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FGMOS BASED VDTA AND ITS APPLICATION AS A BIQUAD FILTER

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***Abstract*—The voltage differencing transconductance amplifier(VDTA) is a very new introduced active elements for fast processing of filters and oscillators. The realization of VDTA using CMOS was first given in [2].VDTA can also be realized as a tunable universal filter [3] by using only one VDTA block and two grounded capacitors and by setting the input conditions accordingly and it also provides the control over natural angular frequency as well as quality factor But the filter given in [2] was realized using TSMC 0.35µm model parameter with DC voltages of +V=-V=2Volt.In this paper we used VDTA as a bi quad filter and realize the filter using 180nm model parameter with DC supply voltages of +V=-V=0.75Volt.Hence,we are working on low voltage technique by replacing the MOSFETs in current mirror[2] to FGMOS. To check the performance of proposed circuit computer simulations are accomplished with the LTSPICE.**

Keywords—Voltage Differencing Trans conductance Amplifier, Floating Gate(FGMOS), Bi quad Filter, Universal Filter, Current Mirror.

I. INTRODUCTION

In recent years, Introduction of new analog building blocks brings a huge improvement in analog circuit design such as CDTA,VDTA,VDBA,CCTA,DCCTA. These blocks work on either on voltage mode or current mode [3] but due to advantageous features of current mode such as space saving, low power simplicity and cost efficient, our recently introduced new active elements work on current mode operations. Introduction of VDTA was first given by BIOLEK ET.AL. [1] and its first realization using CMOS was given by [2]. VDTA has so many applications in filters as well as sinusoidal oscillator given in literature [4-8]. Current mode filters using single active elements are described in the literature [4-13].

In this paper, a current mode compact bi-quadratic filter with three input and single output using single active element and only two grounded capacitors are presented and it realizes the responses of low pass, high pass, band pass and band stop filters only by choosing appropriate inputs. With respect to components, we get low sensitive performance also. Previously in [3], Proposed circuit used as universal filter by using only one active elements and 2 grounded capacitors. but the work had been done on high voltages on 0.35µm model parameter.

In this paper, we are working on the 180nm with supply voltage of ± 0.75 volt and hence we inclined towards low voltage techniques by using FGMOS. This circuit will give the electronic tunability of angular frequency as well as quality control via bias current only. Following are the given comparative analysis between recently reported similar type filter and proposed circuit:

- Lack of electronic controllability of w0 and Q.
- Requires external passive resistors.
- Some of the circuits doesn't provide all 4 responses.
- Need large number of active components.

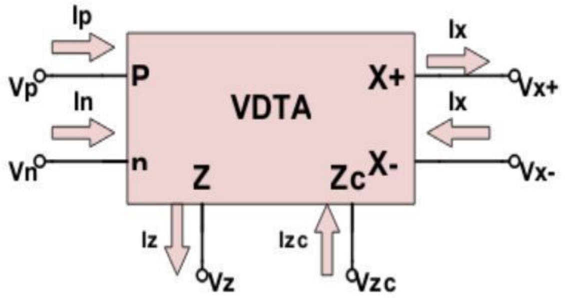

Fig.1. Circuit Symbol Of VDTA

II. VDTA DESCRIPTION

Circuit symbol of VDTA is given in Fig.1. VDTA consists of two trans conductance for its operation. It transfers the difference of its input voltages (V_p - V_n) to the current through z terminal by first trans conductance g_{mF} and dual output trans conductance amplifier converts the voltage drop at z terminal to currents at x-terminal by second trans conductance g_{mS} . The relationship between its different terminals are given by the following equations:

$$Iz = gmF\,(Vp - Vn) \qquad ……(1)$$

&

$$Ix = gmS\,(Vzc) \qquad ……(2)$$

CMOS realization of VDTA using FGMOS is given in Fig.2 having two transconductance. These two trans-conductance are controllable and can be calculated by following equations :

$$gmF = \left(\frac{g1g2}{g1+g2}\right) + \left(\frac{g3g4}{g3+g4}\right) \qquad \ldots\ldots(3)$$

$$gmS = \left(\frac{g5g6}{g5+g6}\right) + \left(\frac{g7g8}{g7+g8}\right) \qquad \ldots\ldots(4)$$

Where $g_i = \sqrt[2]{\frac{\mu C_{ox} W I_{bi}}{L}}$ is the transconductance value ,I_{bi} the bias current, μ is the mobility, Cox is gate-oxide capacitance per unit area and W_i and L_i are the effective channel width and length of the i^{th} transistors, respectively and i=1,2,3,4,….

III. FGMOS DESCRIPTION

Popularity of movable and wireless system leads the requirement of low power application. In digital circuits, it is easy to control the static and dynamic power by controlling the supply voltages but in analog circuits, it creates some problem regarding threshold variations, signal swings as well as it also effects the MOSFET drivability. Floating gate MOSFET(shown in fig. 3) is one of the most efficient low voltage transistor implementation technique. As comparison to the MOSFET, FGMOS has one extra gate(floating-gate) that is completely isolated within the oxide [14] [15]. Due to high quality insulator, charge on the floating gate remains same and hence, FGMOS is also applicable in memories such as flash, EPROM, EEPROM.

