People'sDemocraticRepublic of Algeria

Ministère de l'Enseignement Supérieur et de la Recherche Scientifique

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Faculty of Science and Technology
Department of Electronics
Sector: micro-electronics

DESIGN OF CIRCUITS WITH BIPOLAR TRANSISTORS

Npn current mirror

written by :

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introduction :

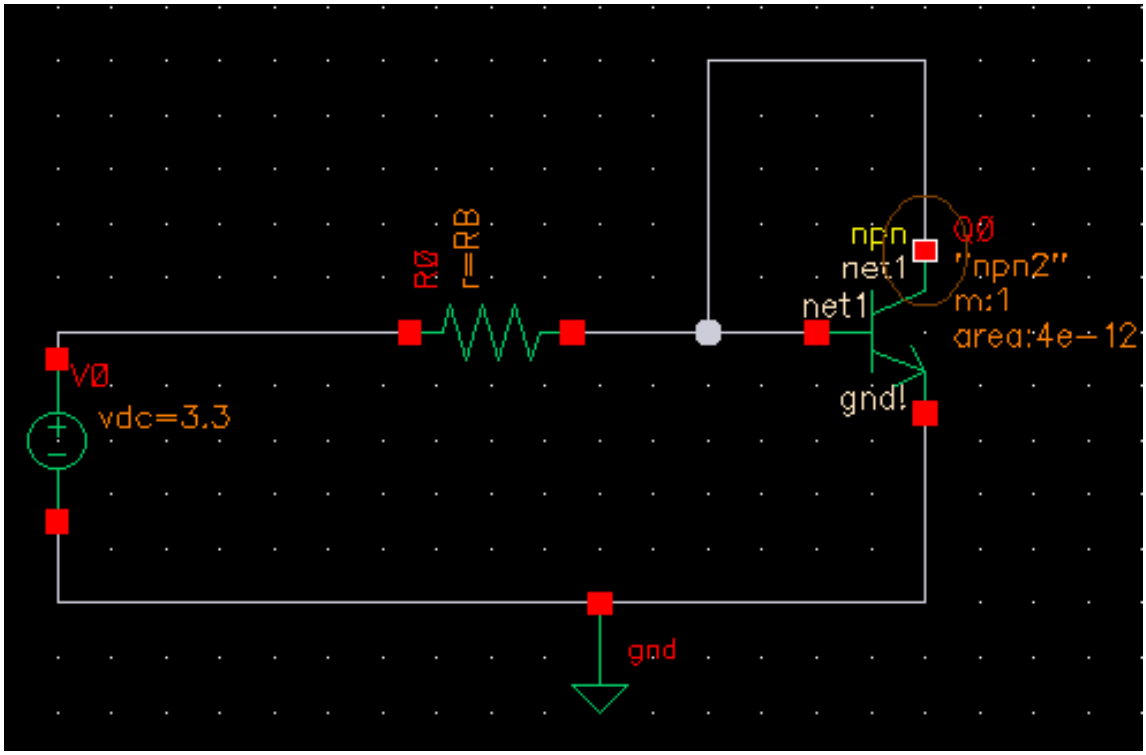
A current mirror is an electronic circuit designed to copy a current flowing through an active device, by controlling the current in another active device, so as to keep the output current constant, regardless of the load. The “copied” current may be a time-varying current. Conceptually, an ideal current mirror is simply a current inverting amplifier or a controlled current source.

Goal of the TP: this TP is the understanding of the functioning of a current source widely used in the polarization of the different stages that constitutes an integrated circuit.

The figure below presents an npn transistor whose base is directly connected to the collector and consequently, the transistor will function as a diode ($I_B = I_C$).

Polarization of a diode-mounted transistor:

The following circuit is carried out on cadence to determine the value of the resistance R with V_{CC} (V_{dc} = 3.3V) by a transient and parametric simulation with respect to this resistance for which a current of 25uA is obtained in the transistor collector.



