Design of High pass and Low pass Filter using CMOS Operational Trans-conductance Amplifier

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Abstract- Low Power Consumption is the main target in today's Technological aura and as Very large scale integrated circuit (VLSI) designing is very complex and it require much conceding nature to realise application precise objective. With increasing the efforts to reduce Power Consumption and to reduce W/L ratio, Low pass and high pass filter structure have widespread application and using CMOS Operational Trans-conductance amplifier gives capability to perform well in Nano-meter range as it has better control over short channel effect and other scaling problem like gate leakage, sub-threshold conduction. Low pass and high pass filter based on OTA for VHF and UHF frequency applications. At high frequencies, the OP AMP based active filters has limited performance. We cannot change the values of resistors and inductors but OTA-C filter provides ability to change their values by changing trans-conductance of OTA. The proposed filter consists of OTA and capacitors. This filter shows low sensitivity to passive components, low component count and ease in design. The simulations are done using Tanner EDA version 16.2 at 0.25nm technology.

Index Terms- AC characteristics; CMOS; DC characteristics; High pass filter; Low pass filter; OTA-C; Slew Rate;

I. INTRODUCTION

Analogue filters play a very significant role in every electronic system. Low pass filter passes signal with a frequency lower than a certain cut-off frequency and attenuates signal with frequencies higher than the cut-off frequency. The designing of filter using passive ladder filter as a prototype for active filters, such as operational trans-conductance amplifiers and capacitors (OTA-C), has become very popular. There is a increasing concern in continuous time filters because of applications such as portable electronic equipment, wireless receivers, continuous-time analogy-to-digital converters and etc. and for low power consumption here the most important part of the modulator is the OTA.[1] The main specifications of loop filter are very high linearity, high tune-ability and high DC-gain. The minimum input of the modulator is determined by the input referred noise seen at the trans-conductor, and the maximum input is limited by the linearity of trans-conductor, because transistors have nonlinear behaviour at high frequency and introduce harmonic distortions.[2]

The Designing of OTA is done on Tanner EDA software. It is a suite of tools for the design of integrated circuits. These tools allow us to enter. There are mainly three tools S-edit, W-edit, and L-edit. In S-edit that is Schematic, is a representation of the elements of a system using abstract, graphic symbols rather than realistic pictures. Design of the High Pass and Low Pass filters are first done on Schematic to check its Simulation and waveforms it generates T-Spice file and that shoe the results of the circuits. Another tool of Tanner EDA is L-Edit and it is an integrated circuit Physical design tool it allows us to draw layout of a circuit and look at cross-section, perform DRC (Design Rule Check) and generate a Netlist of your Layout so that we can perform LVS (Layout Versus Schematic) using a different tool.[3]

II. OTA DESIGN

Design of operational trans-conductance amplifier (OTA) is the main focus of this paper for designing high pass and low pass filter. The simplicity and linearity are the essential features of the OTA intended for any application. Filters using OTA and capacitors are called OTA-C filters or Gm-C filters. The Schematic of OTA is shown in Figure 1. An OTA integrator is the simplest OTA-C filter, which can be called as a first order low pass filter. It consists of only OTA and a capacitor. For designing of OTA-C filter, the passive ladder is taken as prototype and then using signal flow graph, and finally the required filter circuit is designed. There are numerous unlike OTA's are used in which this OTA is a simple OTA with low supply voltage and high gain. The Op-amp is considered by various constraints like open loop gain, Bandwidth, Slew Rate, Noise and etc. [4]. The performance Measures are fixed Due to Design parameters such as Transistors size, Bias current and etc. In this paper we describe design of OTA amplifier and this design is done in 0.25µm technology. The higher order filter can be designed to improve the frequency response and increase the sharpness of filter. They can be designed using different topologies like- cascade and passive ladder. The different types of filters like band pass, high pass and band reject filter can be realized using OTA and capacitor.

