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A Review on Current Mirror Circuits

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ABSTRACT:. The current Mirror circuits are the most important configuration in field of electronics industry . Mirrors produces the reflection of the object which are placed in fron of them . Similarly the current mirror circuits works in the same way as mirror do . These circuits reflects the currents so that those can be supplied to other sub circuits instead of using more current sources . Constant current source is the heart of the differential amplifiers , hence these circuits are very important in analog VLSI design. These have many more advantages which are highly useful in designing circuits.

KEYWORDS: Cascodes , Wilson , Mirror , high swing

I.INTRODUCTION

Since the Mirrors are the most important components in our daily life . Inspired form that , a new concept has arisen which produces reflection of current to provide that current as a constant current source to other circuit associated . These circuits have large output impedance and low input resistance which keeps the input & output current source constant in any circuit . These circuit can be split into current – to- voltage and voltage – to-current connected back to back as shown in figure 1.

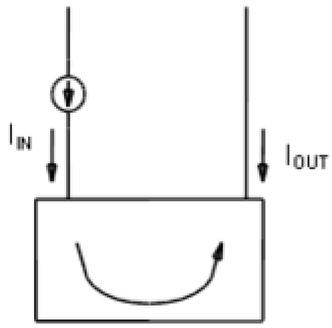

Figure 1 : Basic Principle of Current Mirror Circuits

There are five main types of current mirror circuits

1. Simplest Current Mirror
2. Cascoded Current Mirror
3. Wilson Current Mirror
4. High Swing Cascode Current Mirror
5. Active Current Mirror

II.VARIOUS CURRENT MIRRORS

If ideal current mirror circuit is to be considered, the it must have gain of -1 but practically there is no such circuit with gain -1. So here is brief description about above mentioned categories of current mirror circuits

Introduction to BGR

Since , the single voltage is supplied to the single chip (either 1.8 V , 2.5 V or 1 V) , But , some intermediate voltages are also required (0.8 V, 0.6V) . There is circuit known as BGR known as Band Gap Reference circuit . This circuit

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has a great advantage of providing constant current source to the circuit . The working of BGR is described below with the help of figure 2 . There are some variations in voltage and current due to temperature variation which is also compensated with BGR.