After simulation, the following curves are obtained:

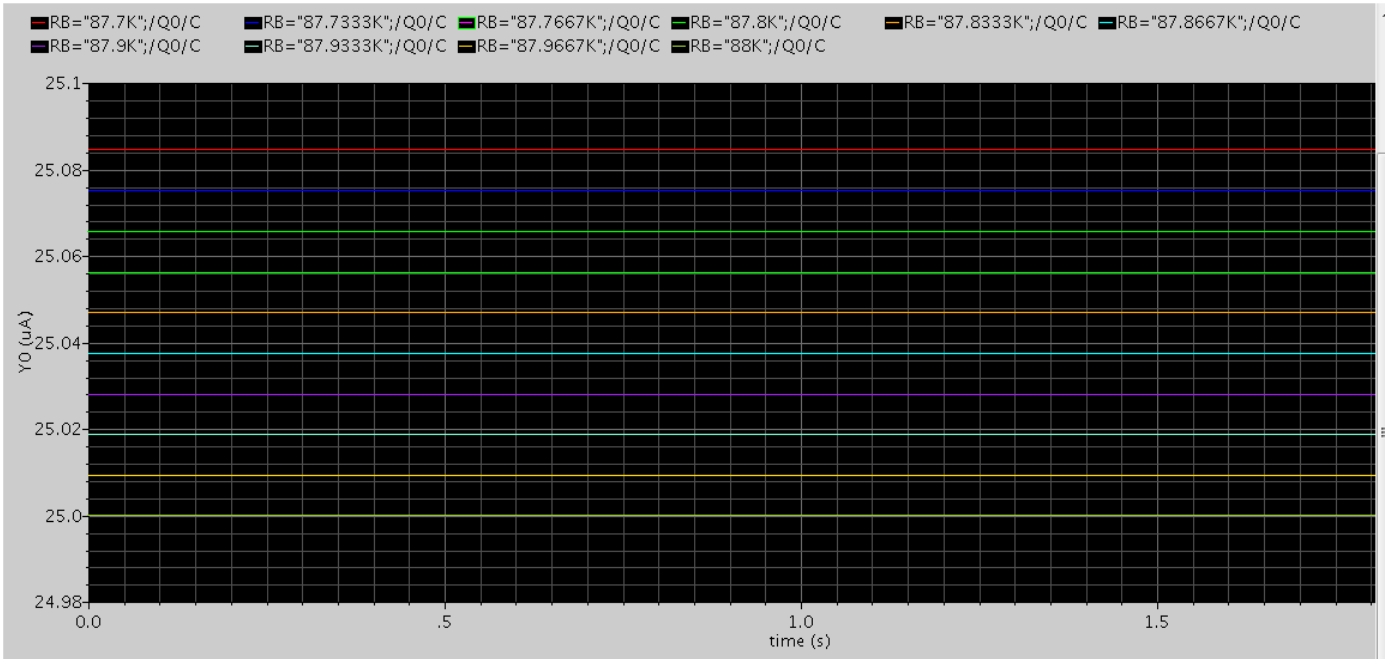
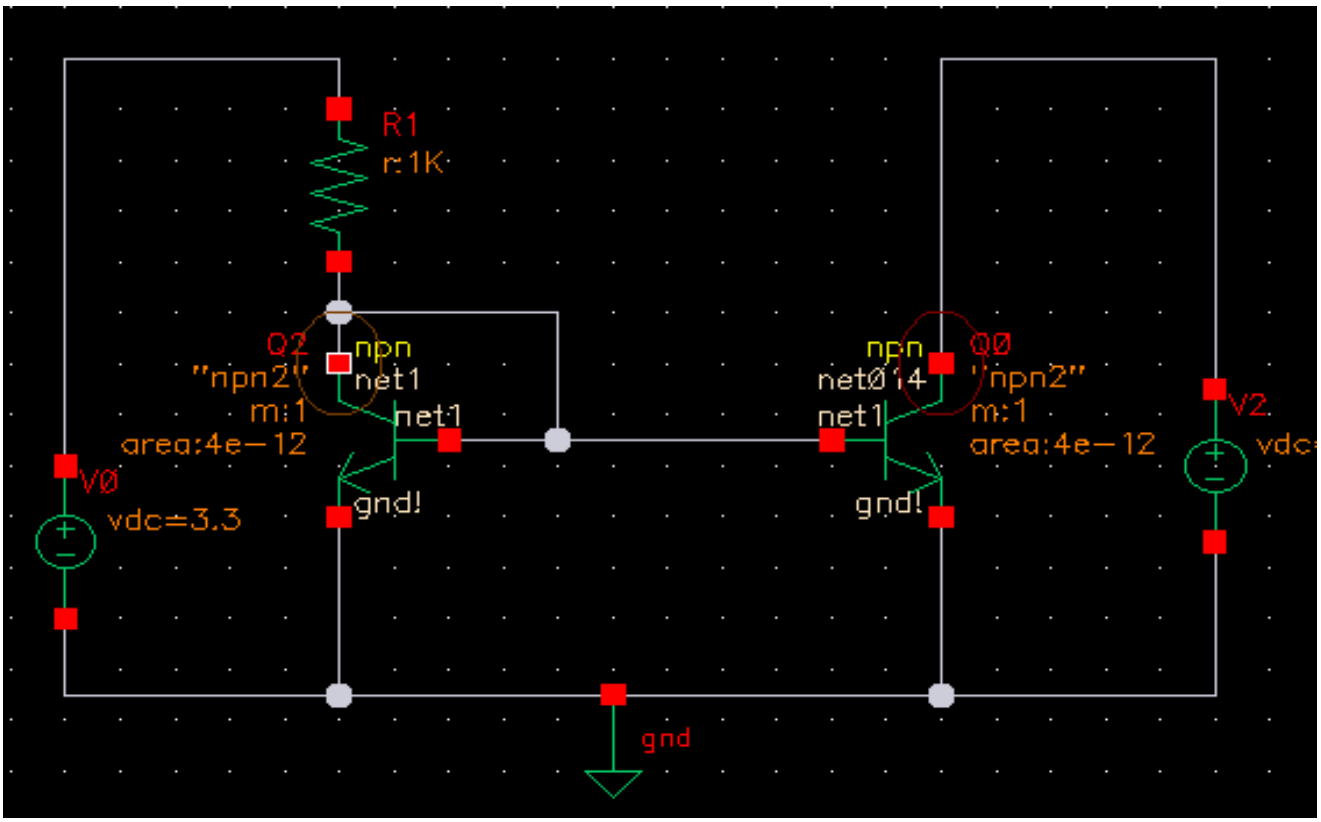


