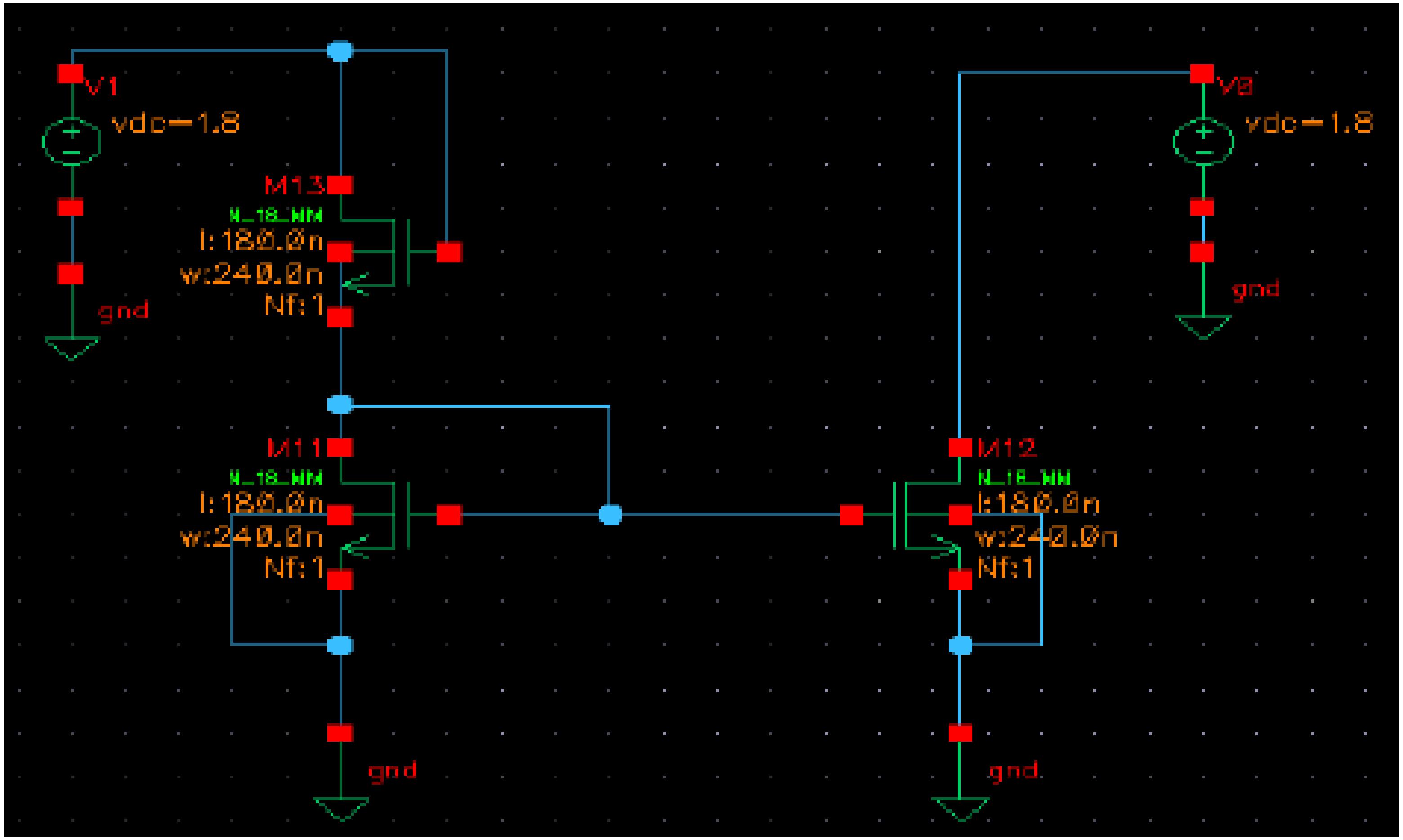
A New CMOS Voltage Divider Based Current Mirror, Compared with the Basic and Cascode Current Mirrors

Introduction
:

- Current Mirrors made by using active devices have come to be widely used in analog integrated circuits both as biasing elements and as load devices for amplifier stages.