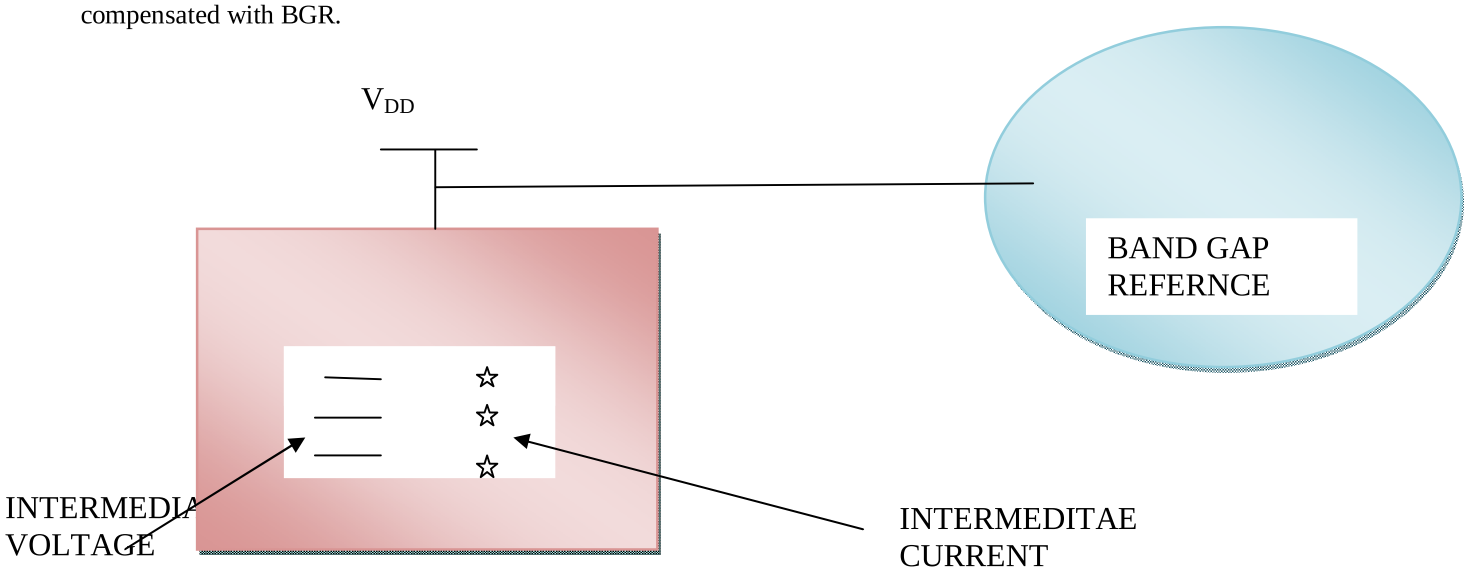

Figure 2 : Working Principle of BGR

Simplest Current Mirrors

Since current mirrors are used to provide reflection of current in whatever for like scaled or multiplies , to other subcircuits . A typical Simple current cascade is shown below in figure3

Let I_{reff} is the reference current provide bi reference source. Similarly , I_O is the current flowing from M_1 . Three cases arises:

1. $I_0 > I_{reff}$
2. $I_0 < I_{reff}$
3. $I_0 = I_{reff}$

   Vgs1 = Vgs2 , the body of the transistor is grounded

   Then a equation arises;

$I_{reff}=K/2(W/L)_2(Vgs2-Vth_2)(1+\lambda Vds2)$..................................1

$I_{reff}=K/2(W/L)_1(Vgs1-Vth_1)(1+\lambda Vds1)$...................................2

$Vth_1=Vth_2$ and λ approaches to 0

Dividing eq1 & eq 2

$$[I_O/I_{reff}] = \frac{(w/l)_2}{(w/l)_1}$$

1. If $W_2 > W_1$, then $I_0 > I_{reff}$
2. If $W_2 < W_1$, then $I_0 < I_{reff}$
3. If $W_2 = W_1$, then $I_0 = I_{reff}$

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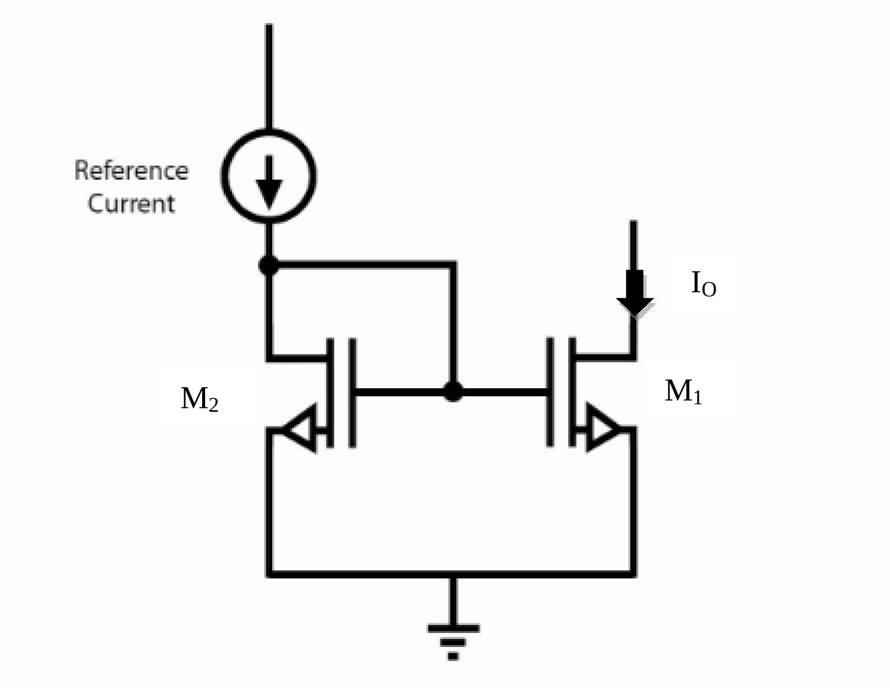

Figure 3 : Simplest Cascode Circuit

If the current variations are to be observed then it is shown below in figure 4 & 5.
The curve is drawn from I_{reff} =0 to some value , it is assumed that Vds1=Vds2 .