Figure 2 results obtained

For a current I_C = 25uA, the resistance value is equal to 88kΩ.

Current mirror

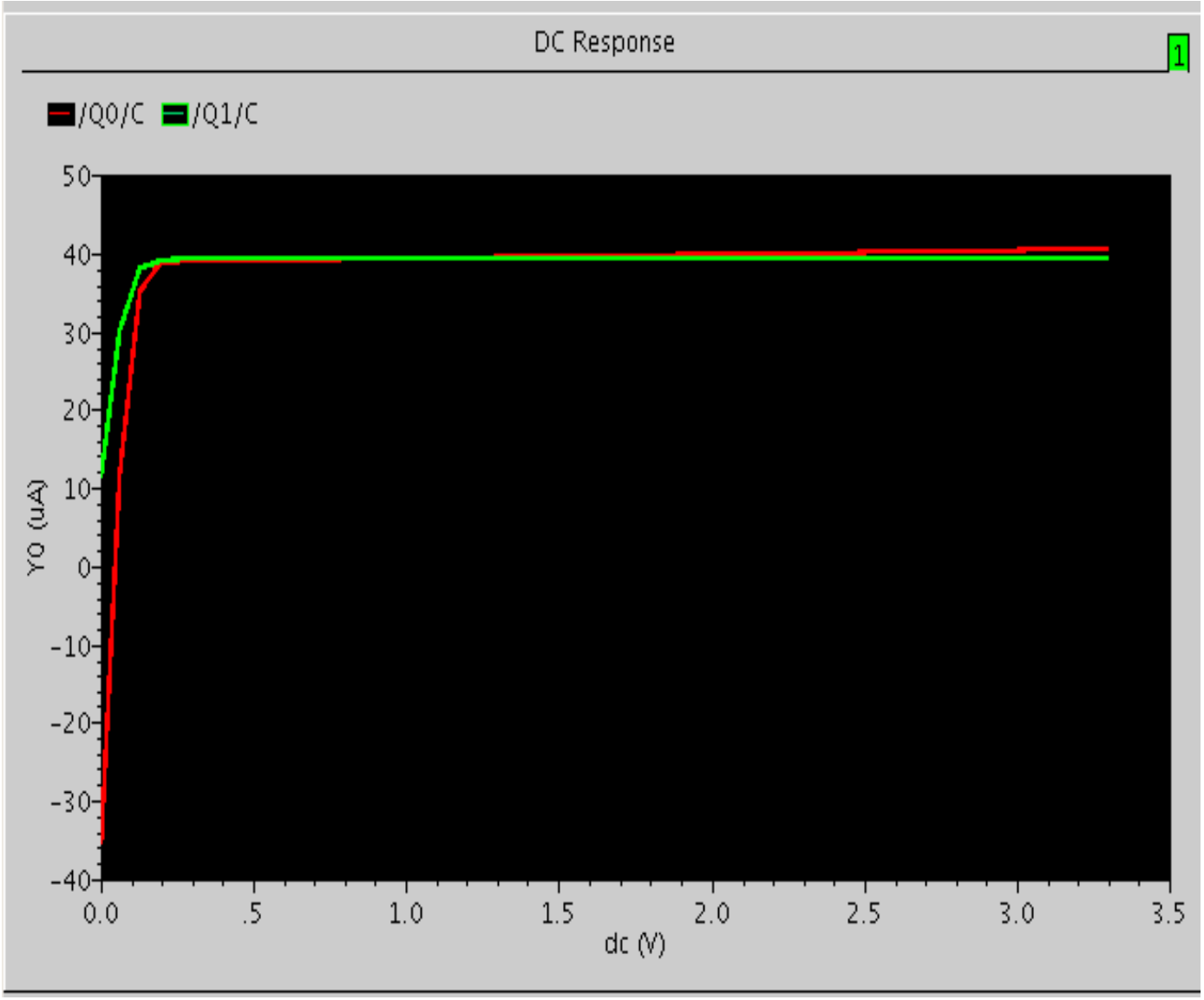
Through the following circuit, we will show the correct operation of the current mirror. It is composed of two identical transistors which have the same voltage V_{BE} have the same collector current with V_{CC} = 3.3V and V_2 variable R_1 = 50KΩ.