- The use of current mirrors in biasing can result in superior insensitivity of circuit performance to variations in power supply and temperature.
- NMOS current mirrors are used as current sinks and PMOS current mirrors are used as current sources.
- There is variety of Current Mirror circuits available, each of them having their own advantage and applications

Current Mirror:



- The basic current mirror as shown in above figure.
- Transistor M_{11} is operating in the saturation mode, and so is M_{12}. In this setup, the output current I_{OUT} is directly related to I_{REF}.
- The drain current of a MOSFET I_D is a function of both the gate-source voltage and the drain-to-gate voltage of the MOSFET given by $I_D = f(V_{GS}, V_{DS})$.

$$I_{out} = \tfrac{1}{2}\,\mu_n C_{ox} (W/L)_2 (V_{gs} - V_{th})^2$$

$$I_{ref} = \tfrac{1}{2}\,\mu_n C_{ox} (W/L)_1 (V_{gs} - V_{th})^2$$

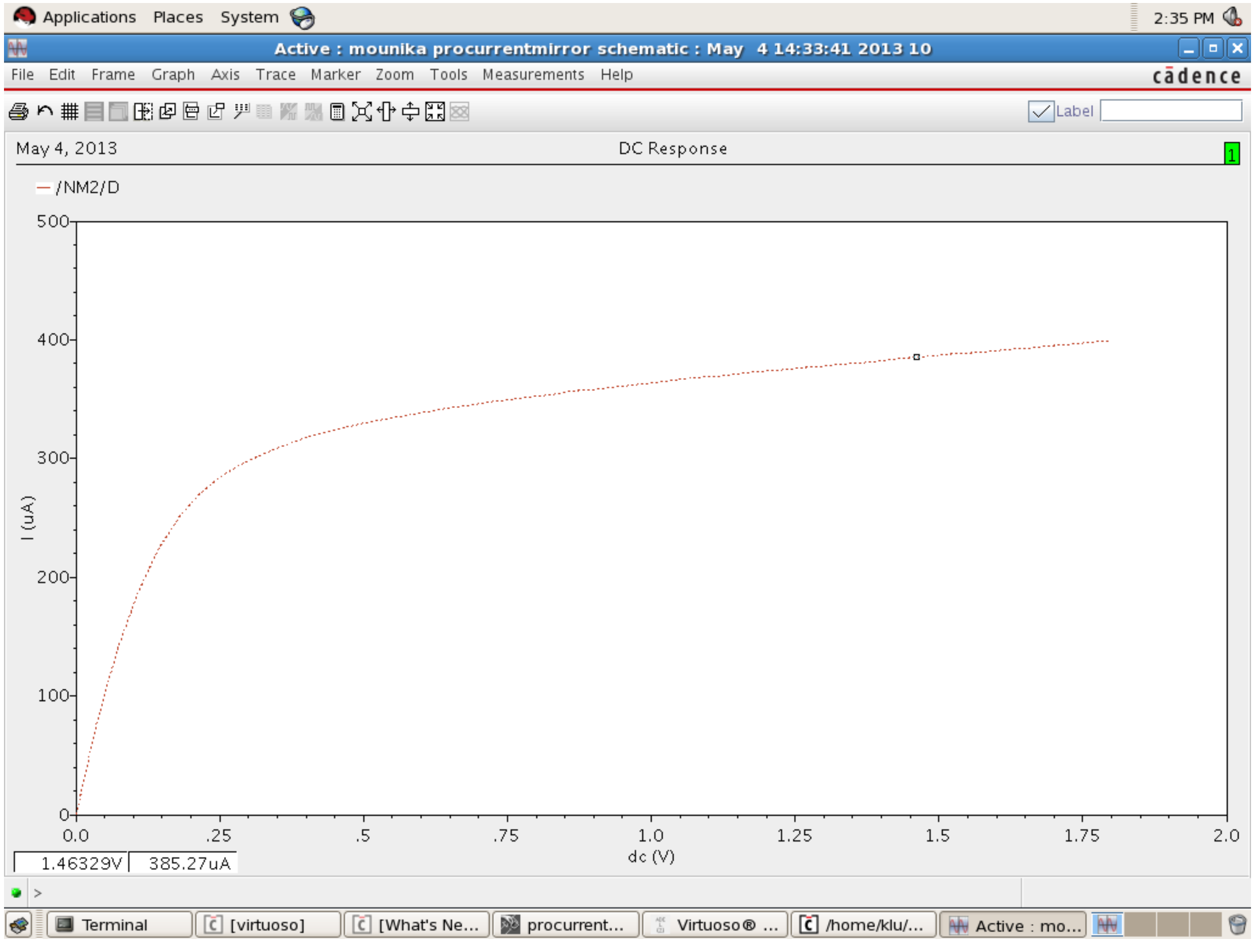
Limitations:

¬ Output resistance is finite and small value.

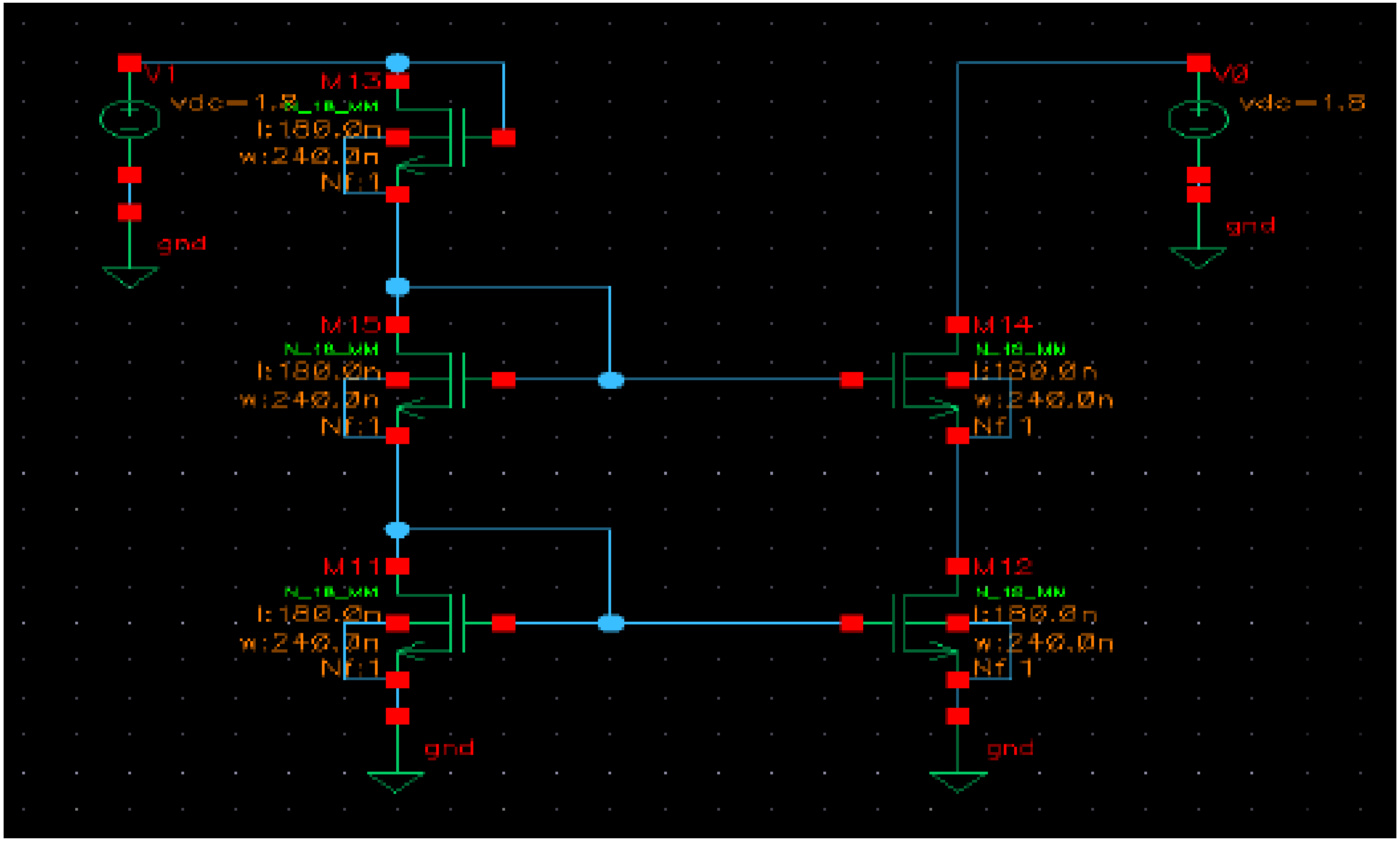
¬In basic current mirror circuit we can neglect the channel length modulation.