1. For M_2 When I_{reff}=0 , Vgs1=0 and Vds1 =0=Vds2 , all the transistors are in saturation , current will move till triode point , after that Vds1 will not be equal to Vds2 shown in figure4.
2. For M_1 , When when I_{reff}=0 , the voltage drop across M_1 will be VDD , so the curve will start from vdd as shown in figure 5

1. FOR M_2 TRANSISTORS

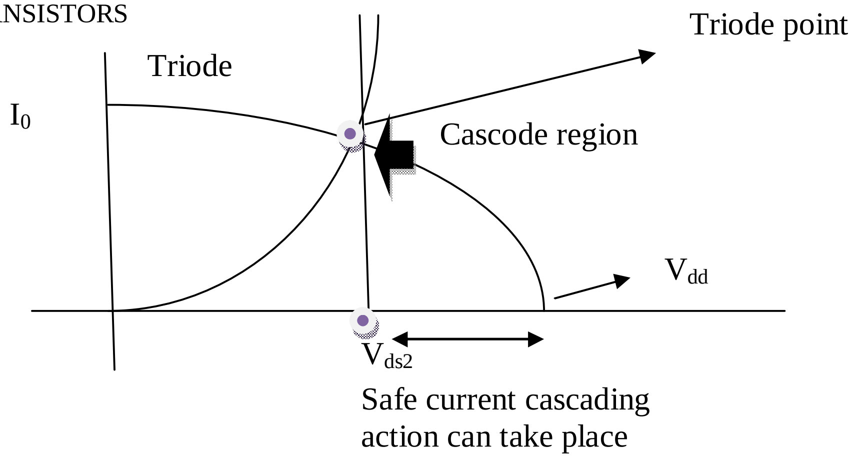

Figure 4 : Current Variations M_2

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2. FOR M_1 TRANSISTORS

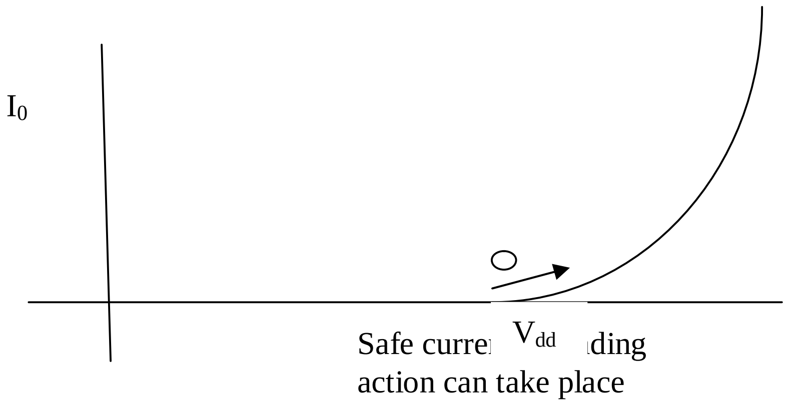

Figure 5: Current Variations for M_1

Drawback of Simplest Cascode Current Mirror :

1. If Vds1 is not equal to Vds2 then it is not obvious that I_{REFF} & I_O will be defined by 'W' and error will increase as shown in figure 6.
2. Second problems mismatch in Vth due to mismatch in the transistors characteristics.