So if the collector current of one of the transistors is fixed, it imposes the same value of the collector current of the other transistor.

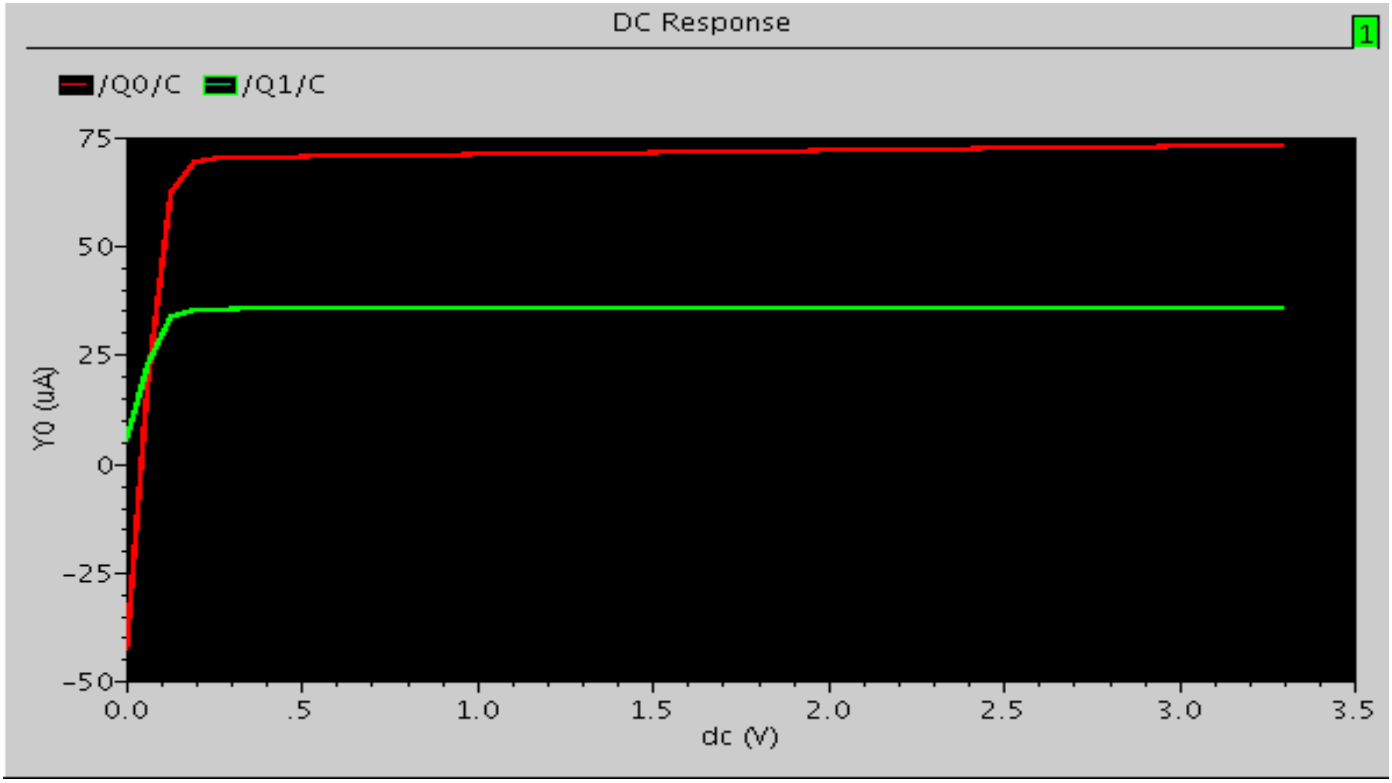
- **In the case of two identical transistors ($m_1 = m_2$)**

This curve indicates that the collector currents of the transistors are equal.

