A Stable CMOS Current Reference Based on the ZTC Operating Point

Shubham kumar Aayushya Srivastav Neha Gupta Shailendra Bishariya
Student ECE Student ECE Student ECE Mentor & Associate professor
ABES EC ABES EC ABES EC ABES EC

ABSTRACT

This circuit is used to provide a constant current of fixed value in deep submicron technology . As the size of the channel is decreasing with the scaleing technology , the corresponding voltage is also decreasing . Also this voltage is reaching near the noise level of MOSFET . So , it's very difficult to design a circuit having constant voltage sources . Hence , current reference circuit came to picture . Designing a current reference we have to deal with some parameters ,which are going to vary , but we have to keep our reference current constant . The two major parameters are supply voltage and temperature . We will use concept of PTAT and CTAT and ZTC to solve these problems .

1. Introduction :

As we know in the modern era , we are trying to shrink the size of nearly every electronic device . With decreasing size of the MOSFET we have decreased the size of the device . Hence , the size is minimized , but with this we need to make it portable , so we are using batteries to power the devices . Now , the power has become a important parameter . With improvement in the VLSI . We can make our circuit work at few volts . But If we want to reduce the power efficiency of circuits even more then we need a new circuit to supply the power , because voltage reference circuit is not going to work due to MOSFET leakage etc . The current reference or current bandgap circuit is going to used nearly in every VLSI circuit to provide power . This circuit will be used extensively in the Analog circuits . We will use ZTC compensation to deal with temperature variation. A current with small temperature coefficient is generated using the zero temperature coefficient (ZTC) operating point of a MOSFET . The transistor is used in a feedback to cancel the effect of temperature of a poly-silicon resistor. It is shown that simple equations with simulations of the ZTC point and a special temperature coefficient can get us an accurate design .

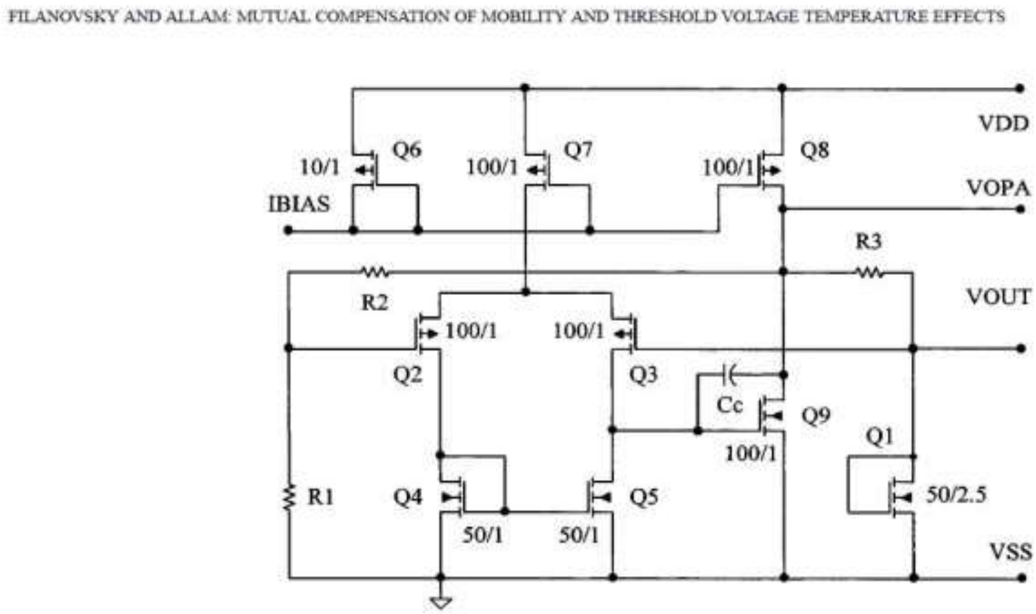
2. Literature Review :

Now a days many techniques are adopted for designing a current reference circuit to improve its efficiency and make it free completely free from variation of supply and temperature . Here we are having a circuit which is going to understand and certain others works are carried out for the implementation of band pass filters. Some of the methods employed are discussed here as follows.

