Design of CMOS Ackerberg-Mossberg Filters Using 0.18μm Technology

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1. Abstract

In this paper describes design of operational amplifier and different types of filters like as low pass, high pass, band pass filters. 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 ±1.8V, fabricated in a conventional 0.18μm CMOS process is presented. The op-amp achieves unity GAIN bandwidth of 76.33 dB which is used to implement analog filters, mainly in the audio frequency range, is by means of Ackerberg-Mossberg filters circuit. The measured simulation result of different types of filters with waveforms for a supply voltage of ± 1.8V. Design circuit is done in Cadence spectre environment with UMC 0.18μm CMOS process.

Keywords__Analog IC design, op-amp and different types of filters like as low pass, high pass and band pass circuit.

2. 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, 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 4 to 3.

- 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 performances in terms of bandwidth, distortion, Noise

3. Circuit Implementation

3.1 OP AMP Design:

The circuit provides good voltage gain, a good common-mode range and good output swing. Before the analysis of the op-amp is done, some of the basic principles behind the working of MOS transistors are reviewed. The first stage in Fig.3.1 consists of a p-channel differential pair M_1-M_2 with an n-channel current mirror load M_3-M_4 and a p-channel tail current source M_5. The second stage consists of an n-channel common-source amplifier M_{10} with a p-channel current-source load M_6. The sizes of the transistors were designed for a bias current of 413.2μA to provide for sufficient output voltage swing, output-offset voltage, slew rate, and gain-bandwidth product.

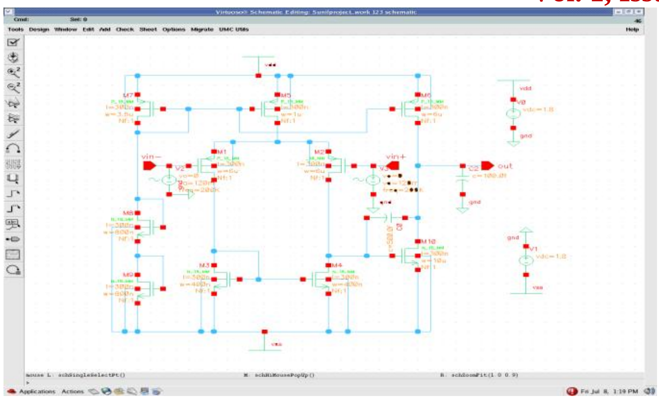


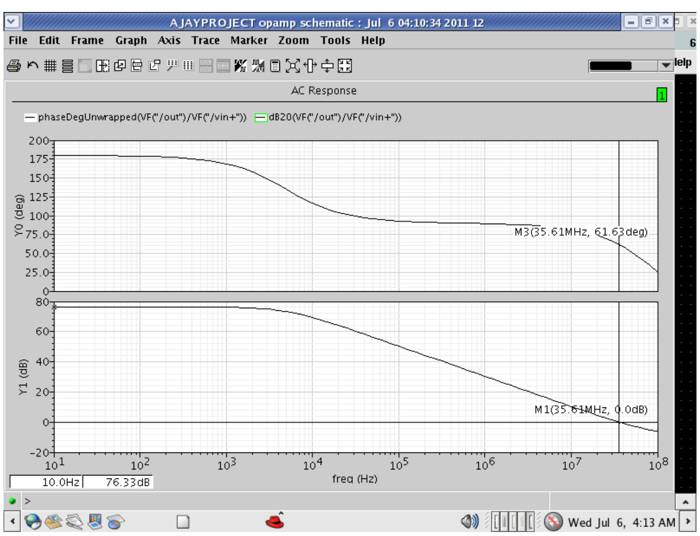
Figure 3.1 Schematic of CMOS Op-Amp

S. NO.	DEVICE	W/L(μm)
1	M1, M2 ,M6	06/0.3
2	M3, M4	0.4/0.3
3	M5	01/0.3
4	M7	3.5/0.3
5	M8, M9	0.8/0.3
6	M10	10/0.3

Table3.1 Transistor sizing for CMOS Op-amp Design

4. Result of op-amp

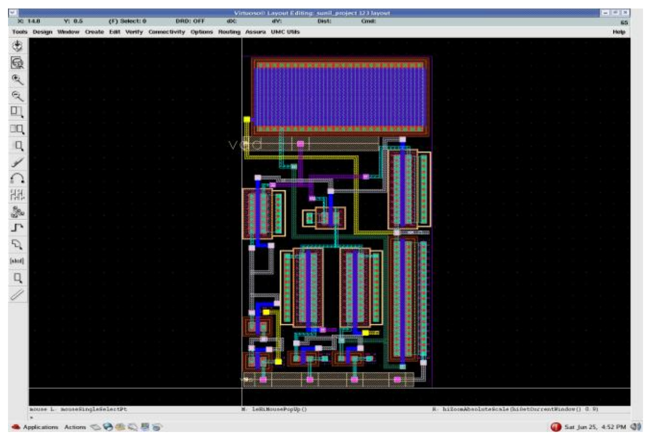
4.1 Gain and Phase of op-amp:



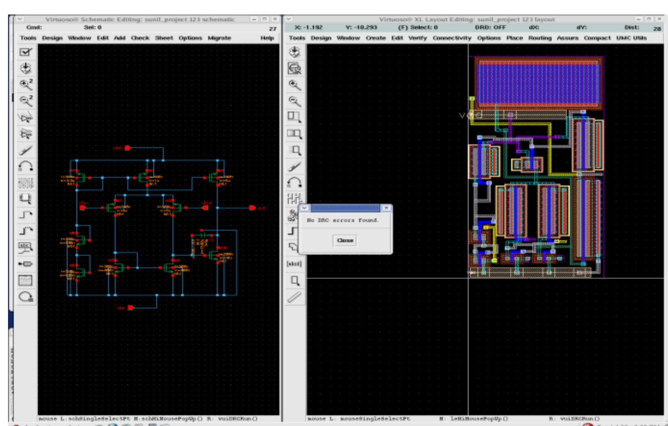
Tab.4.1 SUMMARY OF EXPERIMENTAL RESULTS

S.NO.	Experimental	Results Value
1	Open Loop Gain	76.33dB
2	3dB Frequency	31.41kHz
3	Unity Gain Frequency	86.76MHz
4	Slew Rate	2.344V/μsec
5	Power Dissipation	0.74mW
6	Load Capacitance	0.1pF
7	C_c	500.0fF
8	PSRR	80dB
9	CMRR	91dB

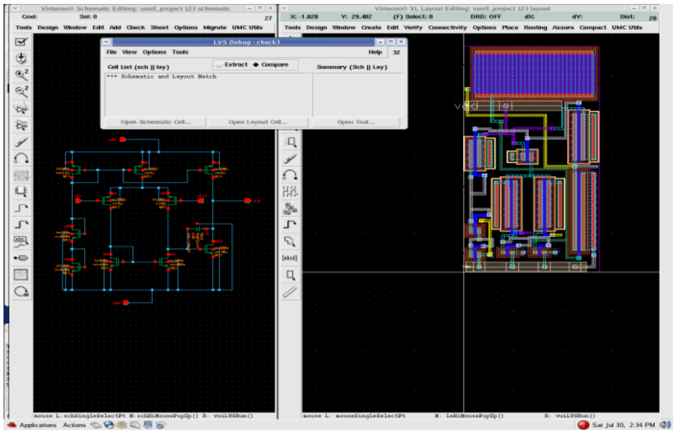
4.2 Layout of op-amp:



4.3 DRC (Design Rule Check) of op-amp:



4.4 LVS Report of op-amp



5. Ackerberg-Mossberg Low Pass Filter

A low-pass filter is a filter that passes low-frequency signals but attenuates. The actual amount of attenuation for each frequency varies from filter to filter. It is sometimes called a high-cut filter. LP filters exist in many different forms, including electronic circuits, anti-aliasing filters for conditioning signals prior to analog-to-digital conversion, digital filters for smoothing sets of data, acoustic barriers, blurring of images.