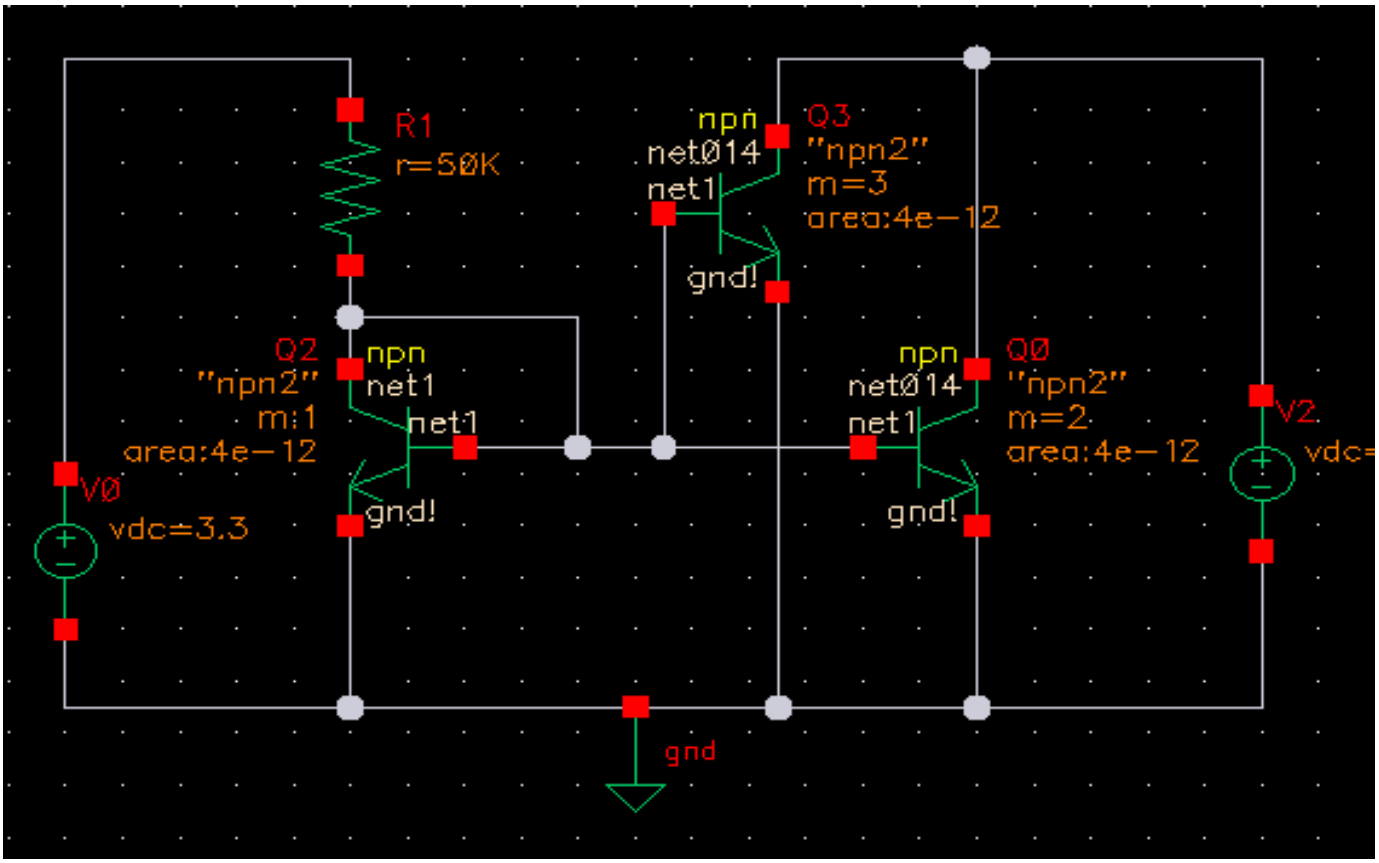


- In the case where the m of the second transistor and the double of the first ($m_2 = 2m_1$)