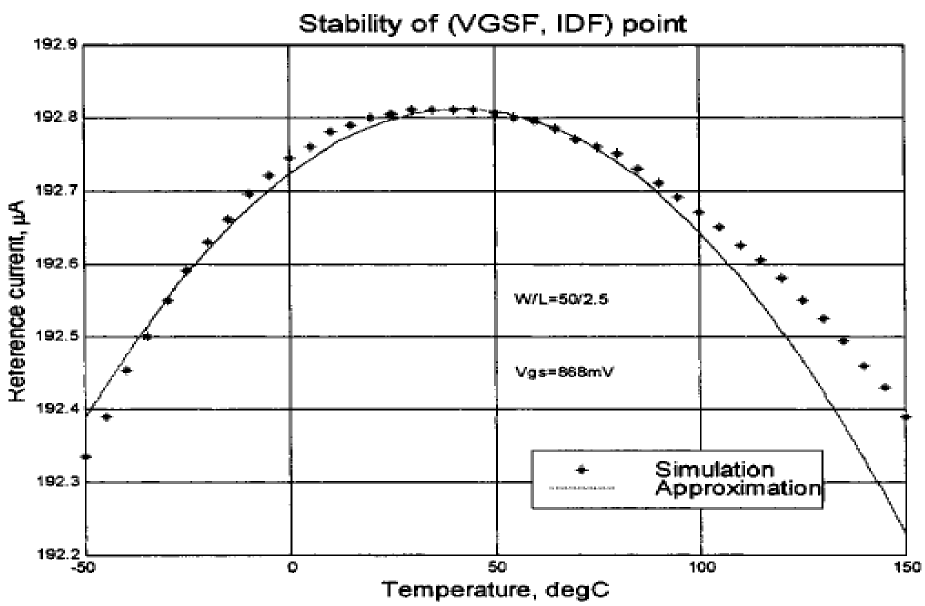
2.1 Compensation of Mobility and Threshold Voltage and Temperature with application in cmos circuits [R1] :

Mutual compensation of mobility(u) and threshold voltage(vth) temperature effects in MOSFET .but compensation resulting in the zero temperature coefficient (ZTC) point in MOS transconductance characteristics was never found before . In early CMOS technologies, this ZTC point was found for high gate-source voltages that is exceeding power supply voltages of modern .

Day circuits, and this may be an explanation that the compensation has not attracted anyone. The theory has been verified with experiments the temperature realisation of a simple voltage reference circuit realized in 35-nm CMOS process.

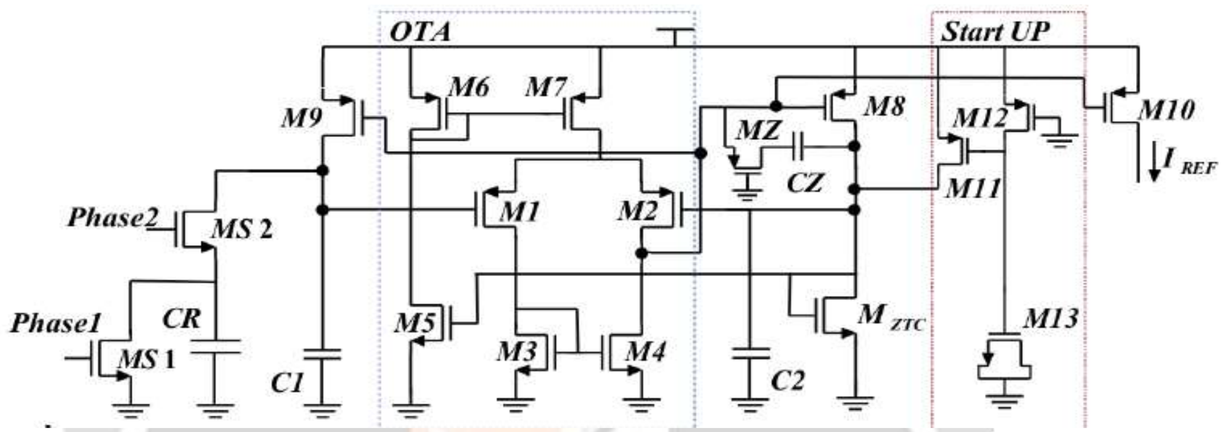


This work assumes the conditions of compensation of mobility(u) and threshold voltage (vth)temperature effects in MOSFET transistors. The compensation requires that the MOSFET threshold voltage (VTH) is a linear function with temperature, , and that the mobility is proportional to . These two conditions, in general are known . But if the first condition is aproximately satisfied (say, in the temperature range 20 to 120 C), the second is not satisfied in practice. It is shown here that the exponent in the mobility temperature dependence may be different from two, and is a weak function of temperature. Hence, this exponent determines the temperature stability of current or voltage reference circuits using ZTC bias point .



2.2 **Resistorless switched-capacitor current reference based on the mosfet ZTC condition : [R2]**

The MOSFET with zero temperature coefficient (ZTC) condition is a well known biasing point when drain current gives a very small temperature sensitivity as can be seen in this condition occurs in any technological process, for nmos and pmos transistors, and derives from the mutual cancellation of the charge mobility and threshold voltage dependencies on temperature, since charge mobility(u) and threshold-voltage(vth) both decrease when temperature increase. remembering that drain current depends directly on mobility and inversely on threshold voltage, it can be proved that both effect are able to cancel each other at certain bias point. The normal analysis of this effect presented in literature is based on the strong inversion quadratic MOSFET model and its uses a well known design strategy .



The refered resistor-less self - biased ZTC switched capacitor current reference circuit . It is composed by a current biased NMOS transistor operating in ztc condition (ZTC), which gate-source voltage is counterbalanced by a pseudo-resistor, that is formed by a switched capacitor (Cr) . The equilibrium condition is achieved using an operational amplifier (m1, m2, m3, m4 and m5) that controls the current mirror (M8 and M9) that is biasing the nmosfet and the pseudo-resistor. The pseudo-resistor is composed by two switches (MS1 and MS2) and a ripple reduction capacitor (c1;2). Mz and cz form the frequency compensation network, and m11-m13 form the start-up circuit. Dummy devices for matching improvement and charge feed-through reduction devices are not shown in the schematic view. The addition of C1 and C2 is necessary to mitigate the ripple in the output reference current, being both with the same value, for easier frequency compensation.