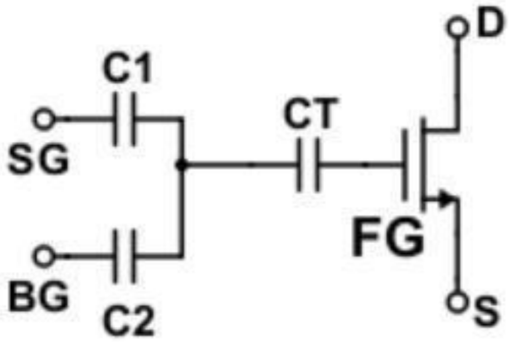

Fig.3 Symbol of FGMOS

IV. PROPOSED CIRCUIT

Fig. 4 shows the proposed circuit of the VDTA using single active elements and two grounded capacitors that is required for the IC implementations having three inputs and single output. From equation (1) & (2) output current expression is given as follow:

$$Iout = [P(s)I' + (gmS1/C2)sI'' + \left(\frac{gmF1gmS1}{C1C2}\right)I''']/P(s) \qquad \ldots..(5)$$

Where:

$$P(s) = s^2 + \left(\frac{gmF1}{C2}\right)s + \left(\frac{gmF1gmS1}{C1C2}\right) \qquad \ldots\ldots(6)$$

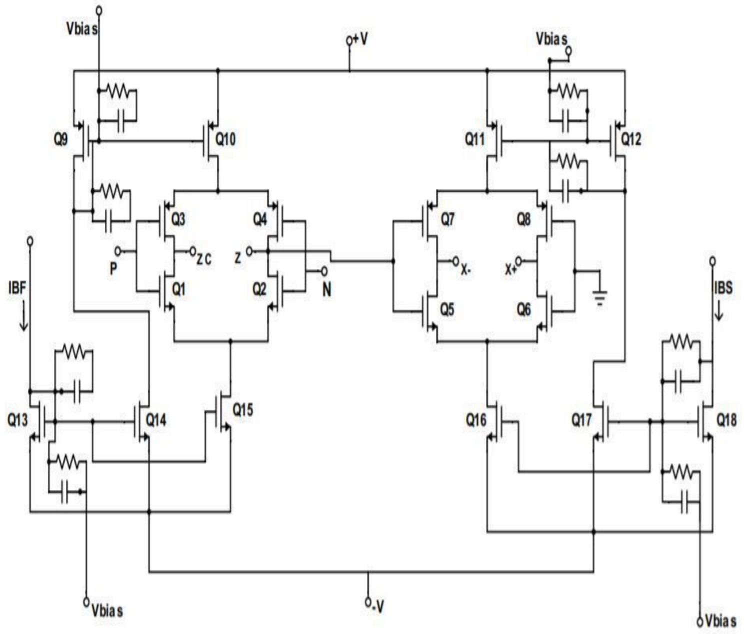

Fig.2. CMOS Implementation of VDTA using FGMOS

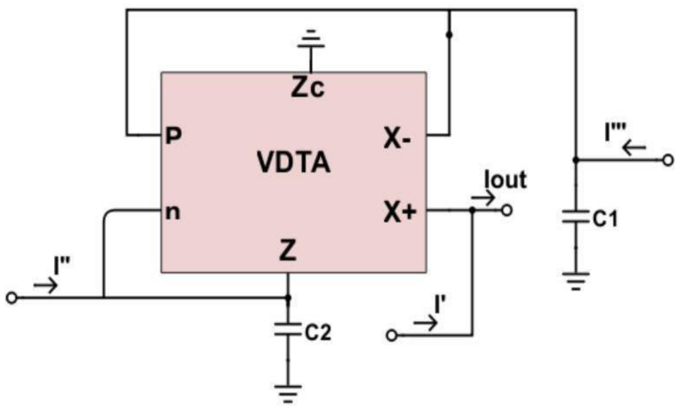

Fig.4. Proposed Circuit Of VDTA

Above equations shows that the circuit performs 4 actions according to the input conditions. Following are the conditions for the responses:

1). If I’’’ = Iin & I’=I’’= 0, the low pass current response with unity pass band gain can be obtained.

2). If I’’ = Iin & I’=I’’’= 0, the band pass current response can be obtained.

3). If I’= -I’’= -I’’’= Iin , the high pass current response with unity pass band gain can be obtained.

4). If I’ = -I’’= Iin , I’’’=0 the band stop current response with unity pass band gain can be obtained.

From equation (5) & (6),we can also calculate the angular frequency(w0) such as:

$$w0 = \frac{\sqrt{gmF1gmS1}}{C1C2} \quad \text{……(7)}$$

Equations (7) shows that by using only one active elements as well as minimum no. of passive elements , we can control w0 and Q by just controlling gmF1 & gmS1.