ϖPOWER DISSIPATION: 116.39uW

Simulation Results of Basic Current Mirror



Cascode Current Mirror:



- In order to suppress the effect of channel length modulation, a cascade current source can be used.

$$I_{D1} = \left(\frac{1}{2}\right) \mu_n C_{ox} (W/L)_1 (V_{gs} - V_{th})^2 (1 + \lambda V_{DS1})$$

$$I_{D2} = \left(\frac{1}{2}\right) \mu_n C_{ox} (W/L)_2 (V_{gs} - V_{th})^2 (1 + \lambda V_{DS2})$$

$$\frac{I_{D2}}{I_{D1}} = \frac{(W/L)_2}{(W/L)_1} \frac{(1+\lambda V_{DS2})}{(1+\lambda V_{DS1})}$$

While $V_{DS1} = V_{GS1} = V_{DS2}$, V_{DS2} may not equal V_{GS2} because of the circuitry fed by M_2.

- The idea of cascode structure is employed to increase the output resistance and the implementation requires NMOS technology.

¬ **Advantages:**

- High gain
- High bandwidth
- High slew rate
- High stability and high input impedance

Limitations:

- The minimum allowable voltage equal to two overdrive voltages plus one threshold voltage.

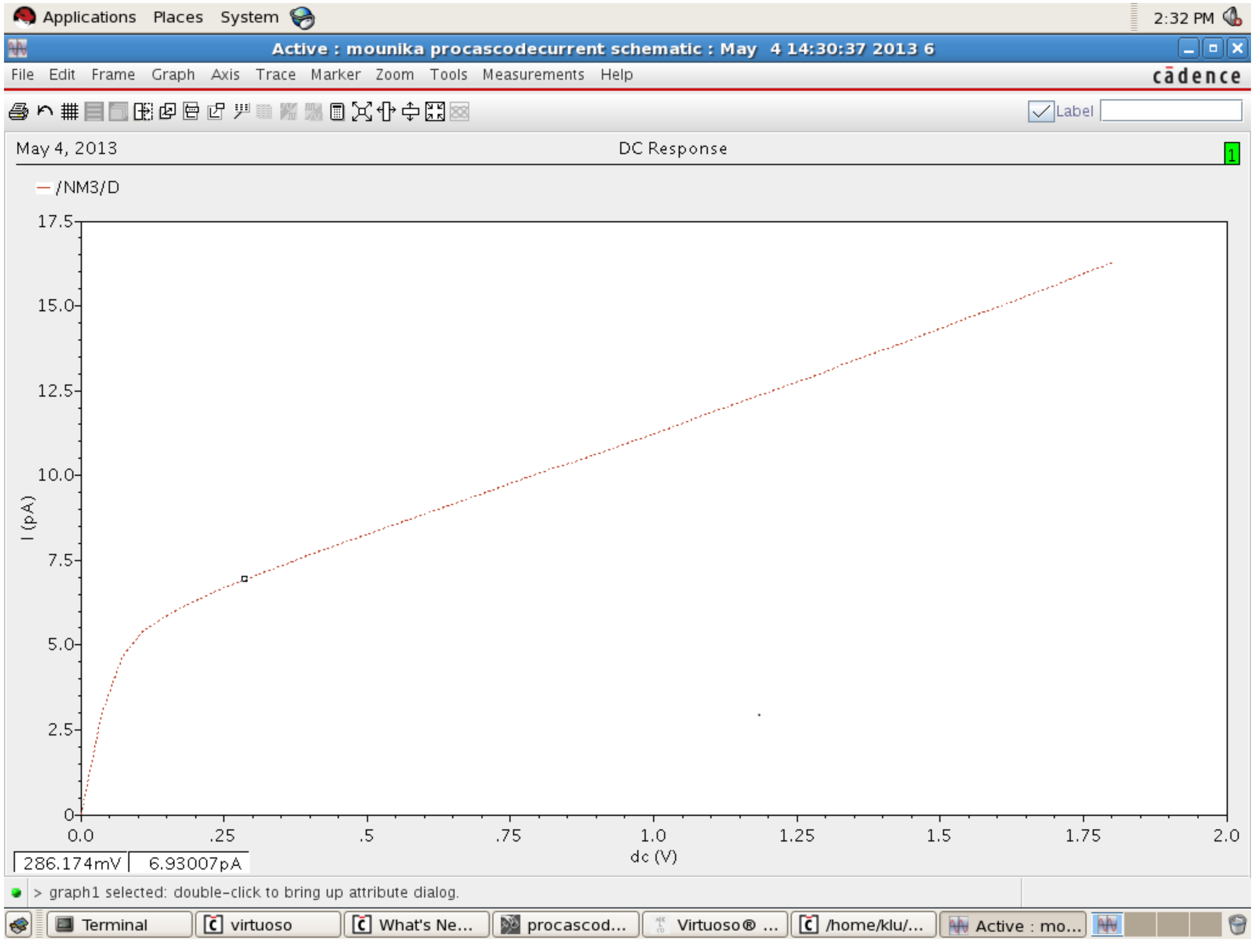
$$V_N - V_{TH} = V_{GS0} + V_{GS1} - V_{TH} = (V_{GS0} - V_{TH1}) + (V_{GS1} - V_{TH1}) + V_{TH}$$

- Thus the cascade mirror wastes one threshold voltage in the headroom.