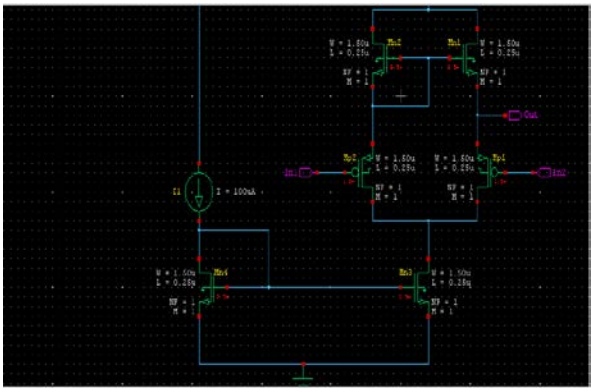

figure1:- Schematic of OTA

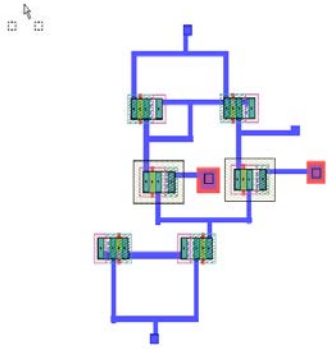

figure 2: Layout of OTA

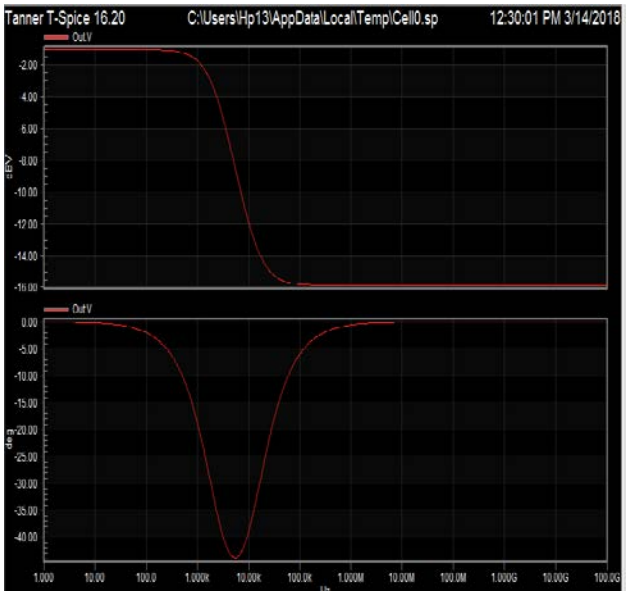

figure 3:- AC analysis of OTA

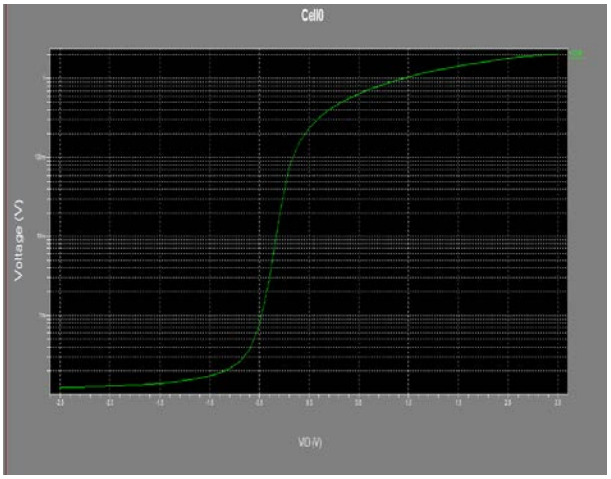

figure 4: DC analysis of OTA

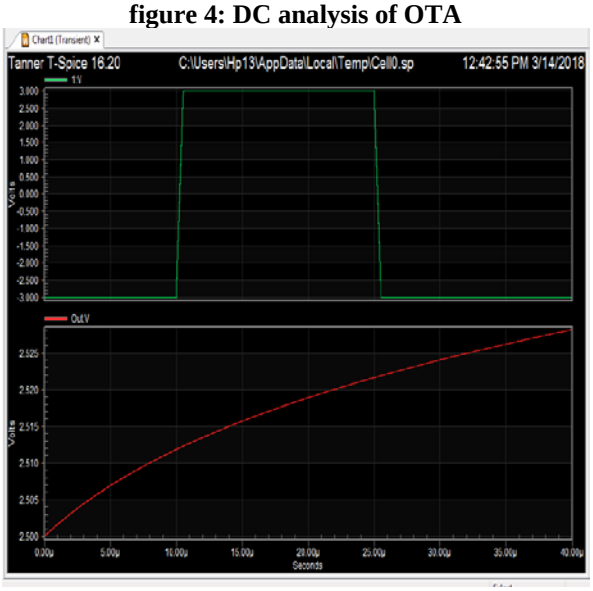

figure 5:Slew rate of OTA

III. BACKGROUND

Today Power Consumption has become an increasingly important issue in filter. Previously filters were designed using Operational Amplifier which is a circuit that deliver high-gain amplification of the difference in Voltage between two inputs [3] [4]. Op –amp provide a very effective mean of creating low pass and high pass filter without the need for inductor. Low pass and high pass filter using op-amp can be used in many areas power supplies to the output of digital to analogue converters to remove alias signals and many more application. But as the advancement takes place in technological world Operational Trans-conductance Amplifier attains some merits over Op-amp [5]. OTA are “Voltage Controlled Amplifier” and has three inputs while op-amp has only two. Besides the two differential input terminals that an OTA and an Op-amp share, the OTA has third input that lets us set the gain of the amplifier by applying a current and the OTA is able to multiply two time varying signals, although both Op-amp and OTA has their own purpose of work

but Op-amp is used in closed loop circuits while OTA are open loop [3].

