Design of Ackerberg-Mossberg High Pass Filter with Opamp Using 0.18 µm Technology

Ajay Kumar Kushwaha[#1], Dilip Singar[#2], D.S Ajnar[#3] and Pramod Kumar Jain [#4]

[#1, 2, 3, 4.] *Micro Electronics and VLSI design*

*** Electronics & Instrumentation Engineering department, SGSITS, Indore, MP, India*

[#1]*Email: ajay.igecsagar@gmail.com,* [#2]*Email: dilip.singar@gmail.com,* [#3]*Email: dsajnar@gmail.com*

[#4]*Email: pramod22_in@yahoo.com*

Abstract - In this paper describes design of operational amplifier and high pass filters of modified type Akerberg-Mossberg with the help of use of the active modern elements. The main purpose to create physical realization of one of these filters which embodies better properties during digital tuning of its individual parameters. Since a considerable part of the power consumption is due to the analog baseband filters, improved and/or novel analog filter design approaches have to be developed. We design of Ackerberg-Mossberg high pass filter for this application in this paper. To demonstrate the proposed techniques, a ±0.8 V, 2-MHz second-order filter fabricated in a conventional 0.18 µm CMOS process is presented. The opamp achieves a GAIN of 76.33 db which is used in high pass filter . The measured power consumption for the filter alone consumes about 0.19 mW for a supply voltage of ± 0.8 V. Design,simulation and layout of the circuit is done in Cadence specter environment with UMC 0.18 µm CMOS process.

Keywords - Analog IC design, op amp, Ackerberg-mossberg high pass filter

I. INTRODUCTION

An Akerberg Mossberg filter is two pole filter topology. It is available in low pass, high pass, band pass and notch versions. It is the topology that offers complete and independent control over gain, frequency, and type (Butterworth, chebyshev, and Bessel). Signal input at different places for the different versions, but output is always taken from the same point. The filters are widely used in instrumentation and communication systems. Technical evolution and market requirements demand for high-performance fully integrated telecom transceivers.

The Akerberg Mossberg topology is suited to operate from a single supply. Current feedback amplifiers cannot be used, because a capacitor is connected from the op-amp output to inverting input. The Akerberg Mossberg technique can be used with fully operational amplifiers, with the additional advantage that the number of op-amps required is reduced from 3 to 2.

- The power consumption minimization is strongly required by portable devices to increase the battery life;
- Different communication standards require strongly different analog active-RC filter's performances in terms of bandwidth, distortion, Noise.

II. CIRCUIT IMPLEMENTATION

2.1 OP AMP Design

Design of op-Amp: operational amplifier is very important to get accurate result. The Op-Amp is characterized by various parameters like open loop gain, Bandwidth, Slew Rate, Noise and etc. The performance measures are fixed due to design parameters such as transistors size, bias current and etc. Transistors M8 and M9 functions as a constant current source, and transistors M1, M2 and M3 functions as two current mirror 'pairs'. The transistors M4, M5, M6 and M7 are the differential amplifier. Transistor M10 is an output amplifier stage.

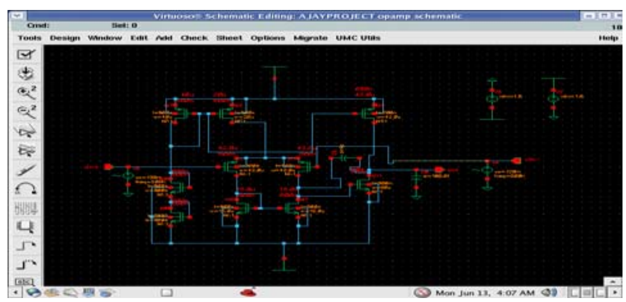


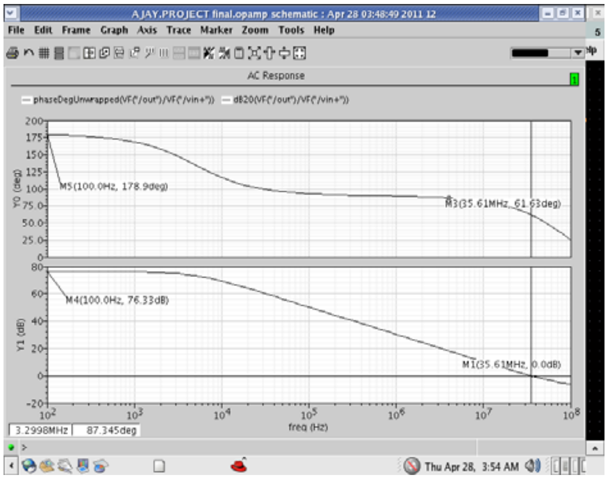
Figure 2.1 Schematic of CMOS Op-Amp

S NO.	DEVICE	W/L(um)
1	M1	40/0.6
2	M2	20/0.6
3	M3,M4,M5	42/0.6
4	M6,M7	50/0.6
5	M8,M9	0.8/0.6
6	M10	60/0.6

Tab.2.1 CMOS Transistor sizing for CMOS Op-amp design.