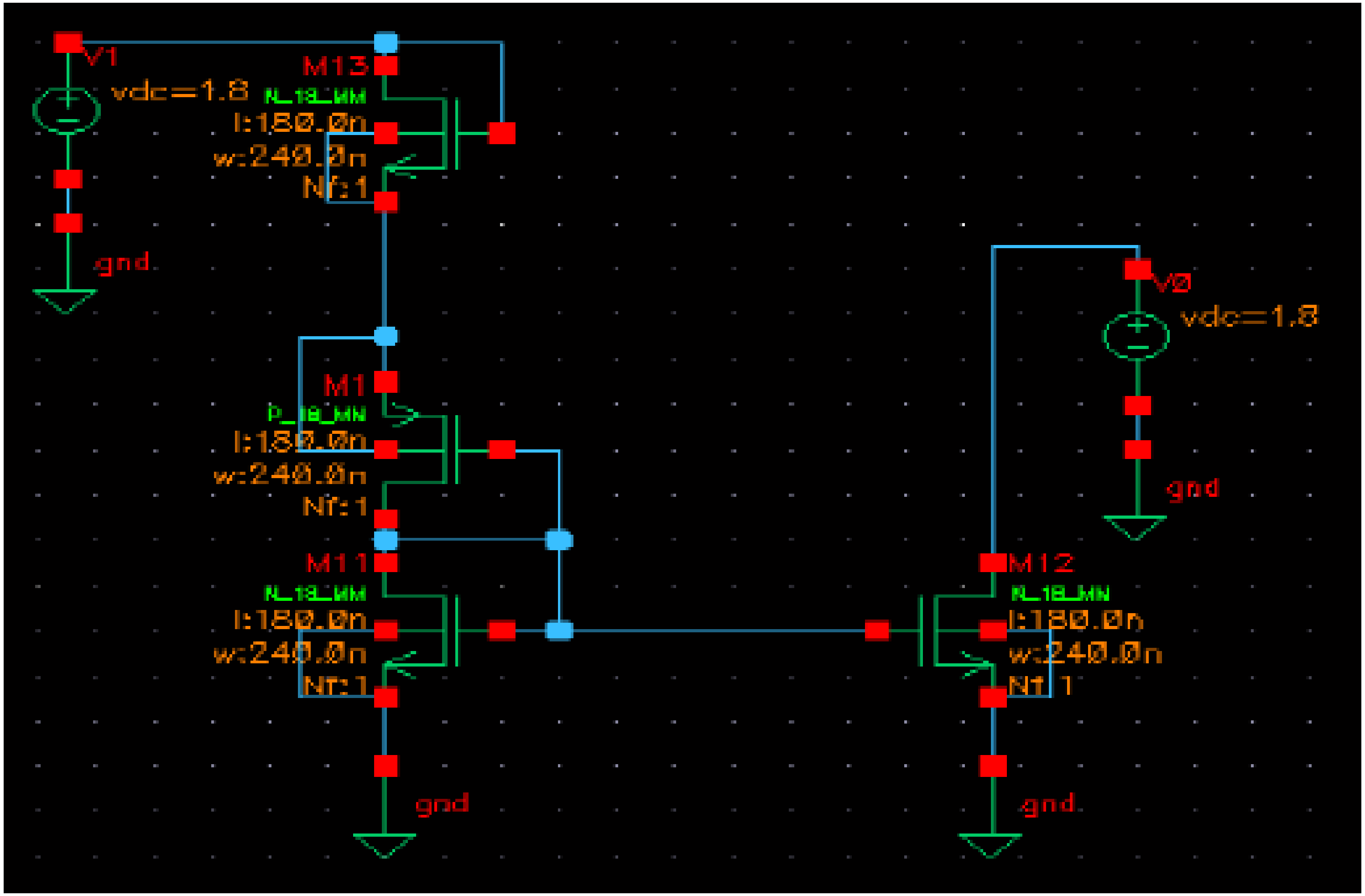
- This is the drawback of Cascode current mirror

ϖ POWER DISSIPATION:68.3217uW

Simulation Results of Cascode Current Mirror



CMOS Voltage Divider Current Mirror:



- Figure shows the circuit of CMOS Voltage Divider based Current Mirror.
- Improved circuit uses NMOS and PMOS transistors to form a Voltage Divider, so called as CMOS Voltage Divider based current mirror.
- NMOS and PMOS transistors are diode connected produces the reference voltage Vgs to bias the NMOS transistor M12, which in turns controls the Output Current Iout.