IV. SCHEMATIC IMPLEMENTATION

The Schematic end user interface provides a diverse tool set for quickly and efficiently organizing element within the schematic views manually or with out- of- the-box or custom algorithm. However, to successfully deploy the functionality to the end user, Schematics project parameters configuration is required to tailor the application to the client's environment and deliver functionality to the end user. The schematics designer interface provides the tools to configure the schematics project, and developer can use object to extend the base application to meet specific requirement.[6]

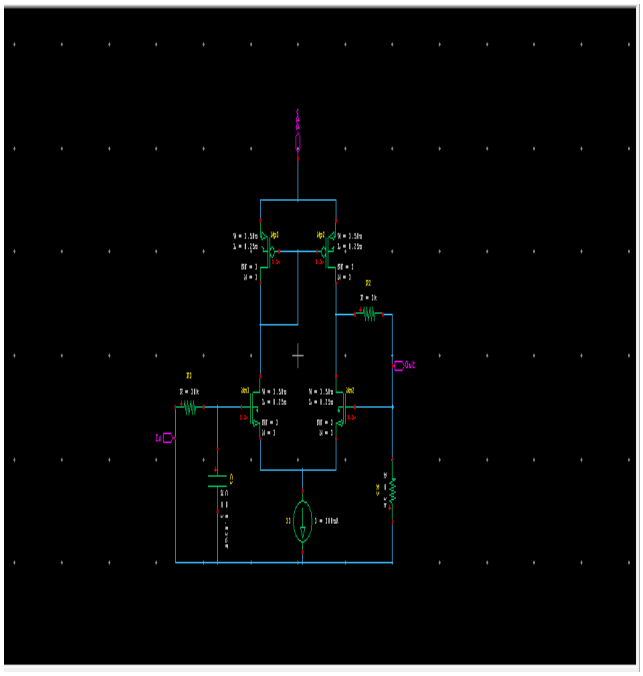

figure 6:-Schematic of LPF

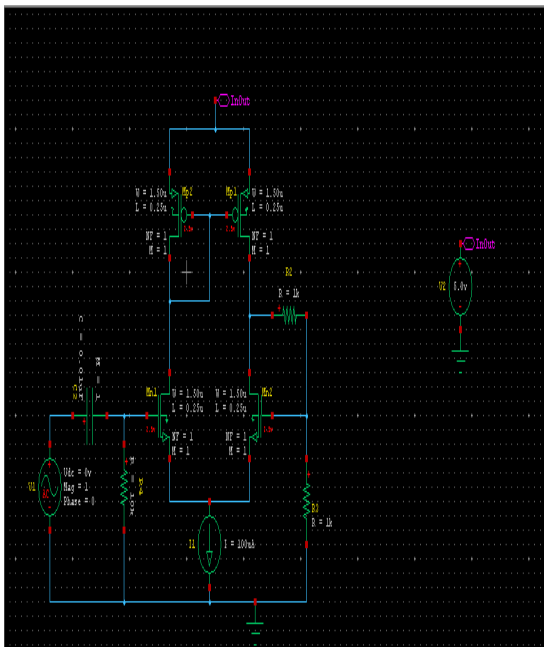

figure 7:-schematic of HPF

V. LAYOUT IMPLEMENTATION

Layout is essential a drawing process. You are drawing the two-dimensional geometries that will end up on your mask. Layout tools are essentially CAD drawing tools, but include additional useful features. We had implemented these techniques in Low Pass and High Pass filter using OTA. Filters were designed by using two NMOS and two PMOS and OTA was designed using four NMOS and two PMOS [7].