V. SIMULATION RESULTS AND DISCUSSIONS

Aspect ratios are shown in table I.
Equal capacitors were chosen as C_1=C_2= 20 pF.
Filters are simulated using LTSPICE and the filter was realized with f_0= 3MHz and Q=1. Here for all FGMOS we choose R=10Gohm and C=100 pF. Fig.2 was realized using LTSPICE 180nm model parameter with DC supply voltages of +V = -V = 0.75Volt. In this case, we choose the value of I_{BF}=I_{BS}=10µA and put V_{BIAS} = 0V. We can vary the value of Bias current such as 40µA,10µA,160µA to control the angular frequency and quality factor. Fig. 5,6,7,8 shows the current responses of proposed filter.

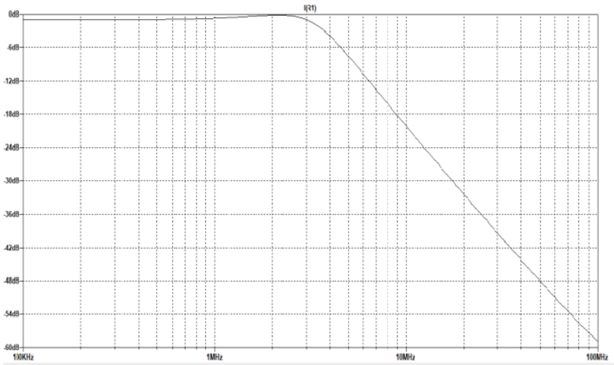

Fig.5 Low Pass Frequency Response

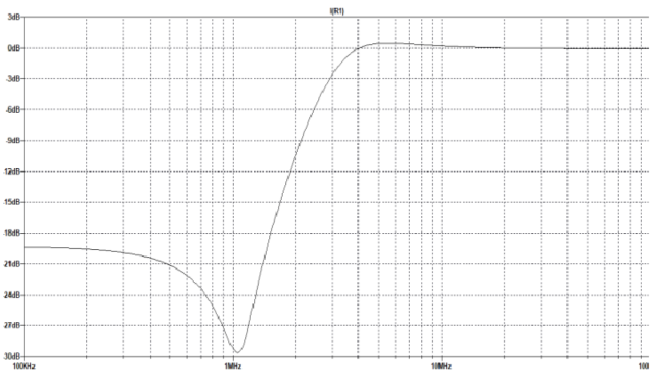

Fig. 6 High Pass Frequency Response

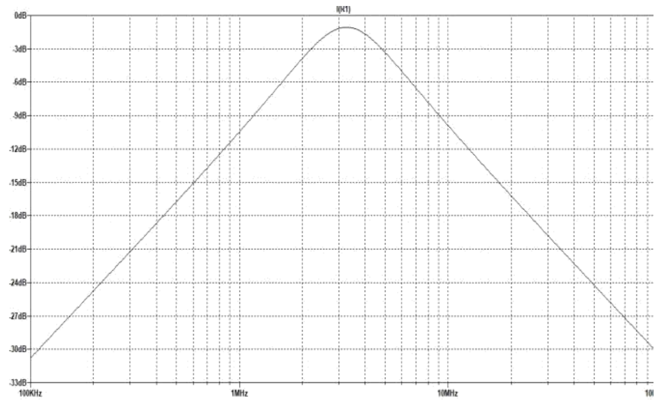

Fig.7 Band Pass Frequency Response

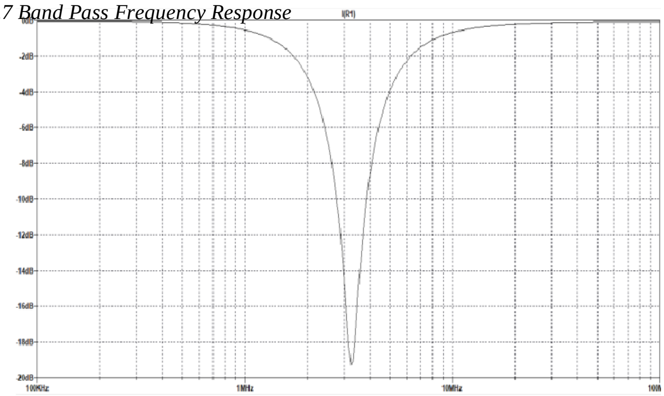

Fig.8 Band Stop Frequency Response

TABLE I ASPECT RATIOS OF MOSFETs.

S.N.	**ASPECT RATIOS**		
	Transistors	***W(µm)***	***L(µm)***
1.	Q_1,Q_2,Q_5,Q_6	8.28	0.36
2.	Q_3,Q_4,Q_7,Q_8	14.4	0.36
3.	$Q_9 – Q_{12}$	10.8	0.36
4.	Q_{13},Q_{18}	3.6	0.36
5.	$Q_{14} – Q_{17}$	4.37	0.36

VI. CONCLUSION

Proposed circuit has very simple configuration and it gives the responses of LP, HP,BP,BS at very low voltages as well as it also controls the frequency and quality factor by controlling the bias current of VDTA by using only one single elements and only two passive components. Hence, it provides the flexibility to the tuning procedure of the circuit.

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