•The reference current Iref generated by the above circuit is given by

Where

Iref= Reference Input Current

$$Iref = \frac{(Vdd + Vgs1 - Vgs11)}{R}$$

Vdd= Supply Voltage

Vgs1= Gate to Source Voltage of M1

Vgs11= Gate to Source Voltage of M11

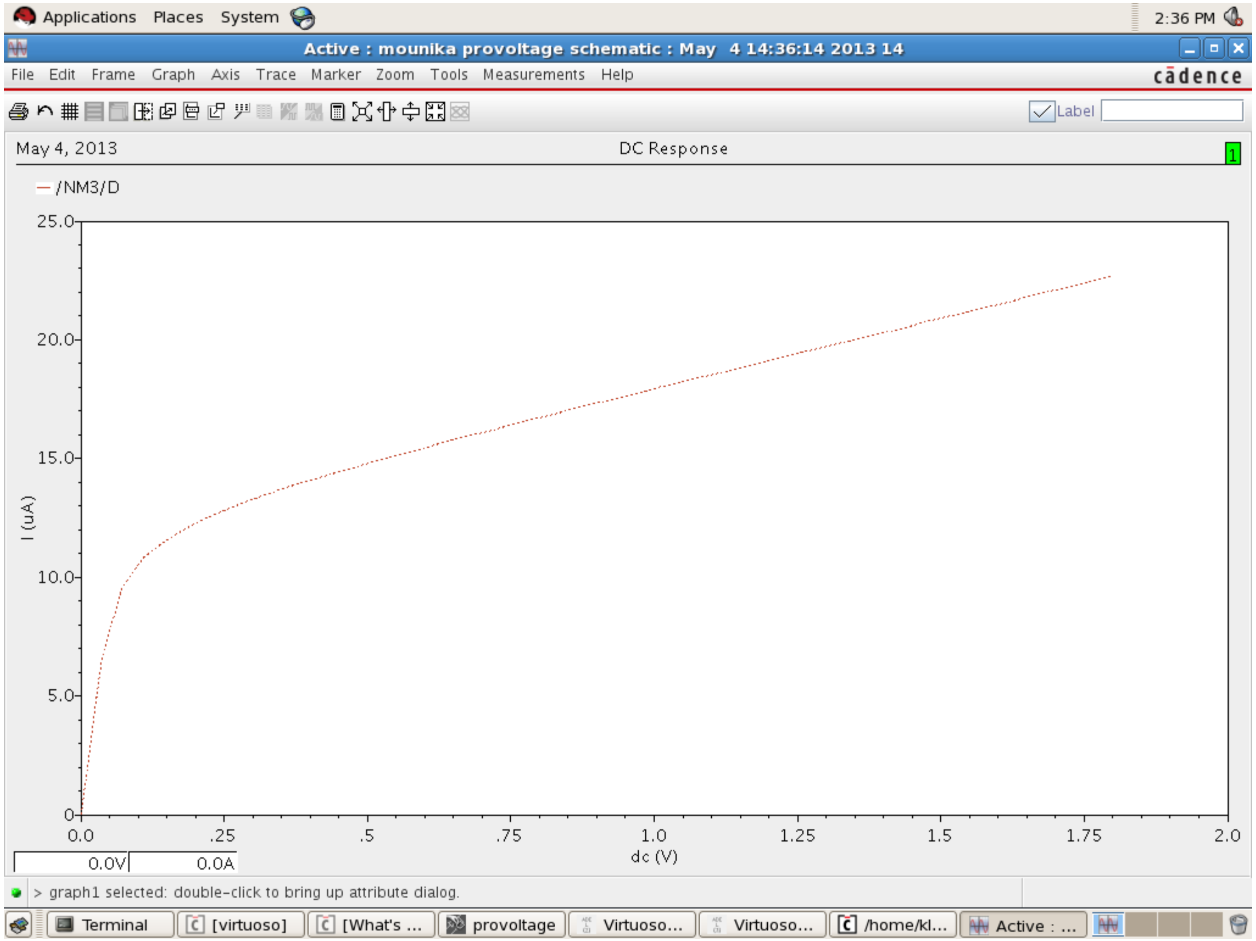
$$Iout = Kn'\left(\frac{W}{L}\right)(Vgs11 - Vds2)\text{\textasciicircum}2(1 + \lambda Vds2))$$

R= Resistance offered by the MOS M13

•Consider the MOS M12 operates in saturation region, and then the output current becomes

ϖPOWER DISSIPATION:5886uW

Simulation Results of voltage divider



Applications:

High speed data converters such as RF, A/D, D/A converters

- oscillators

CONCLUSION

- Main intention of this paper is to present the simple idea of designing a new CMOS Voltage Divider based Current Mirror, than its comparison with the Basic and Cascode Current Mirrors. This new Mirror is well suited for low current biasing applications. Like the Wilson and Widler current Mirror Circuits, this new Current Mirror can be used as a Low Current Biasing circuit. Also, when compared with Basic Current Mirror, improved one consumes only 1/4th of the Power consumed by the Basic Current Mirror.