3.3 **Proposed Method** : Any kind of Direct Current (DC) reference, a current one, must offer thermal stability and power supply rejection, as its main characteristics. In addition, adequate fabrication repeatability ensures that the biasing operation point of the analog blocks is almost the same in every fabricated chip, and reveals how sensitive the current generator is with respect to fabrication process variations . The main idea of this paper is to use the physical condition of MOSFETs called “zero temperature coefficient” (ZTC) to implement a circuit topology where the resulting current offers low sensitivity to temperature and process variations. This condition defines a biasing point where the Id presents small temperature coefficient , as can be seen in . The ZTC current condition occurs for every MOSFET in any technology, for N-Channel MetalOxide-Semiconductor (NMOS) and P-Channel MetalOxide-Semiconductor (PMOS) transistors, and it is the effect of mutual cancellation of the channel carrier mobility and the threshold voltage dependencies on temperature

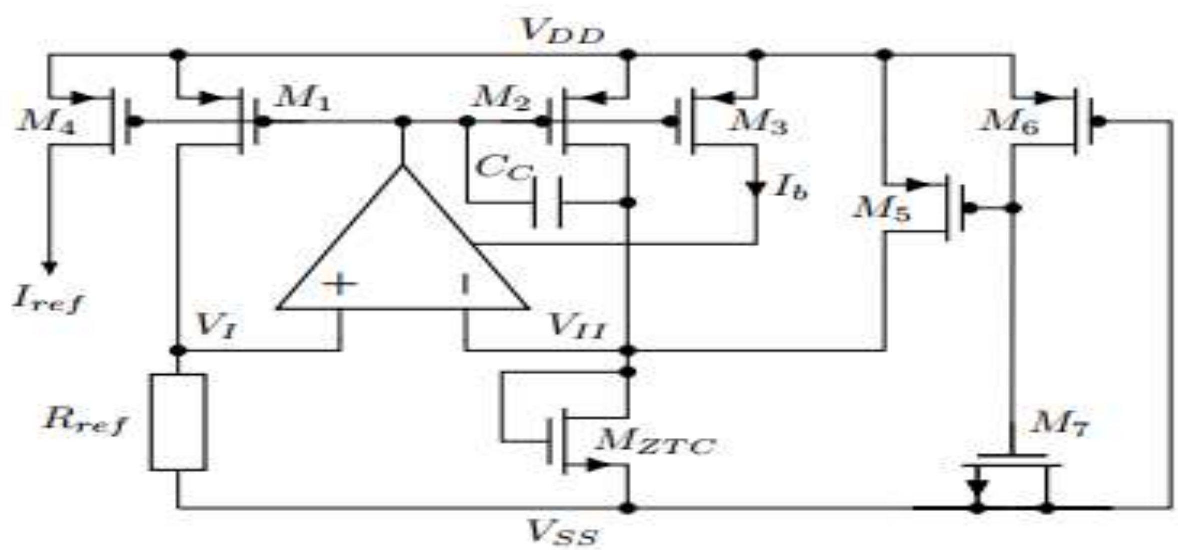


Figure 2. Current reference circuit based on the mutual cancellation of the temperature dependences of R_{ref} and M_{ZTC}

3. Result :

A performance analysis of the works done or the method discussed is done to gather up the differences which can be analysed so that a comparison can be done with works in the past and our method. The table below gives a comparative study .

	[R1]	**[R2]**	**Proposed Work**
supply	**1.8-3.3**	**2.0-3.3**	**1.8-2.0**
technology	**350 nm**	**250nm**	**180nm**
Error amplifier	**NO**	**NO**	**yes**
Temperature coefficient	**1.4 – 3.6**	**1.1-1.9**	**0.3-0.9**

4. Conclusion :

With the above study we can say that a current bandgap or current reference circuit is important for a modern day VLSI block . There were many methods to implement this circuit .but the proposed circuit having more efficiency as compared with others . It also has an error amplifier which reduces the fluctuation in the supply voltage as we know little the error the reference current will be small as possible .

5. References :

[1] Ye, R.W., and Tsividis, Y.P.: ‘Bandgap voltage reference sources in CMOS technology’, Electron.

[2] Bendali, A., and Audet, Y.: ‘A 1-V CMOS current reference with temperature and process compensation’, IEEE Trans. Circuits Syst. I,2007, 54, (2), pp. 1424–1429

[3] Camacho-Galeano, E.M., Galup-Montoro, C., and Schneider, M.C.: ‘A-nW 1.1-V self- biased current reference in CMOS technology’, IEEE Trans. Circuits Syst. II, 2005, 52, (2), pp. 61–65

[4] Fiori, F., and Crovetti, P.S.: ‘A new compact temperature-compensated CMOS current reference’,IEEE Trans. Circuits Syst. II, 2005, 52, (11), pp. 724–728