III. Result of op-amp

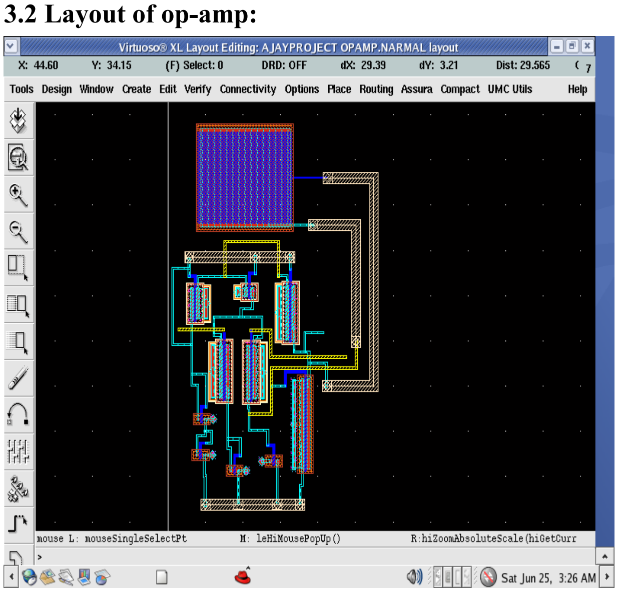
3.1 Gain and Phase of opamp:



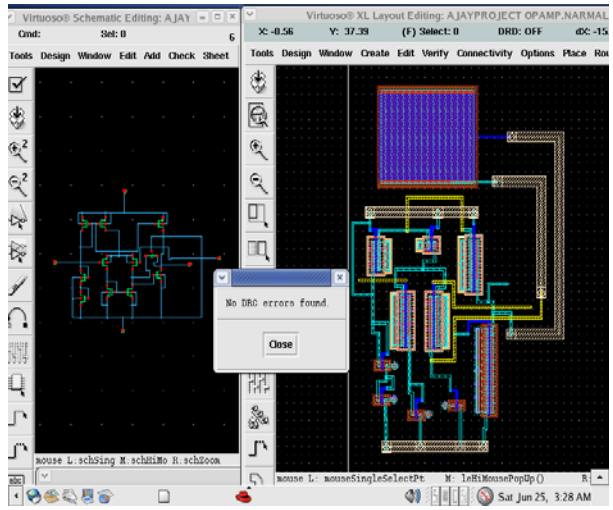
Tab.3.1 SUMMARY OF EXPERIMENTAL RESULTS

S.NO.	Experimental	Results Value
1	Open loop Gain	76 dB
2	3dB frequency	150 kHz
3	Unity Gain Frequency	10 MHz
4	Slew Rate	2.344 V/μsec
5	Power dissipation	0.50 Mv
6	Load capacitance	0.1 pf
7	Input Offset Voltage	1.46 mV
8	PSRR	80 dB
9	CMRR	91 dB

3.2 Layout of op-amp:



3.3 DRC (Design Rule Check) of OPAMP:



IV. ARCHITECTURE OF ACKERBERG-MOSSBERG HIGH PASS FILTER

Figure 5.1 shows the Ackerberg-Mossberg high pass filter using the AM biquad topology. It is the suitable filter structure needed to achieve high filter pole frequency for a given unity bandwidth. The biquad is the slightly modified form of the original AM biquad. In which C_2 will be omitted and a resister will be added in parallel with C_1 of the first integrator to control Q factor. The advantage of the modification is that it allows the adjustment of Q factor by adjusting the value of C_2 only for given value of C_1. The pole frequency is depends on the value of C_1 and C_2. In the above figure four op-amp filters (so called quads) are used in one integrated circuit. The circuit can be adjusted in a non-interactive manner for precise filter parameter. A_3 is non-inverting op-amp amplifier and A_1, A_2, A_4 are the inverting amplifier. The A_1 and A_3 have no dc feedback path in between and converted the signal directly. Quality factor is set by the resistor QR.