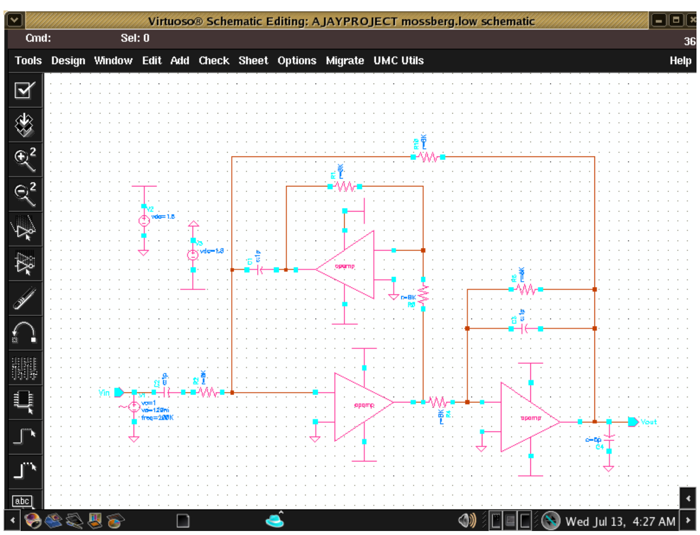


Figure 5.1 Schematic of Ackerberg-Mossberg Low Pass Filter

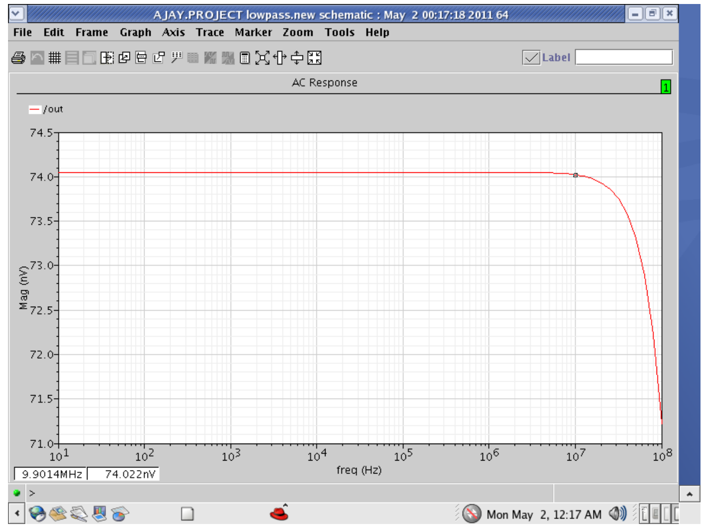


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Figure 5.2 Simulation result of Low Pass Filter

6. Ackergerg-Mossberg High Pass Filter

It is the schematic of CMOS Ackerberg-Mossberg high pass filter using the AM biquad topology. The design of this CMOS active-RC high pass filter is done using cadence tool. The simulation results are found using cadence spectre environment using UMC 0.18 μm CMOS technology

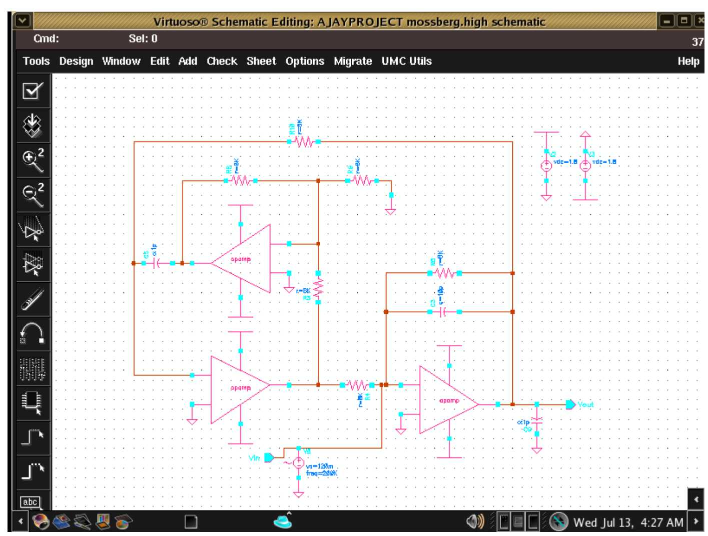

Figure 6.1 Schematic of Ackerberg-Mossberg High Pass Filter

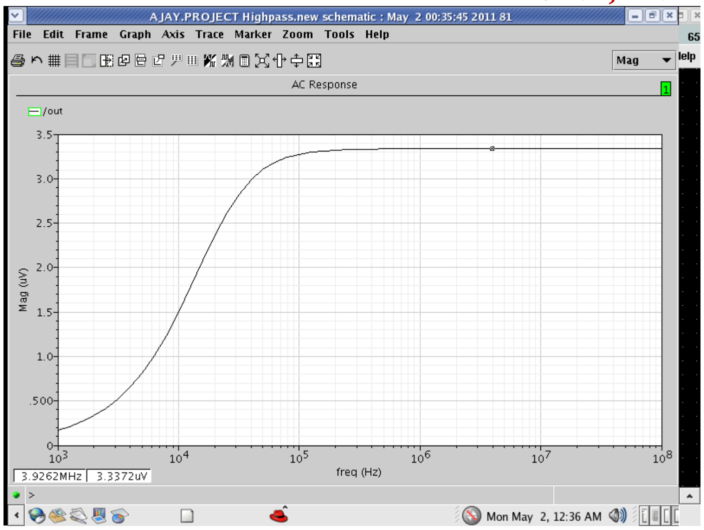

Figure 5.2 Simulation result of high pass filter

7. The Ackergerg-Mossberg Band Pass Filter

A band-pass filter is a device that passes frequencies within a certain range and rejects frequencies outside that range. Band pass is an adjective that describes a type of filter or filtering process; it frequently confused with pass band, which refers to the actual portion of affected spectrum. Hence, one may correctly say 'A dual band pass filter has two pass bands'. A

band pass signal is a signal containing a band of frequencies away from zero frequency, such as a signal that comes out of a band pass filter

