NMOS Wilson Current Mirror

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Abstract

This paper describes about implementation of NMOS Wilson Current mirror circuit. Wilson current mirror accepts an input current at input terminal and provides mirrored current at output terminal. The mirrored current is exact copy of input or reference current. The four-MOS version of the Wilson current mirror has extended the linearity for operation at high currents, better stability and avoids current gain errors due to channel length modulation effect and they can also be used as current amplifiers. This paper includes, the design and analysis of NMOS Wilson current mirror using the 130nm technology.
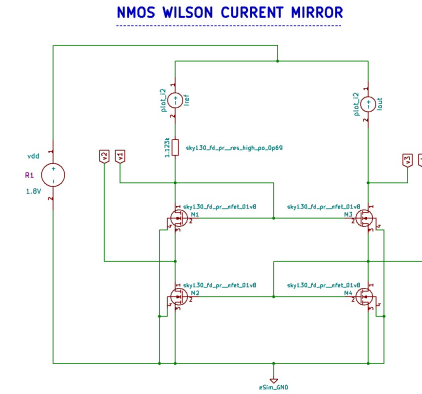
1 Circuit Details

The Current-mode analogue signal processing has led to the development of many systems based on the current-mode approach. The current mirrors are particularly useful for the distribution of bias currents in larger circuits. It is well-known that the Wilson current mirrors have better high frequency behavior than other current mirrors. Wilson current mirror balances the two branches to avoid systematic error introduced by differences in Vds voltages is the main advantage of using it. Negative feedback is included in this circuit and will give stable output currents for wide voltage swings and enhanced output impedance. It consists of four NMOS M1, M2, M3, M4. M1 and M4 are diode connected transistor. A diode connected transistor always remains in saturation region. So, no need to provide external biasing. Negative feedback is due to negative feedback drain current and series sampling is used at output to increase output impedance. M4 is in saturation and senses the current at output side. As M2 and M4 are identical MOS with same Vgs, Same current flows in both input and output side due to feedback action. Input branch and output branch currents are taken as Iref and Iout respectively. Keeping Vdd as 1.8V and resistance as 1.123k ohms, current of 6.23uA flows at input branch. From transient analysis which was performed for 1ms, it is observed that Iref current of 6.23uA is perfectly mirrored at output branch. This Implementation of NMOS Wilson Current Mirror for 6.23uA of current was done using eSim, ngspice and SKY130 PDK.

2 Implemented Circuit

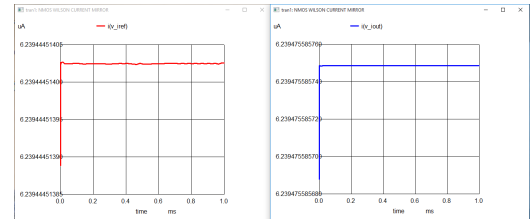

Figure 1: Implemented circuit diagram.

3 Implemented Waveforms

Figure 2: Implemented waveform.

References

[1] G. Csipkes. Current mirrors. http://www.bel.utcluj.ro/ci/eng/aic/documents/crtmirrors.pdf.

[2] D. D. Estreich. N-mosfet current mirrors. https://web.sonoma.edu/esee/courses/ee330/fa2017/labs/lab07.pdf.

[3] B. A. Minch. Low-voltage wilson current mirrors in cmos. https://ieeexplore.ieee.org/document/4253114.