EE518 Analog IC-DESIGN LAB
Experiment 3

Design and analysis of various current mirror circuits.

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Contents

1 EXPERIMENTS

Design and analysis of various current mirror circuits.

2 OBJECTIVE

- Basic current mirror circuit with (W/L) = (0.36/0.18) to generate (3Iref) and one third of the reference current (1/3 Iref).
- Multiple finger based current mirror circuit.
- Normal cascode current mirror circuit.
- High swing cascode current mirror circuit.

3 Theory

3.1 Theory for current mirror circuits

A current mirror circuit is used to copy one active device's input current to the output of other active devices. Here, the flow of current can be copied in the form of inverting from device to device. Once the flow of current within the first active device is altered then the reflected output current from the other active device will also be changed. the designing of current mirror circuits can be done with two main transistors. it copies the flow of current in one active device whereas, in another active device, it maintains the output current stable instead of loading. The copied current is a constant current.

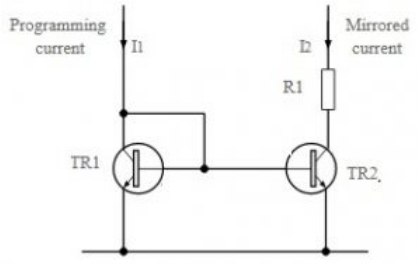

Figure 1: Basic current mirror circuit

here TR1 is a transistor1 and TR2 is a transistor 2. and I1 is the applied current where as I2 is the mirror current
This circuit can be built with two transistors, where one of the transistors base and collector terminals are connected, both the transistor's base terminals are connected whereas the emitter terminals are given to GND. In this circuit, both the transistors work similarly.
The operation of the current mirror is based on the driving equation for the MOSFET current at saturation. Based on Id,sat, we can see that the current is modeled as the square of the overdrive voltage, Vov = Vgs - Vth.
the current flowing through the MOSFETs must be equal if the width and length are equal , assumes negligible channel length modulation. However, this is not always the case in applications. Current mismatch can be caused by some faults such as process change, VDS difference and VTH mismatch.

3.2 Cascoded mirror circuit

In basic current mirror circuit we make both gate to source voltages are same , but we didn't know both drain to source voltage are same.so we are going to build a cascode structure on top of the copy mosfet.so we know that cascode circuit is make drain volatge not vary from the changes from load. also we need to make sure cascode circuit also in saturation,Therefore, we create the same casode circuit on top of the reference MOSFET as well, connecting it as a diode and connecting the gate source voltage to the copy circuit's cascode.

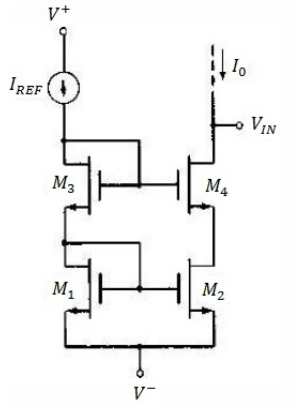

Figure 2: Cascoded current mirror circuit

3.3 High voltage swing current mirror circuit

A current mirror may also be characterized as having an output voltage swing. High voltage swing in current mirrors is desired for accurate operation with low power supply voltages and for increased voltage signal amplitudes which improve the accuracy of analog circuitry utilizing the current mirrors. We received the VDS effect, not the current copy.However, it reduces the drain to source voltage swing.which is the lowest value, and 2VDSAT-Vth. We are therefore going to set the reference cascode gate to source voltage equal to 2VDSAT+Vth in order to maximize the swing, and we will copy the cascode mosfet with a minimum drain to source voltage of 2VDSAT.