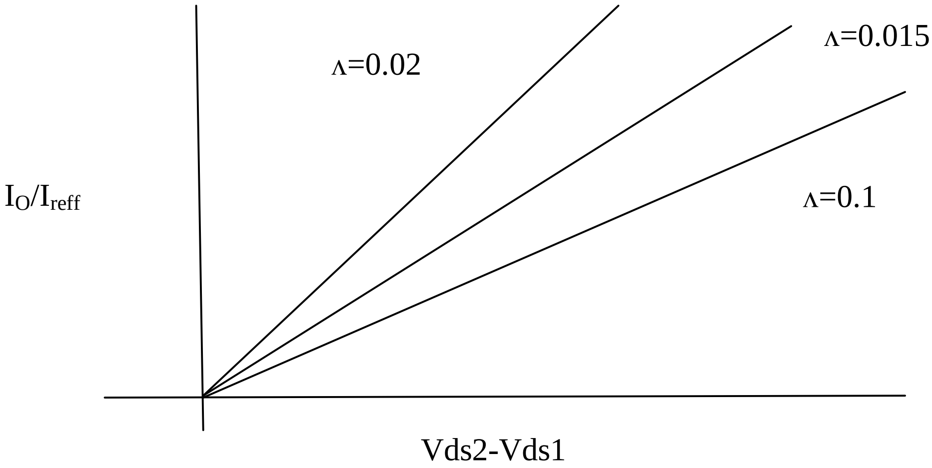

Figure 6 : Error Variations

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Cascode Current Mirror

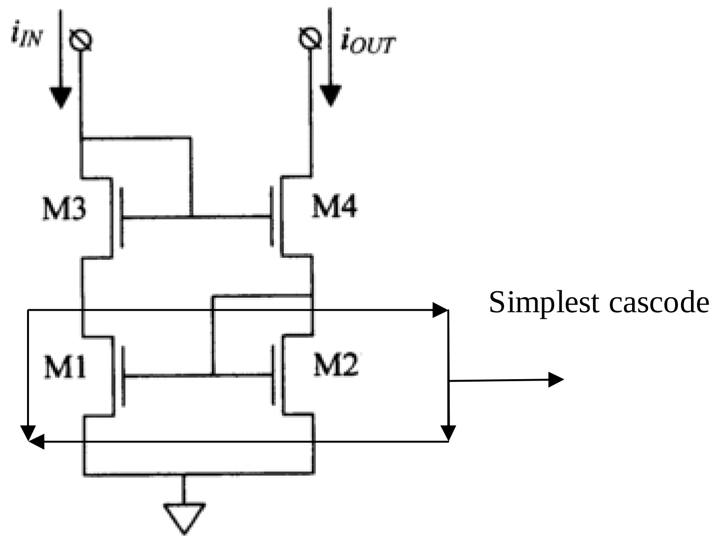

Figure 7 : Cascode Current Mirror

To overcome the drawback of simplest diode M3 & M4 transistors are used
Here Vgs2=Ngs4 While Vgs1 = Vgs3. Similar graphs are drawn for M1 , M2 ,M3 & M4.
The transistors M1 & M3 will be in saturation and these both will conduct from zero if I_{reff} is zero as shown below;

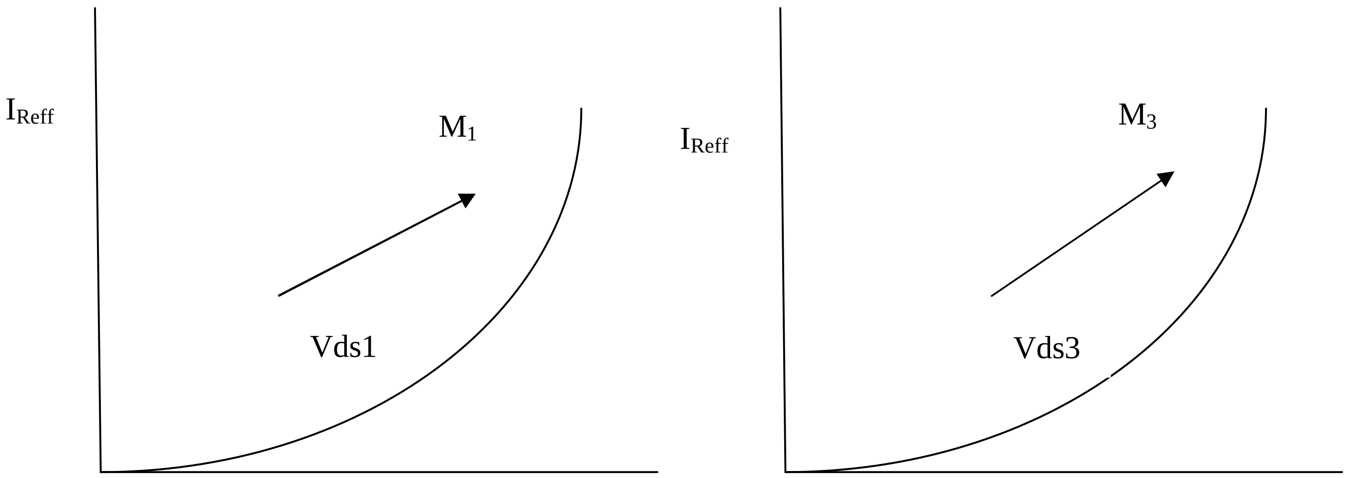

Figure 8 : Current Variations for M1 & M3 Transistors

Situation will be different for M2 & M4. , The curve will start from (Vds2-Vds4) and M2 & M4 need not to be in saturation , the current variation is shown in figure 9;

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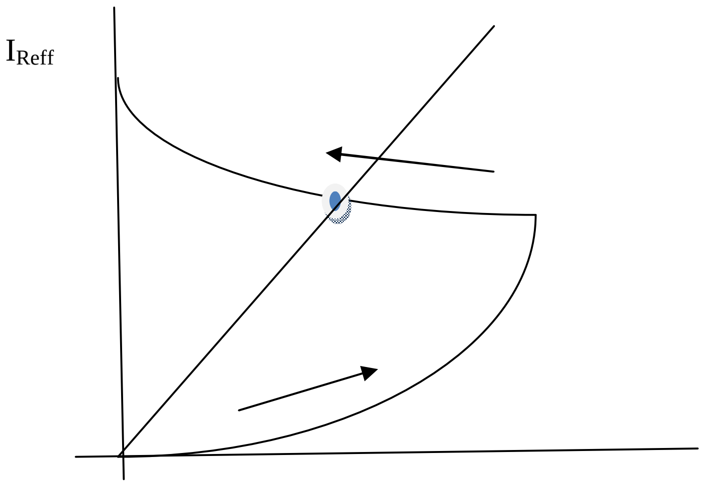

