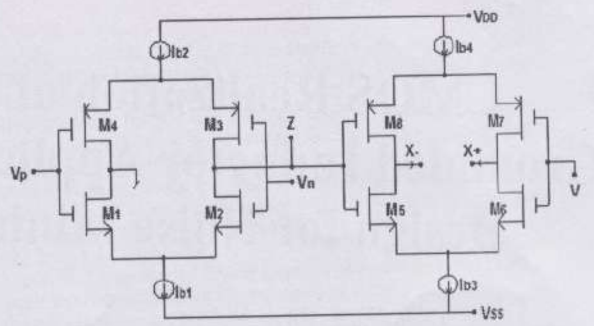

Fig. 4. Proposed C MOS Simulation circuit of VDVTA Based Grounded Circuit for band Pass Amplifier Circuit

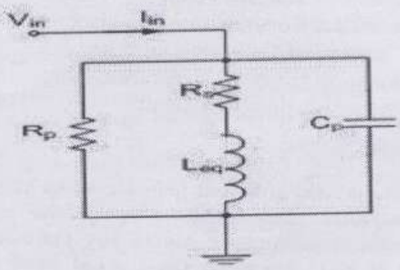

Fig. 5. Equivalent Circuit of Grounded Inductor

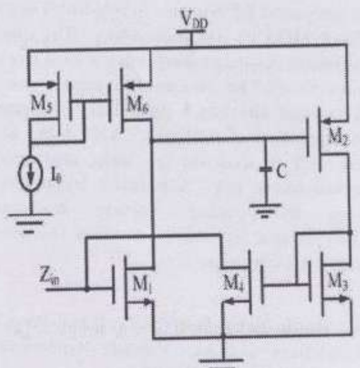

Fig. 6. Proposed High Quality factor grounded Inductor

II. RF Band Pass Amplifier Architecture

A. *Low Noise Grounded Inductor in the proposed RF System*

In this work, differential configuration with positive feedback which makes the entire circuit less sensitive to noise. We employed two techniques: usage of PMOS and (ii) differential configuration using only NMOS transistors. These two presented techniques in the circuit presents high inductive bandwidth and low noise [1][2][3][4][5][12].

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Recently common gate and common source gyrator as well as VDVTA based grounded inductor has been discussed in [15][17][19] as shown in Fig. 17. Less number of MOS transistors provides the small chip area and low power consumption of grounded inductor circuit but the higher value of parasitic series resistance and lower value of parallel resistance value provide the lower value of quality factor[6][7][8][9][18].

B. *Low Noise Amplifier in RF System*

Low noise Amplifier (LNA) plays a vital role in Rf system. The low noise amplifiers are very useful in various field such as wireless communication, Radar System and satellite communication. The low noise amplifier receive from the RF input signal and amplify it after that this signal feed to the mixer stage which can add or subtract the output of the mixer stage with local oscillator. Low noise amplifier effect the sensitivity of the RF system. It is suitable to detect noise and enhanced the signal to noise at the tunable frequency range [9][12][13].

C. *Degenerative Resistive Feedback Resistance*

The addition of degenerative feedback resistance Rf which improves the gain of the proposed RF System. As exhibited in Fig. 2, the feedback resistance Rf presents an additional inductive reactance which significantly increase the inductance. To make the circuit electronically tunable, resistance Rf can be implemented [11][13][14].

In order to electronically tuning range of grounded inductance and quality factor individually presented in Fig. 6 and fig.7.

The addition of feedback amplifier (M4) to control the gate of M3 further reduces the output transconductance and it is electronically tunable with bias current of M3. Fig. 6 and 7are composed of two Trans conductors realized by MOS transistors in common source and common gate configurations connected in degenerative resistive feedback. The common source configuration presents low conductance at the input and output nodes. Therefore it provides high quality factor [17][18][20].