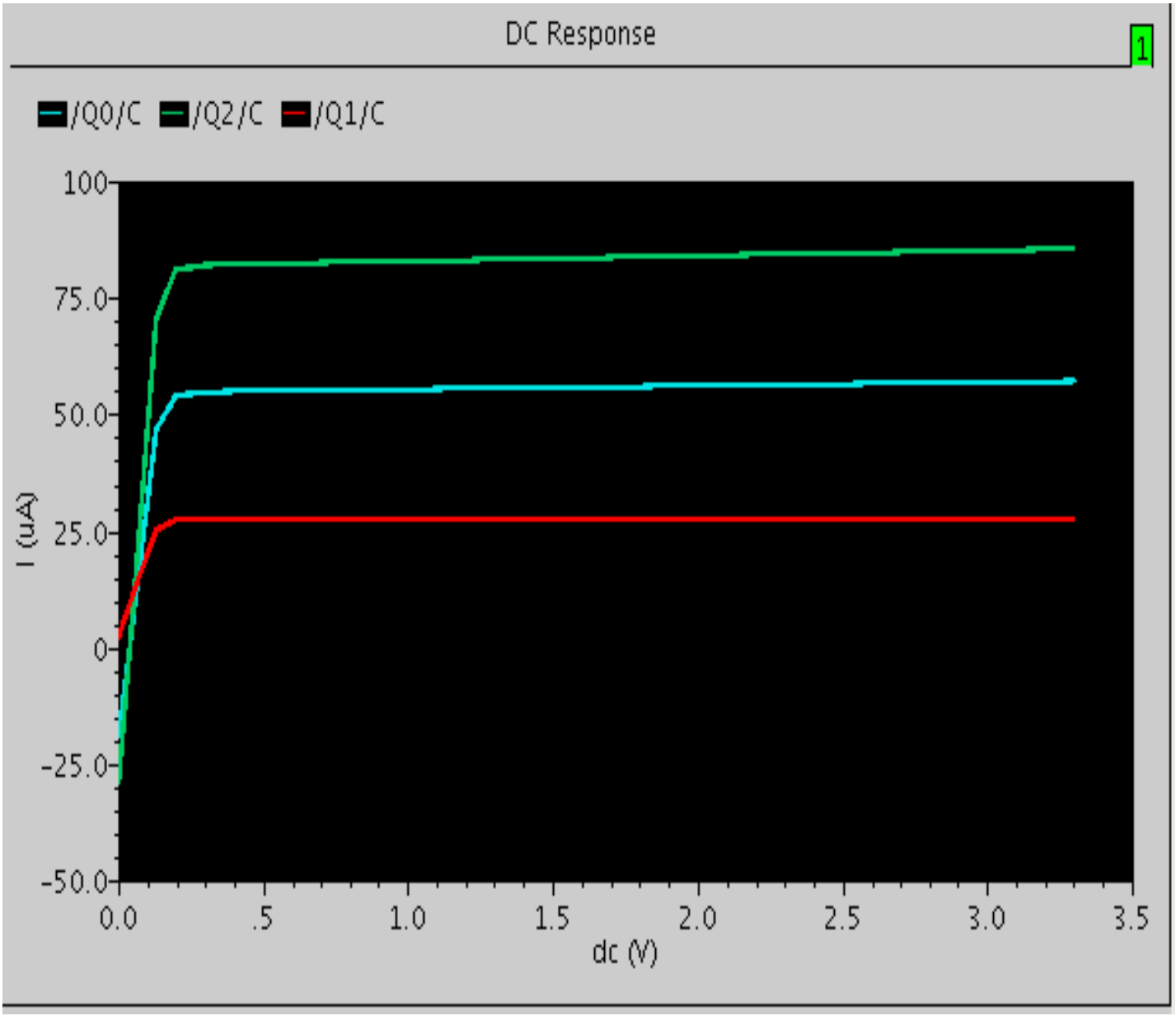
It can be seen that the collector current of the second transistor is doubled compared to the collector current of the first transistor.



We propose a circuit which allows the current to be weighted 2 and 3 times the reference current: $m_1 = 1$, $m_2 = 2$ and $m_3 = 3$:



After a DC simulation, we get:


DC Response
1
/Q0/C
/Q2/C
/Q1/C
100
75.0
50.0
25.0
0
-25.0
-50.0
I (uA)
0.0
.5
1.0
1.5
2.0
2.5
3.0
3.5
dc (V)