Figure 9 : Current Vds2 of M2 Trnasistor

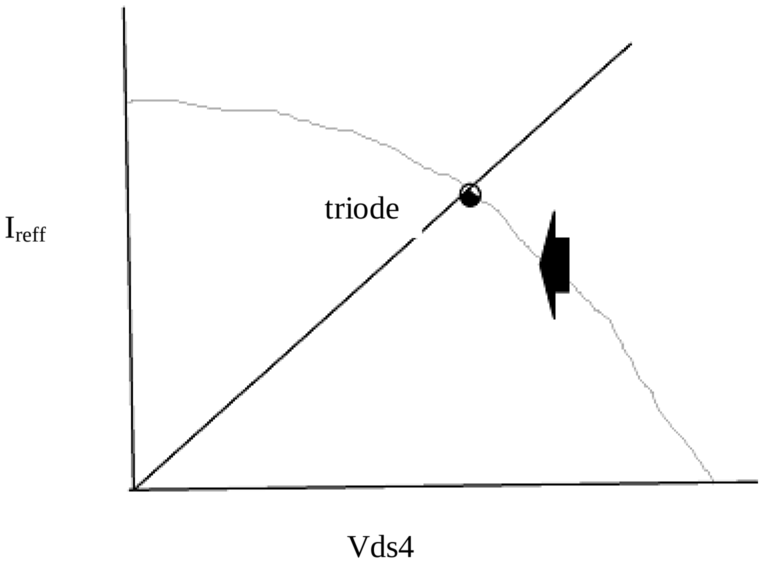

Figure 9 : Current variation for M2 & M4

The basic draw back of Cascode morror circuit is that it decreases the output swing , for that high swing cascade are used .

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High Swing Cascode

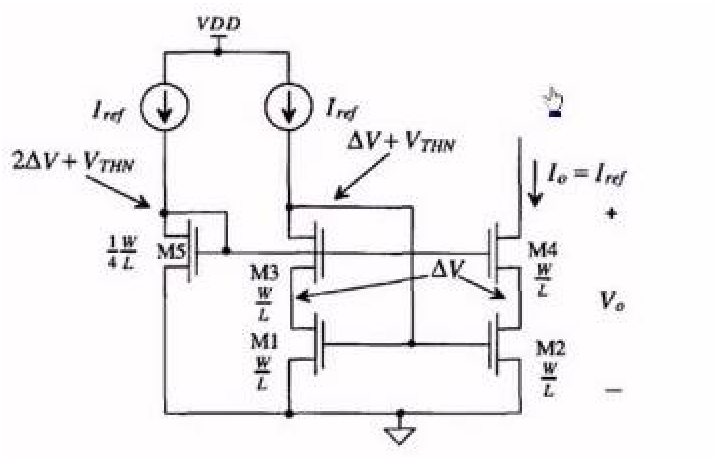
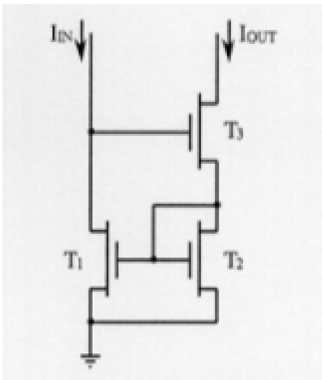


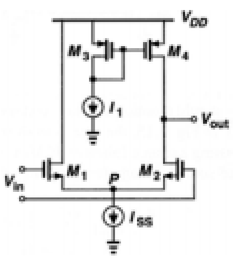
Figure 10 : High Swing Cascode

Wilson Current Mirror

Because of negative feedback , the drain current is stabilized and series sampling is used for increasing high output impedance.



Active Current Mirrors



These are basically used in Differential amplifiers to provide constant current source to the amplifier

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III.CONCLUSION

1. From above discussion it is clear that if comparision is made between Cascode mirror circuit & Simplest mirror circuit , minimum voltage required to make cascade action is more in cascode current mirror than in simplest current mirror
2. There is no variations at transistor level in Cascode mirror circuit while there are variations in simplest due to which Vds1 is not equal to Vds2

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BIOGRAPHY

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