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OTA for WLAN WiFi Application Using CMOS 90nm Technology

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Abstract: WiFi is the innovation in wireless technology used to interface PCs, tablets, cell phones and different gadgets to the internet. The recent innovation WiFi works on two different frequency bands that bands are 2.4 GHz and 5 GHz. For larger coverage 2.4GHz frequency band is used and for higher data rate 5GHz frequency band is used. In this paper present the CMOS based operational transconductance amplifier (OTA) for 2.4GHz and 5GHz both frequency band WiFi application. The proposed OTA is designed using the CMOS 90nm environment with cascade current mirror architecture. The frequency tuning of the proposed OTA is done by using the varying capacitor.

Keywords: *nMOS, pMOS, complementary metal-oxide semiconductor (CMOS), Operational Transconductance Amplifier (OTA), WiFi, Wireless Communication, High Frequency.*

1. Introduction

In recent scenarios wireless communications have grown expeditiously. It requires more minute contrivances to install multiband communications [1]. Wireless communication devices have a new scenario called IoT. Everything that exists in the world or exists in the future, internet is the facility to manage them using IoT [2-3]. In the ongoing age of communication all the data are communicated through the internet [4]. Every one of the equipment's that we use in our day to day existence is a piece of internet and can be controlled and noticed using device. Hence, the connection between human-PC or digital device things is made sense of by innovation [5-6]. The wireless communication system is used by everywhere by using the Bluetooth and WiFi [7]. In the ongoing market max of the device are portable. Since almost every device requires battery to be operated, it has become a necessity to design circuits which consume minimum of supply voltage and current [8]. A small reduction over supply voltage or current consumption returns an increased battery life this in turn be reciprocated in the value of the product. So for that purpose low voltage low power based CMOS device or VLSI device demand increase in the market [9]. These devices need to be connected to the wireless network Bluetooth, Wi-Fi, and at this stage they need a transceiver. With this the enhancement of transceiver device which may operate at low voltage has become a call of time [10].

2. Operation Transconductance Amplifier (OTA)

Operational transconductance amplifier is an amplifier whose differential input voltage generates an output current. Therefore, it is the voltage control current source. Normally, a current input for controlling the current conversion of the amplifier is added. The OTA has a high impedance input phase and is similar to a standard op amp in that it can be used for negative feedback [11].

The first commercially available integrated circuit module was manufactured by CAR in 1969 (before being purchased by GE) as CA 3080 (discontinued product) and then upgraded. Most units consist of bipolar transistors, but field

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effect transistor units are also being manufactured. Because its output is common, the OTA is not useful in most of the standard operating subwoofer functions as normal operational amplifiers. One of the main uses is the implementation of electronic control applications such as oscillator, variable frequency filter, and stage of variable gain amplifier [12].

In many analog and mixed signals the OTA is one of the most important and an integral part of it which is used for the low-power systems designing [13]. The design of the OTA is difficult because the supply voltage and the channel length of the transistor are reduced for each new generation of CMOS technology. OTA is a general purpose building block for analog processing systems [14]. The design of these building blocks is a challenging task in the terms of low power consumption, gain of the circuit and efficiency of the product bandwidth [15]. The driver is classified mainly as OTA output, individual output, differential final output or fully differential OTA.

3. Proposed Methodology

In the fig 1 shown the proposed OTA design. The proposed CMOS OTA design is implemented and simulated using the LTSpice XVII software using 90nm CMOS technology environment. The supply voltage (Vdd) of the proposed OTA is 3.8V and biasing voltage (Vb) is -0.4V. In table 1 display the transistor dimension of the proposed OTA design for WiFi application.

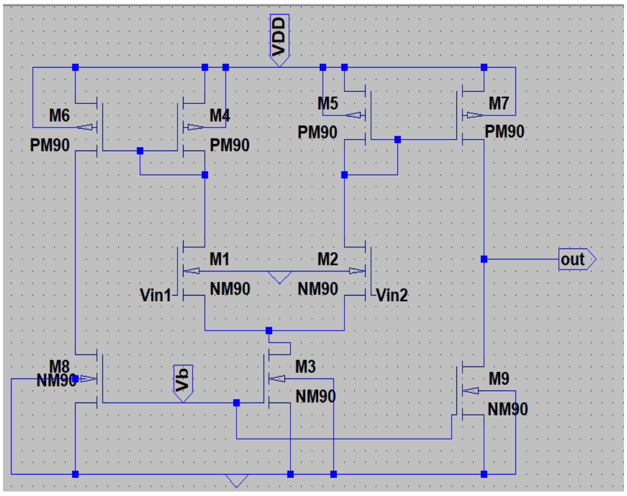

Figure 1- Proposed OTA Design

Table 1. Transistor Dimension of the Proposed OTA Design for WiFi Application

Transistor No.	Width (W μm)	Length (L)
M1, M2	17	90 nm
M3	35	1 μm
M4, M5	4	90 nm
M6, M7	20	90 nm
M8, M9	17	1μm

DC Analysis of Proposed OTA

For DC simulation analysis added register of 10 ohm at the output terminal of the proposed OTA design. The configuration of the proposed CMOS OTA for DC analysis is shown in fig 2. The overall current of the proposed OTA is 37.04mA that is shown in the fig 3.