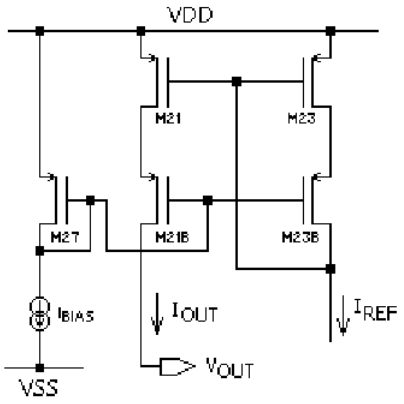

Figure 3: High voltage swing Cascoded current mirror circuit

4 Schematic and graphs

4.1 Basic current mirror circuit

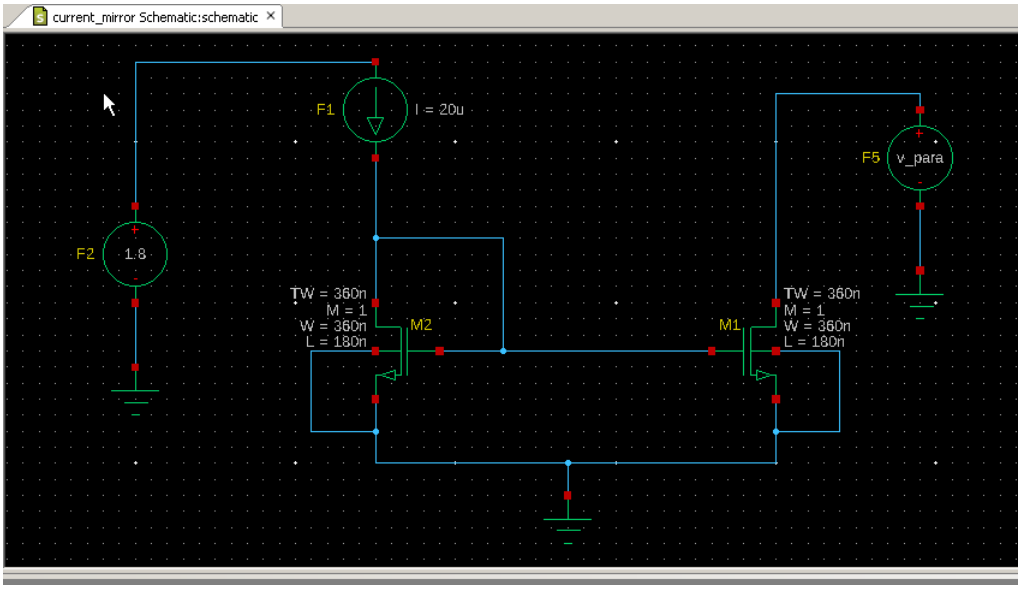

Figure 4: circuit diagram for Basic current mirror circuit

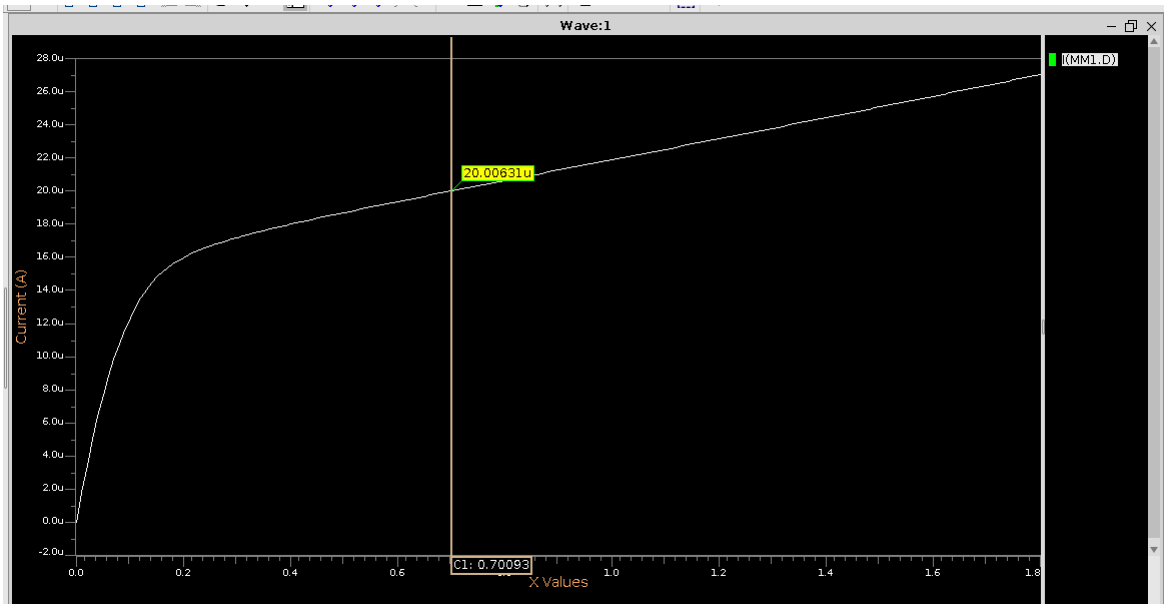

Figure 5: $I_d$for Basic current mirror circuit