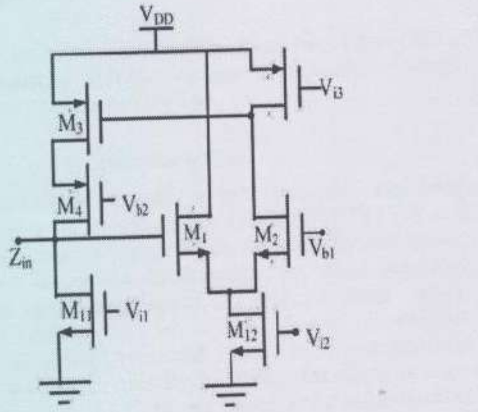

Fig. 7. Proposed Low Noise grounded Inductor

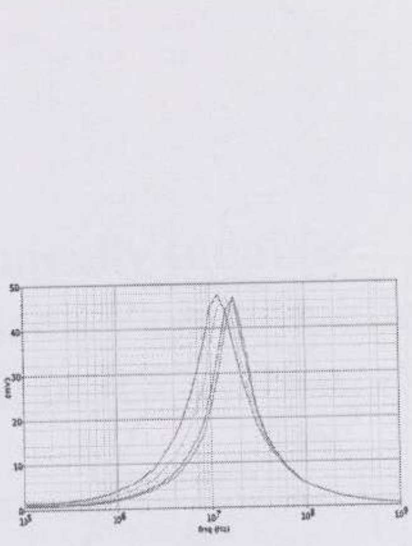

Fig. 8. AC response of Proposed Band Pass Amplifier

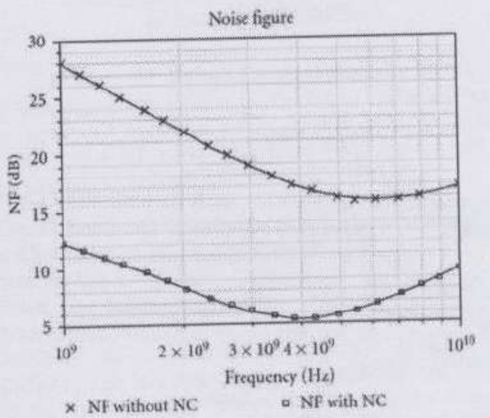

Fig. 9. Noise Figure

III. CMOS Simulation Results

The AC response of band pass amplifies with gain 48.24dB at resonant frequency 3.849 GHz is shown in the fig.8. The simulation result in the fig.9 the low noise figure of 4.2- 5.4 dB with low noise sensitivity 3.10μm - 3.13μm at resonant frequency 3.849 GHz and simulated quality factor 4.0 - 4.4 at 3.849 GHz which is shown in fig10. The tuning frequency range at 3.43 GHz- 3.849 GHz,

The simulation result also shows the power consumption 0.81mW-1.46mW. The proposed grounded Inductor topologies are effectively reduced the output conductance and subsequently reduce the series resistance. The simulated grounded inductor by active building blocks is major component in proposed RF System design. The noise minimization is achieved successfully employed low noise amplifier in the RF system. This approaches to achieve higher inductance and quality factor, it limits dynamic range and it is not compatible with low voltage operation.

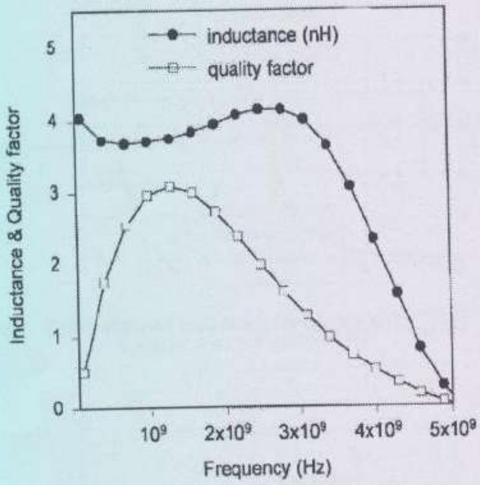

Fig. 10. Quality factor vs. frequency

IV. CONCLUSION

This paper presents of comparative analysis with VDVTA and gyrator based CMOS Band Pass Amplifier. The Band Pass Amplifier has been realized using CMOS 0.18µm as well as 90 nm used to enhance the performance of RF Band Pass Amplifier by using degenerative resistance feedback. As per the application requirement the grounded inductor circuit can be used RF System.

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