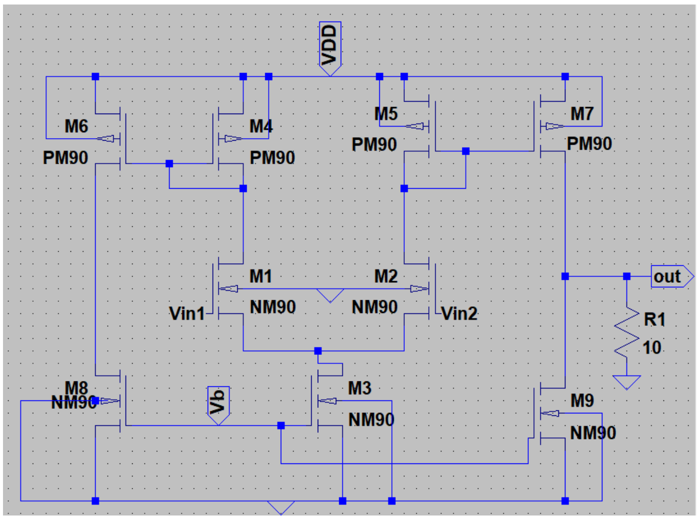

Figure 2- Proposed OTA Design Configuration for DC Analysis

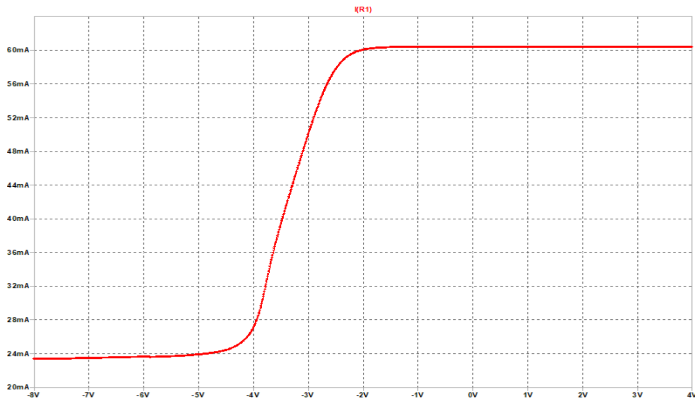

Figure 3- Overall Current of Proposed OTA Configuration for WiFi Application

AC Analysis of Proposed OTA

For AC simulation analysis of the proposed CMOS OTA for 2.4 GHz WiFi application added a capacitor of value 1pF at the output terminal and proposed OTA configuration for frequency response of 2.4 GHz WiFi application is displayed in fig 4. In Fig 5 display the frequency, magnitude and phase response of proposed OTA for 2.4 GHz WiFi application.

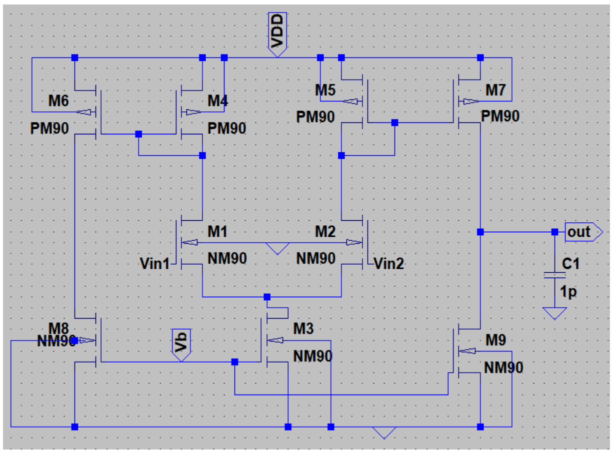

Figure 4- Proposed OTA Design Configuration for AC Analysis of 2.4 GHz WiFi Application