5 Basic current mirror circuit with 3Iref

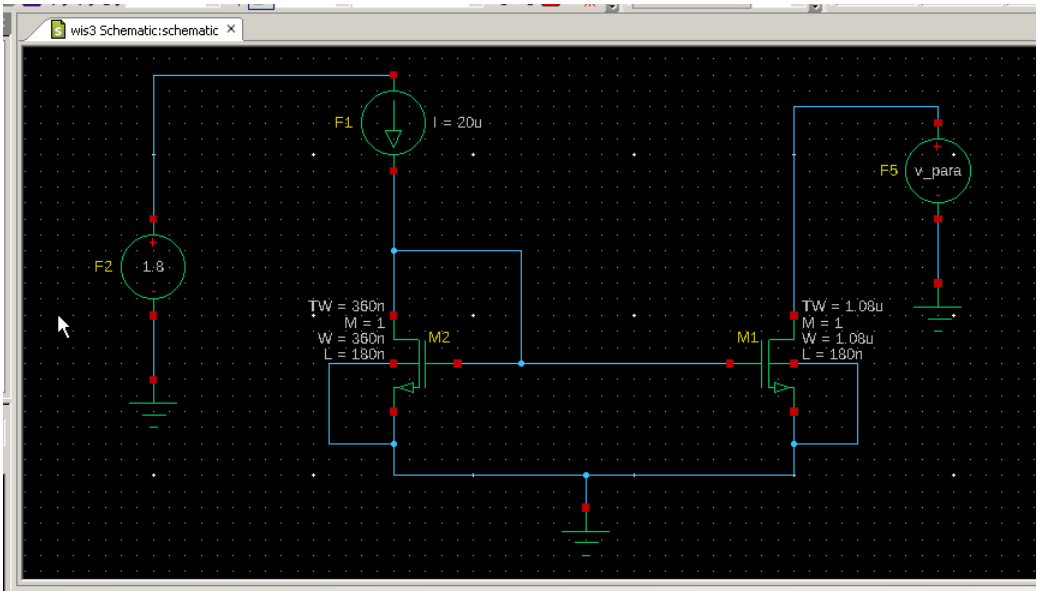

Figure 6: circuit diagram for Basic current mirror circuit with 3Iref

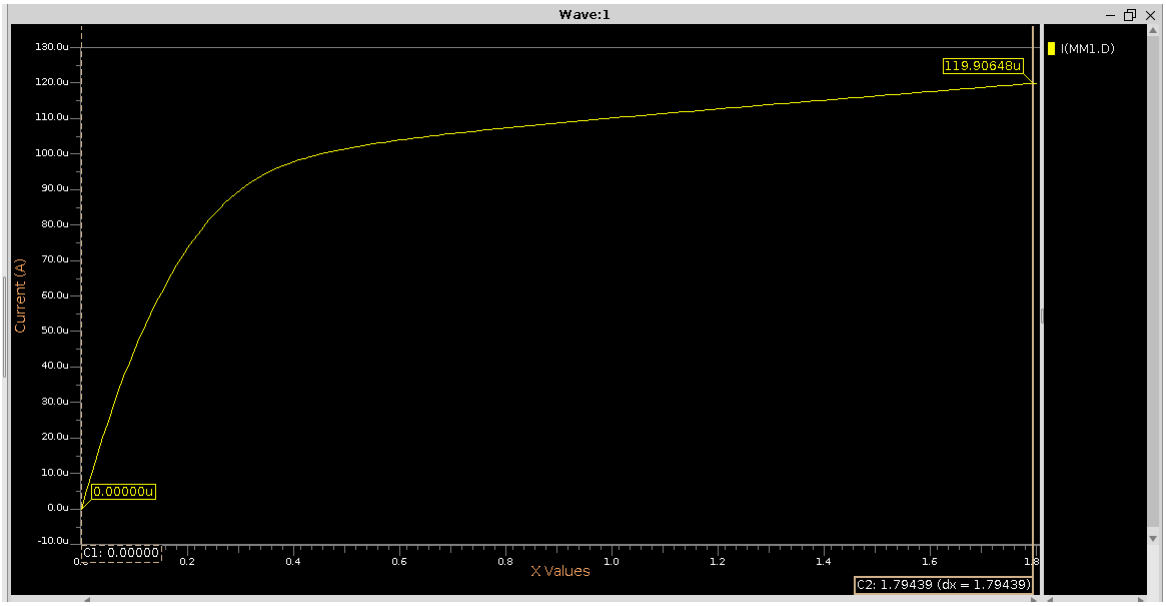

Figure 7: $I_d$for Basic current mirror circuit with 3Iref

6 Basic current mirror circuit with 1/3 Iref

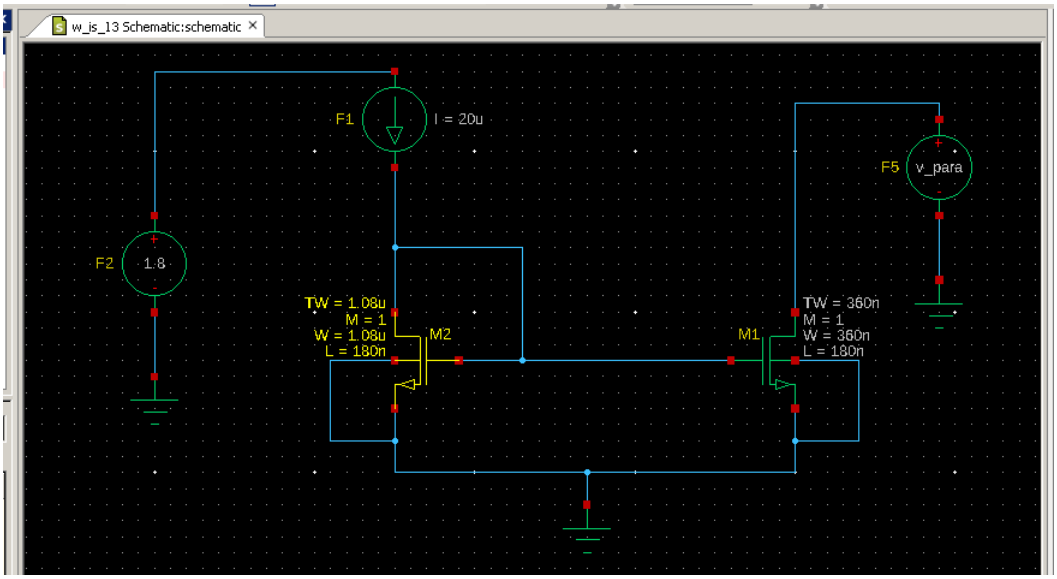