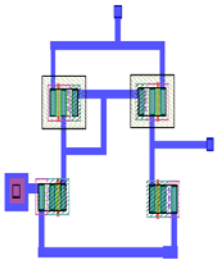

figure 8: Layout of Low Pass Filter

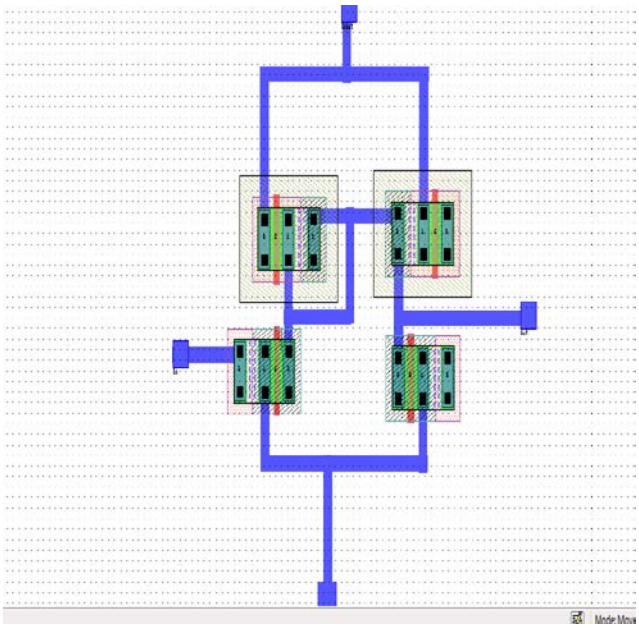

figure 9:- Layout of HPF

VI. SIMULATION RESULT

We had implemented these techniques in Low Pass and High Pass filter. Low pass and High pass filter were designed by passive elements using capacitor and register and were designed by CMOS transistors. After designing schematic of filters using OTA T-spice file got generated and from that T-Spice file layout was implemented. Layout design gave result as net list file which was then taken to the LVS and being compared. We got the output.

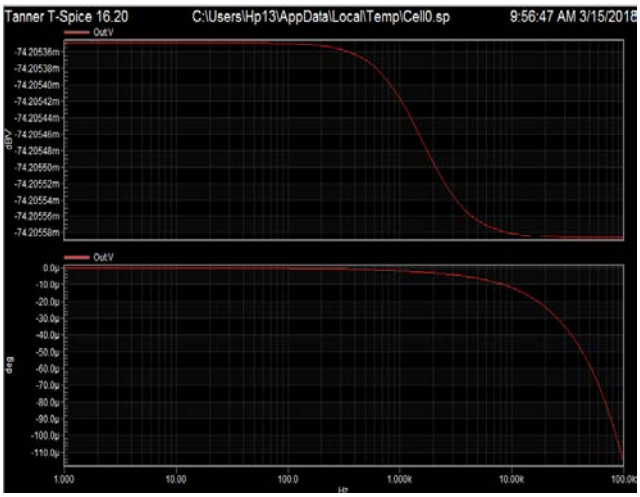

figure 10:waveform of LPF

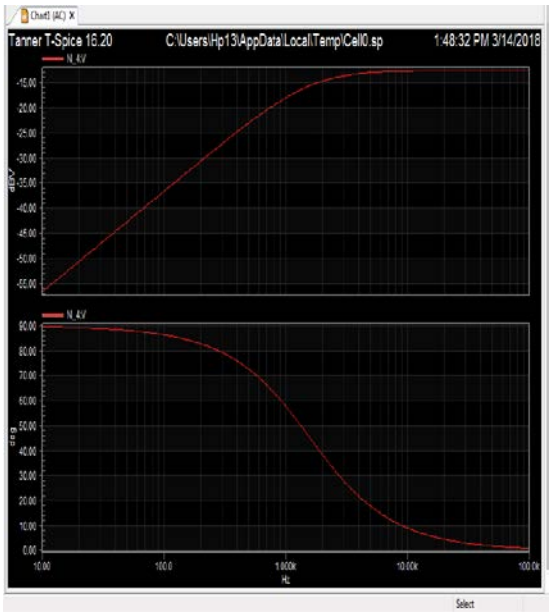

figure 11:waveform of HPF

VII. CONCLUSION

There is a huge demand of filters either low or high pass in technological era at the same time low power consumption is great challenge. Through OTA filter design becomes modest hereafter in this design technique OTA as a basic active element has been consulted. This paper has shown that how a low pass and high pass filter designed using operational trans-conductance amplifier can reduce the power consumption in the circuit and it adds controllability to a number of circuits commonly implemented with the conventional op-amp. The design allows very low trans-conductance values to be achieved, and the clock signal facilitates easy digital tuning. In comparison to previous low pass filters from the literature, the proposed topology provides the lowest power consumption, in addition to very wide tuning range.

VIII. FUTURE SCOPE

As power consumption is going to be utmost demand in the upcoming technology and so as Operational Trans-conductance Amplifier is the basic change which can control the power consumption. To reduce heat dissipation in device due to leakage current .very often in device most of power supply is wasted due to heat dissipation and in the battery devices it reduce the backup of that device. To design second order low pass and high pass filter devices(Schematics and layout design) and then go for power optimization.

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