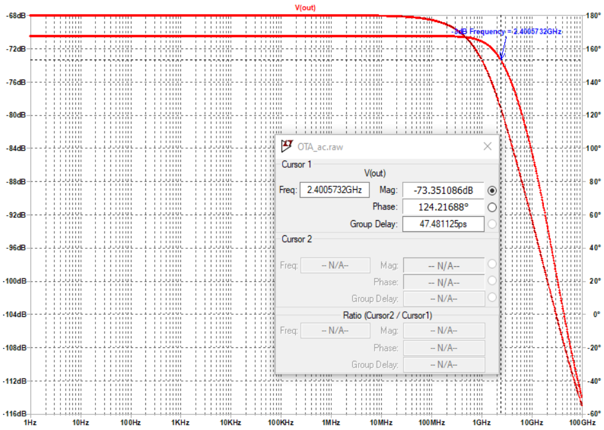

Figure 5- Frequency, Magnitude and phase Response of Proposed OTA for 2.4 GHz WiFi Application

For 5GHz WiFi application of proposed CMOS OTA AC simulation analysis added a capacitor of value 0.4 pF at the output terminal and proposed OTA configuration for frequency response of 5GHz WiFi application is displayed in fig 6. In Fig 7 display the frequency, magnitude and phase response of proposed OTA for 5 GHz WiFi application.

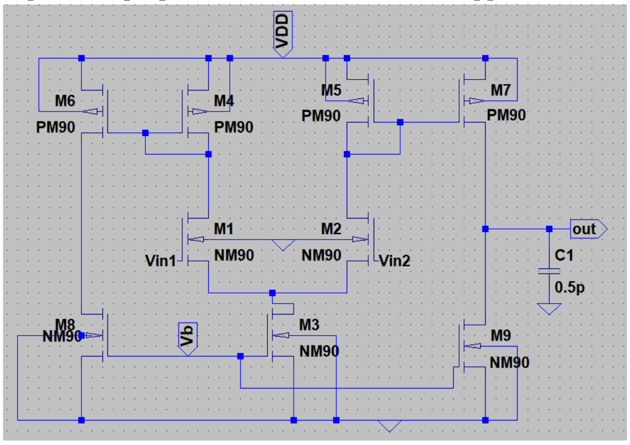

Figure 6- Proposed OTA Design Configuration for AC Analysis of 5 GHz WiFi Application

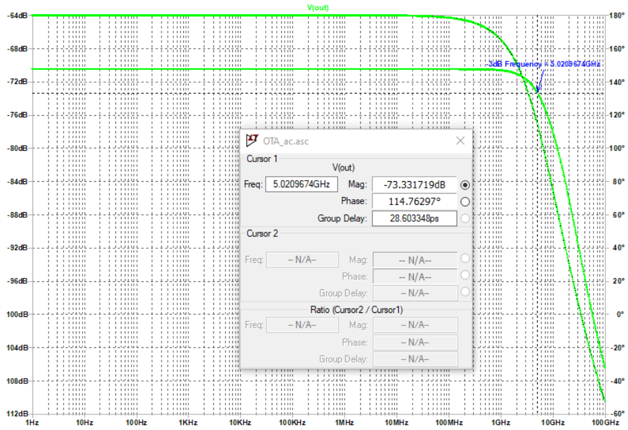

Figure 7- Frequency, Magnitude and phase Response of Proposed OTA for 5 GHz WiFi Application

Table 2. Obtained Results from AC Analysis of Proposed OTA for WiFi Application

Parameter	Value	
	For 2.4 GHz WiFi Application	**For 5 GHz WiFi Application**
-3dB Frequency Response (GHz)	2.4005732	5.0209674
Magnitude (dB)	-73.351086	-73.331719
Phase	124.21688°	114.76294°
Group Delay (ps)	47.481125	28.603348
Power Dissipation (mW)	43.26	43.26

4. Conclusion

In this present a CMOS OTA for WLAN WiFi application. The operating frequency of WiFi is 2.4GHz and 5 Ghz. The proposed OTA is design and simulated in LTspice XVII software using CMSO 90nm technology with 3.8V supply voltage and -0.4 basing voltage. The obtained response for 2.4GHz WLAN WiFi application are -3dB frequency response is 2.4005732GHz, magnitude is -73.351086dB, phase is 124.21688°, group delay is 47.481125ps and power dissipation is 43.26 mW. The obtained response for 5GHz WLAN WiFi application are -3dB frequency response is 5.0209674GHz, magnitude is -73.331719dB, phase is 114.76294°, group delay is 28.603348ps and power dissipation is 43.26 mW. The proposed OTA is work on both the frequency band of WiFi 2.4GHz and 5GHz frequency band. The frequency of the proposed OTA is tune by using the varying capacitance. For 2.4GHz WiFi application the capacitor value is 1pF and for the 5GHz frequency WiFi application the capacitor value is 0.4pF.

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