Figure 8: circuit diagram for Basic current mirror circuit with 1/3 Iref

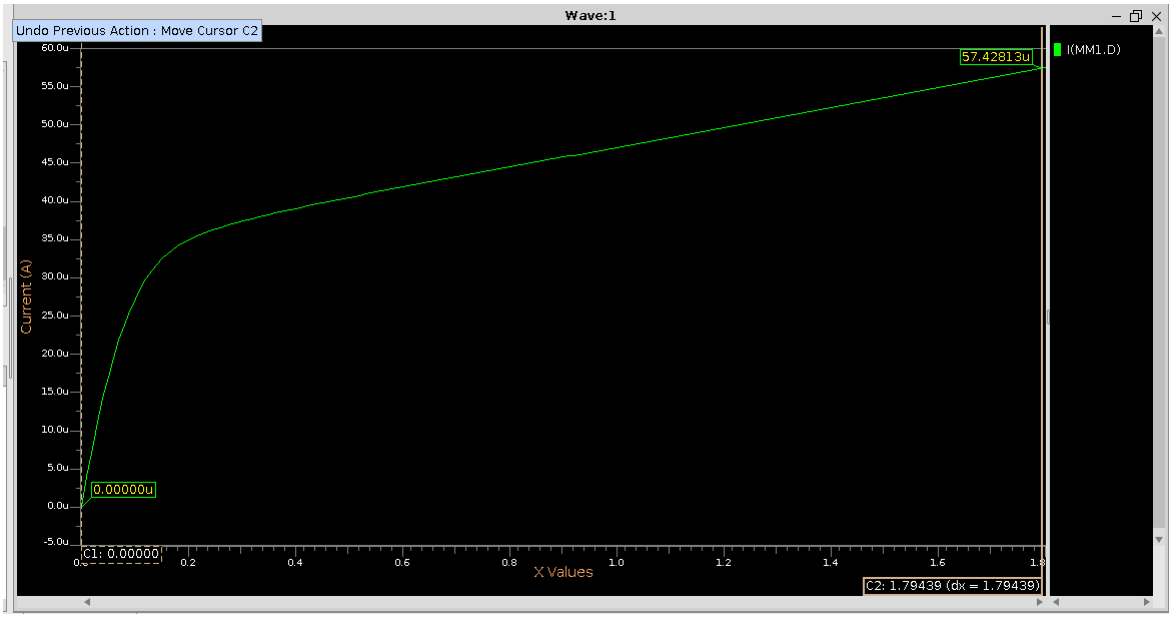

Figure 9: $I_d$for Basic current mirror circuit with 1/3 Iref

7 Multiple finger based current mirror circuits

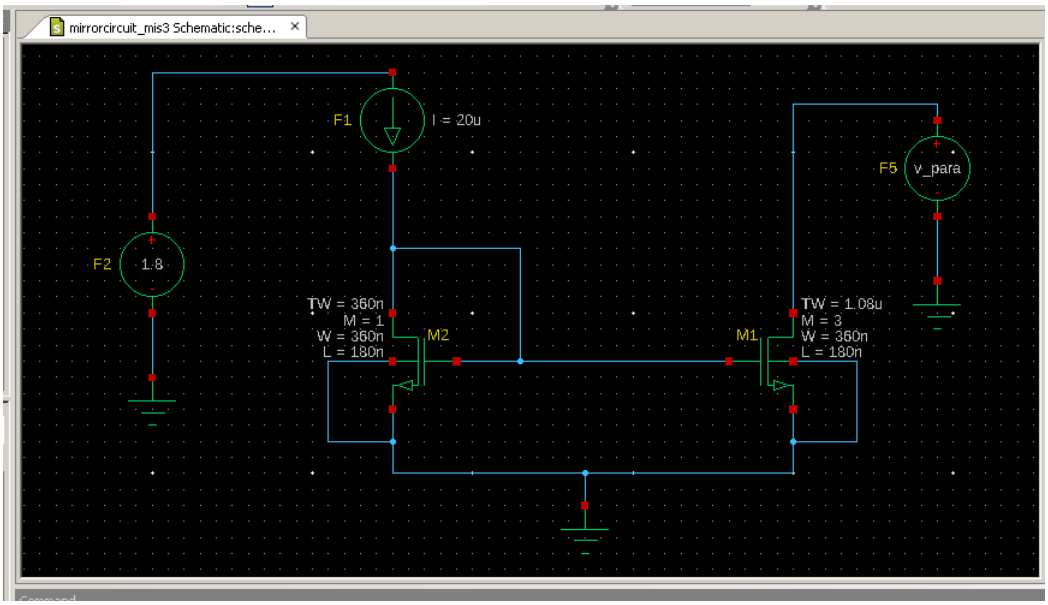

Figure 10: circuit diagram for Basic current mirror circuit with m=3 at transistor2

