# Lab Experiment 5

## MOSFET Current Mirror Circuits

A current mirror is a circuit block which functions to produce a copy of the current in one active device by replicating the current in second active device. An important feature of the current mirror is a relatively high output resistance which helps to keep the output current constant regardless of load conditions. Another feature of the current mirror is a relatively low input resistance which helps to keep the input current constant regardless of drive conditions. Conceptually, an ideal current mirror is simply an ideal current amplifier with a gain of -1. The current mirror is often used to provide bias currents and active loads in amplifier stages. Given a current source as the input, we convert the current (entering the current mirror) into a voltage and then use this voltage to control a current sink (the current exiting the mirror). A current mirror consists of a current-to-voltage converter consecutively connected to a voltage-to-current converter.

BJT and MOSFET current mirrors are widely used to produce supply voltage and temperature independent current sources in integrated circuits. These circuits replicate a golden current produced using sophisticated methods. A basic current mirror circuit using MOSFETs is shown in Fig. 1.

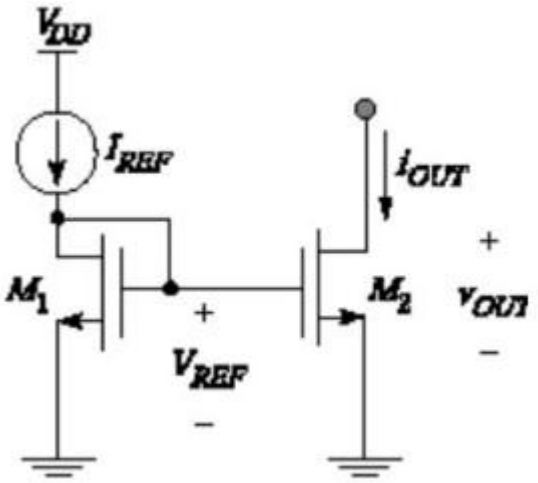


Figure 1: MOSFET Current Mirror Circuit with Constant Supply Current

In the above circuit, the constant supply current at drain of MOSFET *M1* results in a constant voltage across its gate terminal. This same voltage is applied as input voltage to the gate terminal of MOSFET *M2* and hence the current $I_{OUT}$ at its drain remains constant and is given by

$$I_{OUT} = I_{REF} \frac{(W/L)1}{(W/L)2} \quad (1)$$

The above equation assumes that both MOSFETs are perfectly matched in all other parameters like threshold voltage and mobility.

MOSFET Parameters: $K = 0.5mA/V^2$, $V_T = 1V$.

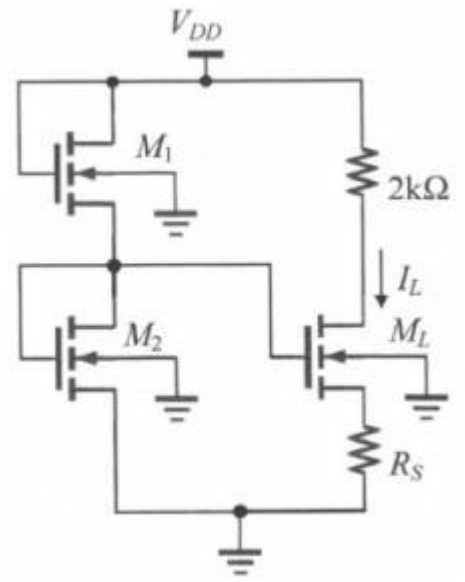


Figure 2: Widlar Current Mirror Circuit

Experimental Setup **(10 Points)**

1. The Widlar current mirror circuit using MOSFET is shown in Figure 2.
2. Short out $R_S$, and adjust $V_{DD}$ such that $I_{D-M1} = I_{REF} = 1mA$. $V_{DD}$ will be given from the DC power supply available in the lab.
3. Set $R_S$ to 1KΩ, and 2KΩ and measure the respective $I_L$?
4. $I_L$ can be calculated by measuring the voltage drop across the 2kΩ resistor.
5. Short out $R_S$, and adjust $V_{DD}$ such that $I_{D-M1} = I_{REF} = 5mA$.
6. Repeat Step 3.
7. Comment on your results, esp. with respect to the Widlar current mirror.

***Grade:* Award 10 points, if the followings are satisfied:**

1. *The current mirror circuit is connected as expected.*
2. *The student is able to demonstrate the reference current with Rs=0, as asked in point 2.*
3. *All the other steps are verified by changing Rs and Iref as asked.*

***Scope of partial marking:* 6 points, if:**

1. *The circuit is connection is proper, and the supplies are reaching to the desired points.*
2. *The student is able to demonstrate at least for one case of Rs (1k or 2k).*

**Note:**

1. Complete the write-up for the experiment before coming to lab. Presenting the lab report in each lab is mandatory.
2. All the observations made must be noted down in the lab report and get the report verified at the end of each experiment.
3. Plot figures from previous lab must be completed and get the same signed at the end of lab. Take a printout of any plots from SPICE simulations and staple them with corresponding experiment.

***Common Point for Rubric:***

*If there are minor mistake in any connections, cross check the MOSFET IC and give hints to rectify the bug. Even after the hints, the students are not able to make the right connections as said, zero marks will be given.*

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