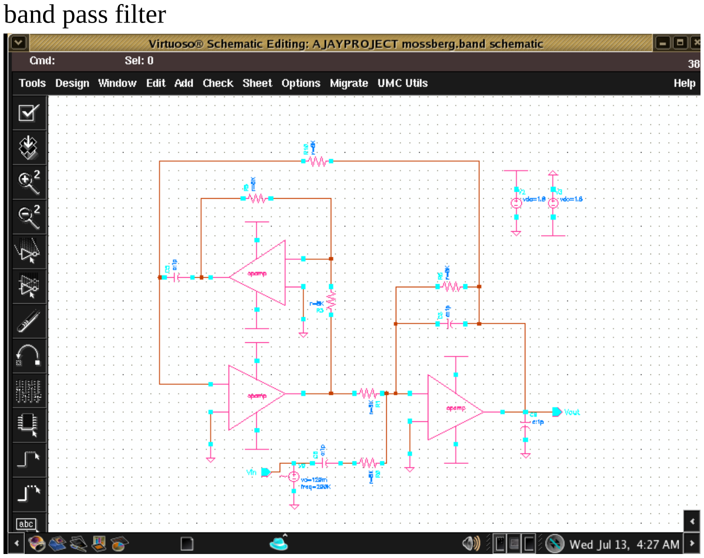

Figure 7.1 Schematic of Ackerberg-Mossberg Band Pass Filter

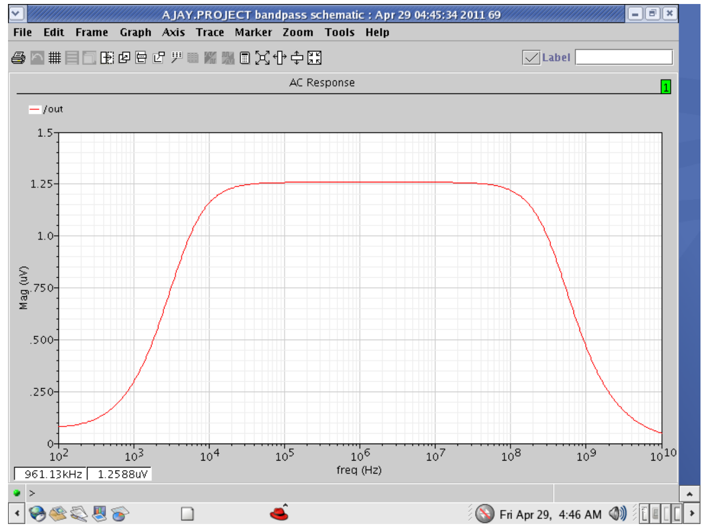

Figure 7.2 Simulation result of Band Pass Filter

7. Conclusion

It is the schematic of CMOS op-amp . It has Open Loop Gain 76.33dB.A unity gain bandwidth is obtained 80.76MHz. Phase margin is the phase difference between phases of Av (W 0dB)

and -180˚ where W 0dB is the frequency at which |Av| is unity, called unity gain frequency. The phase margin is obtained 78.11 degree. The sizes of the transistors were designed for a bias current of 413.2µA to provide for sufficient output voltage swing, output-offset voltage, slew rate, and gain-bandwidth product. There is the plot of power supply rejection ratio. It recognized that the change in output with power supply is 80dB.The common mode rejection ratio was found to be 91dB. The measured value of slew rate is 2.344 V/µs. Power Dissipation is .74Mw.Then schematic of Ackerberg-Mossberg low pass, high pass and band pass filters and its waveforms.

Reference

[1] Sung-Mo kang, Ysuf lablebici “CMOS Digital Integrated Circuits analysis and design” Tata Mcgraw-Hill Edition 2003
[2] R. Gregorian and G. C. Temes, Analog MOS Integrated Circuits for Signal Processing. New York: Wiley, 1986.
[3] JFRANSICISCO DORQUE CARRICCO “Programmable switched capacitor bump equalizer architecture” IEE journal solid state circuit vol.,25, aug 1990

[4] ROBERT R. CORDELL "A new family of active variable equalizer" IEEE Trans. On circuit syst,,vol.CAS-29 NO.25 1982

[5] Eri Prasetyo, Dominique Ginhac, "Design and Implementation a 8 bits Pipeline Analog to Digital Converter in the Technology 0.6 mm CMOS Process" Makalah ada di prosiding ISSM05, Paris, 30th September – 1st October 2005

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