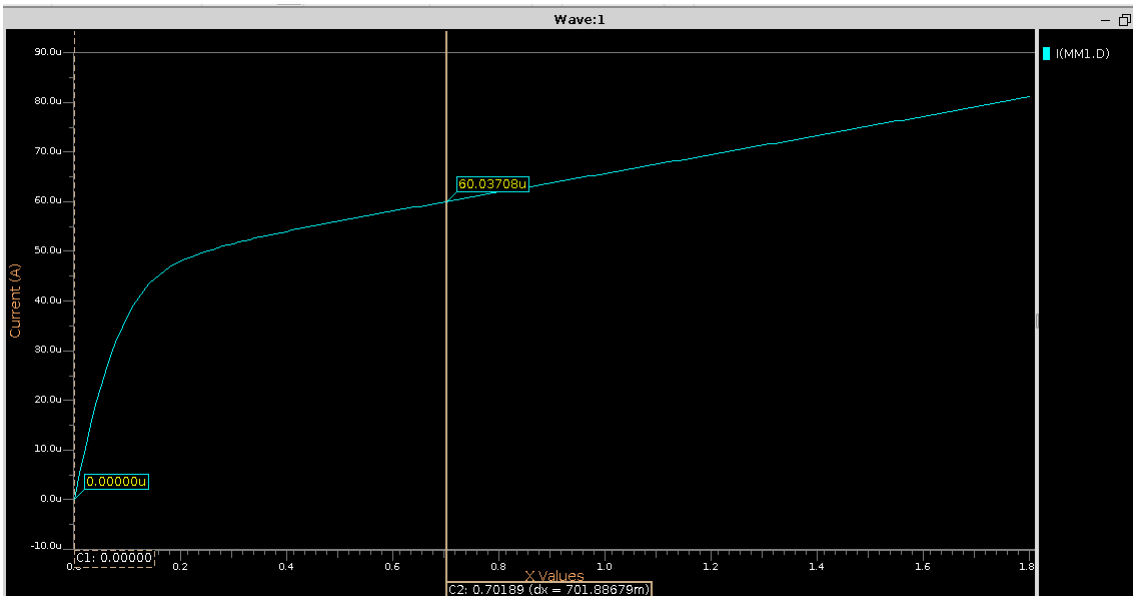

Figure 11: $I_d$for Basic current mirror circuit with m=3 at transistor2

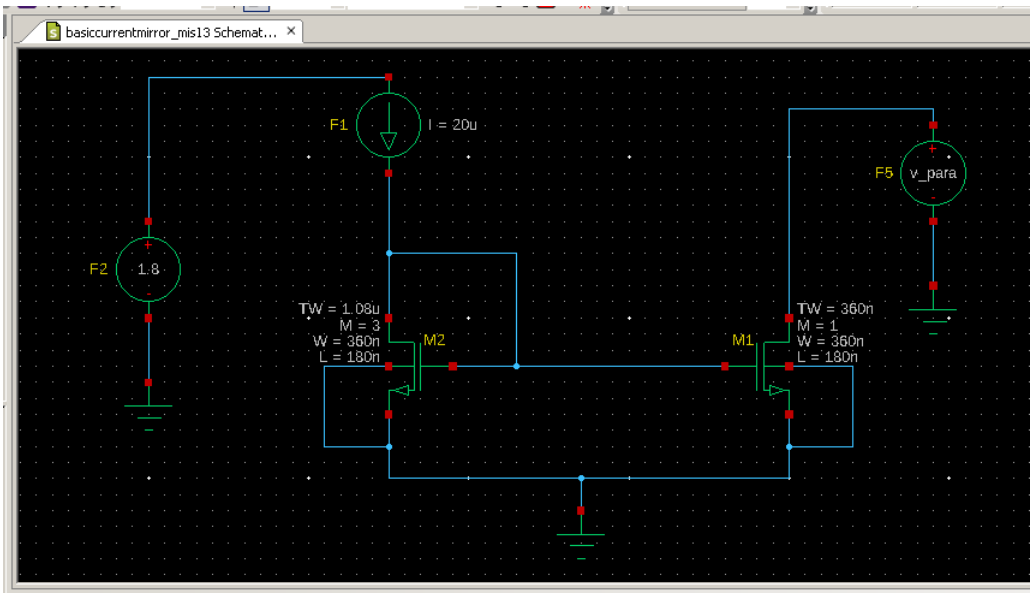

Figure 12: circuit diagram for Basic current mirror circuit with m=3 at transistor1