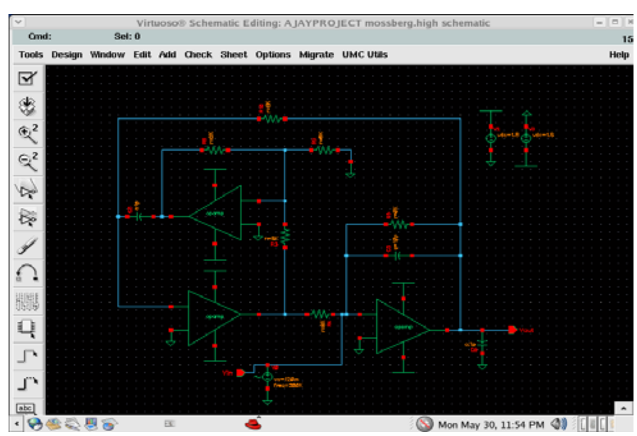


Figure 4.1 Schematic of Ackerberg-Mossberg high pass filter

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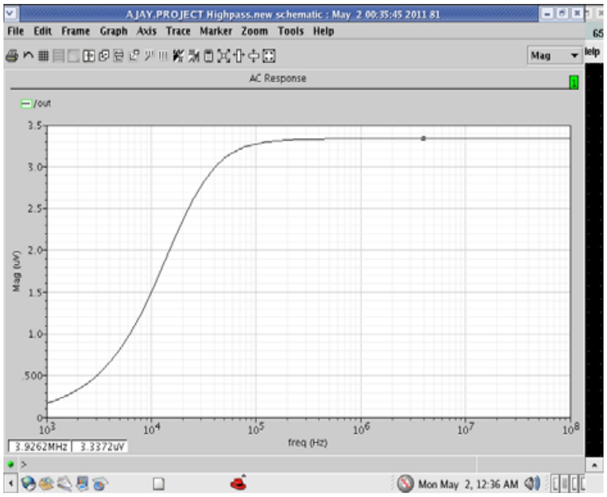


Figure 4.2 AC Respone of Ackerberg –Mossberg high pass filter:

Experimental Results Value

Open loop Gain ≥ 40 dB

Input referred noise(1KHz) ≤ 160 nV/√Hz

Power dissipation ≤ 0.52 mW

PSRR(Vdd) ≥ 29db

Figure 4.1. Schematic on Ackerberg-Mossberg High Pass Filter The output of a second-order high-pass filter with a very high quality factor responds to a step input by quickly rising above, oscillating around and eventually converging to a steady-state value. The high pass filter gain is controlled by R/K, varying the value of this resistor the gain can be adjusted to our specifications of the filter. We will consider this on the Ackerberg-mossberg high pass circuit . The high pass output filter realizes for C1, C2 and indicated resistors.

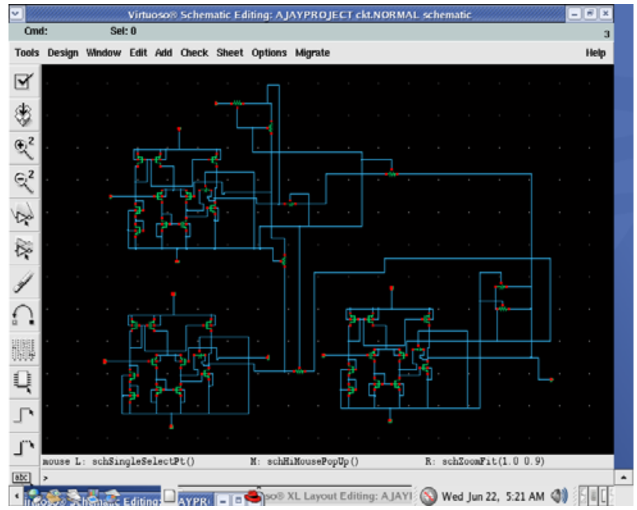
High pass filters: The transfer function Hhp(ω) of an ideal highpass filter is defined as follows:

$$H_{hp}(\omega) = \begin{cases} 0 & |\omega| \leq \omega_c \\ A & |\omega| > \omega_c, \end{cases}$$

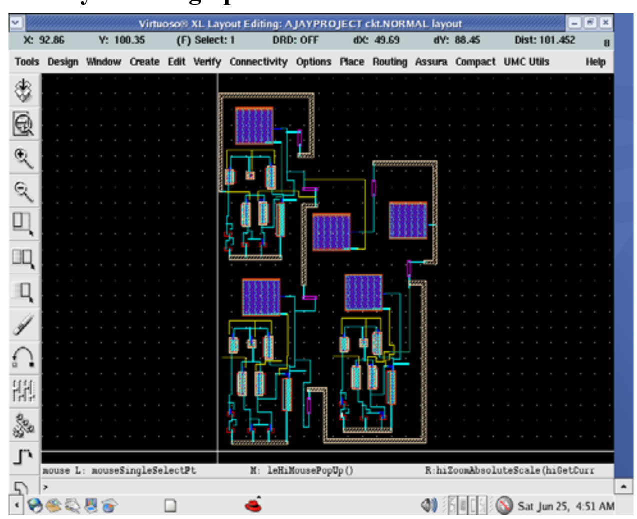
Where ωc is the cut-off frequency of the filter. In other words, the transfer function of an ideal highpass filter Hhp(ω) is related to the transfer function of an ideal lowpass filter Hhp(ω) by the following relationship:

Hhp(ω) = A - HLP(ω)

The pass band of the low pass filter is given by ωc < |ω| <∞, while the stopband of the lowpass filter is given by |ω|= ωc. As was the case for the ideal lowpass filter, the phase <Hhp(ω) of an ideal highpass filter is zero for all frequencies.



4.3 Layout of high pass filter:



V. CONCLUSION

In this design, a low-voltage CMOS active RC High Pass Filter is designed using a Akerberg Mossberg topology. The Proposed techniques can be used to design low-voltage and Low-power active RC high pass filter in a standard CMOS process. To demonstrate the proposed techniques, a 0.8V and 2-MHz second-order filter implemented in a standard 0.18µm CMOS process

VI. REFERENCE

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