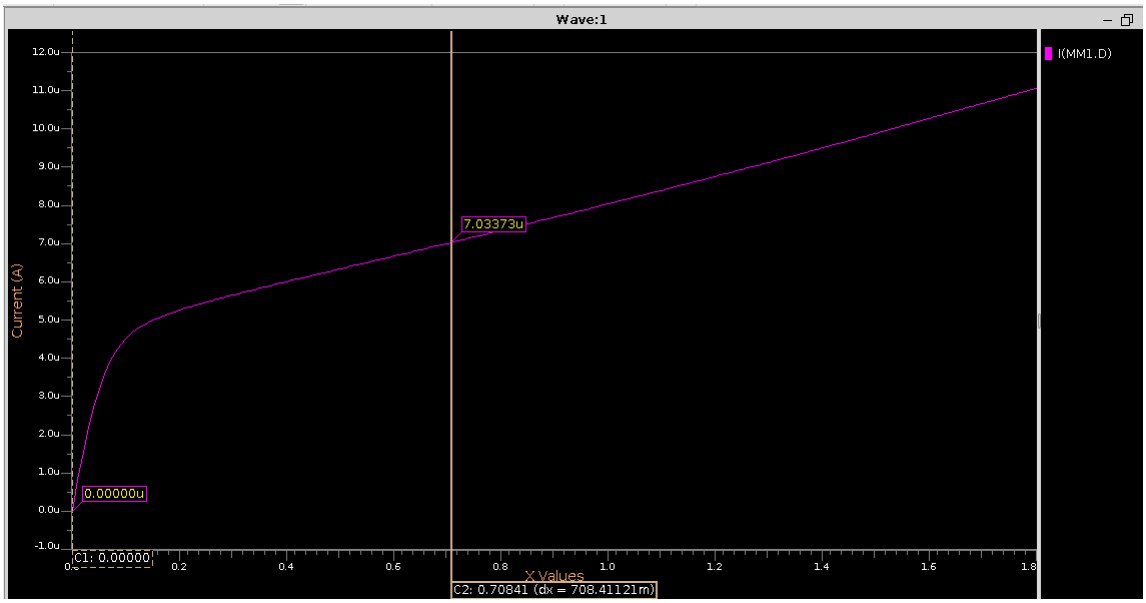

Figure 13: $I_d$for Basic current mirror circuit with m=3 at transistor1

8 Cascoded current mirror circuit

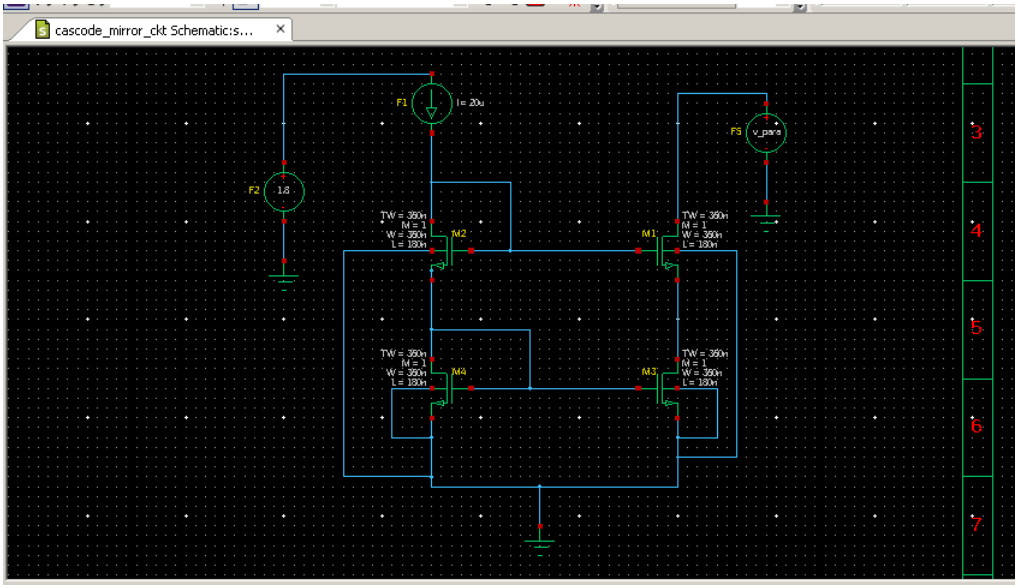

Figure 14: Cascoded current mirror circuit with m=3

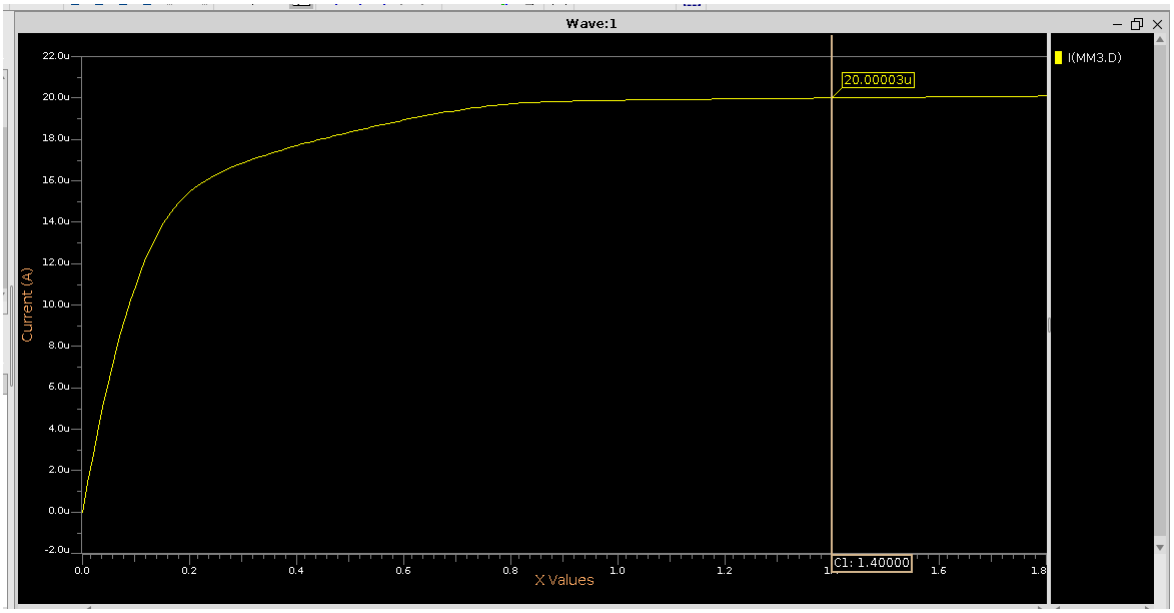

Figure 15: $I_d$for Cascoded current mirror circuit

9 High swing cascoded current mirror circuit

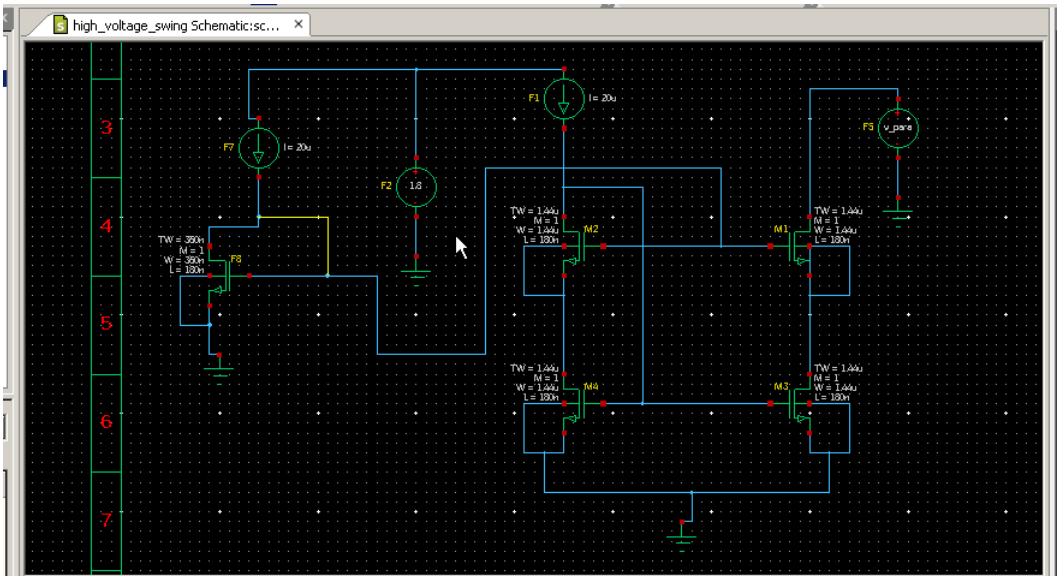

Figure 16: High swing cascoded current mirror circuit with m=3

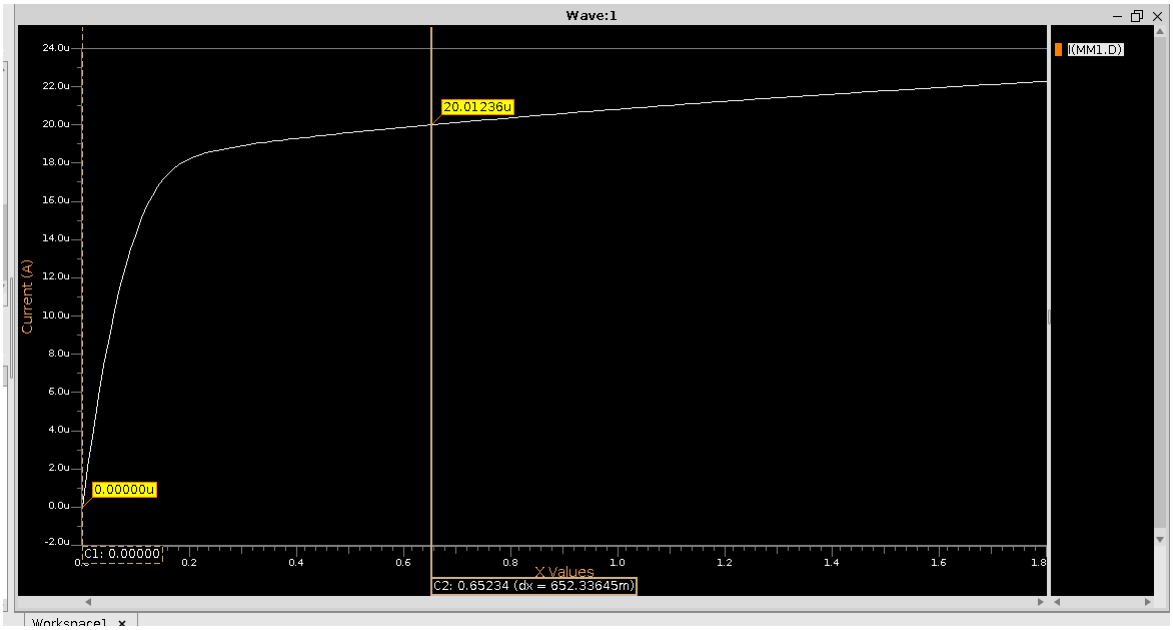

Figure 17: $I_d$for High swing cascoded current mirror circuit

10 Comparison table

	mirror circuit	I_d u	v of transistor2
	basic mirror ckt	20	0.70093
	basic mirror ckt of (3Iref)	20	0.70093
	basic mirror ckt of (1/3Iref)	20	0.70093
	basic mirror ckt of m is 3	60	0.70189
	basic mirror ckt with mis 1/3	70.377	0.70841
	cascoded mirror ckt	20	1.4000
	High swing cascoded mirror ckt	20	0.65234

11 Conclusions:-

- All the results have been obtained practically and matching with the theoretical justification. The theoretical calculations have been done.
- sic current mirror circuit have good output swing ,but is highly depends on Vds
- By increasing the number of parallel circuits, so we get the same drop on every circuit, therefore if you increase the fingers, we get proper copy current within range.
- The cascode current mirror circuit works properly to eliminate Vds on copy current, however it is reducing the swing.
- if you need stability and best copy of current Cascode circuit is highly preferable,f you need only high swing ,then High swing cascode current mirror circuit ,highly preferable.