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Revisit to Bipolar Analog Circuits: Two Base Current Compensation Techniques

Lei Sha, Minh Tri Tran, Anna Kuwana, Haruo Kobayashi

Division of Electronics and Informatics
Gunma University

群馬大学
GUNMA UNIVERSITY

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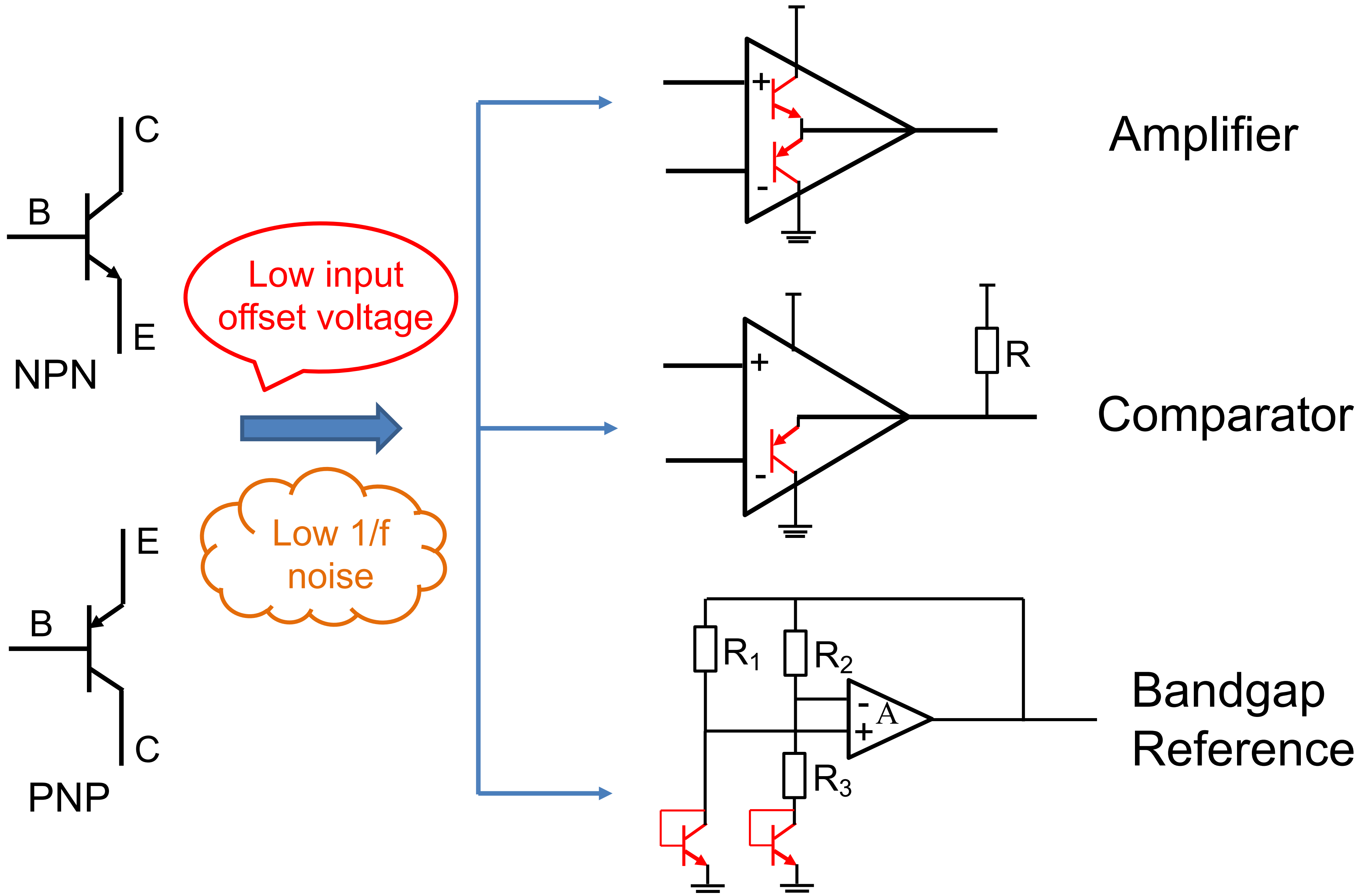
Research Background



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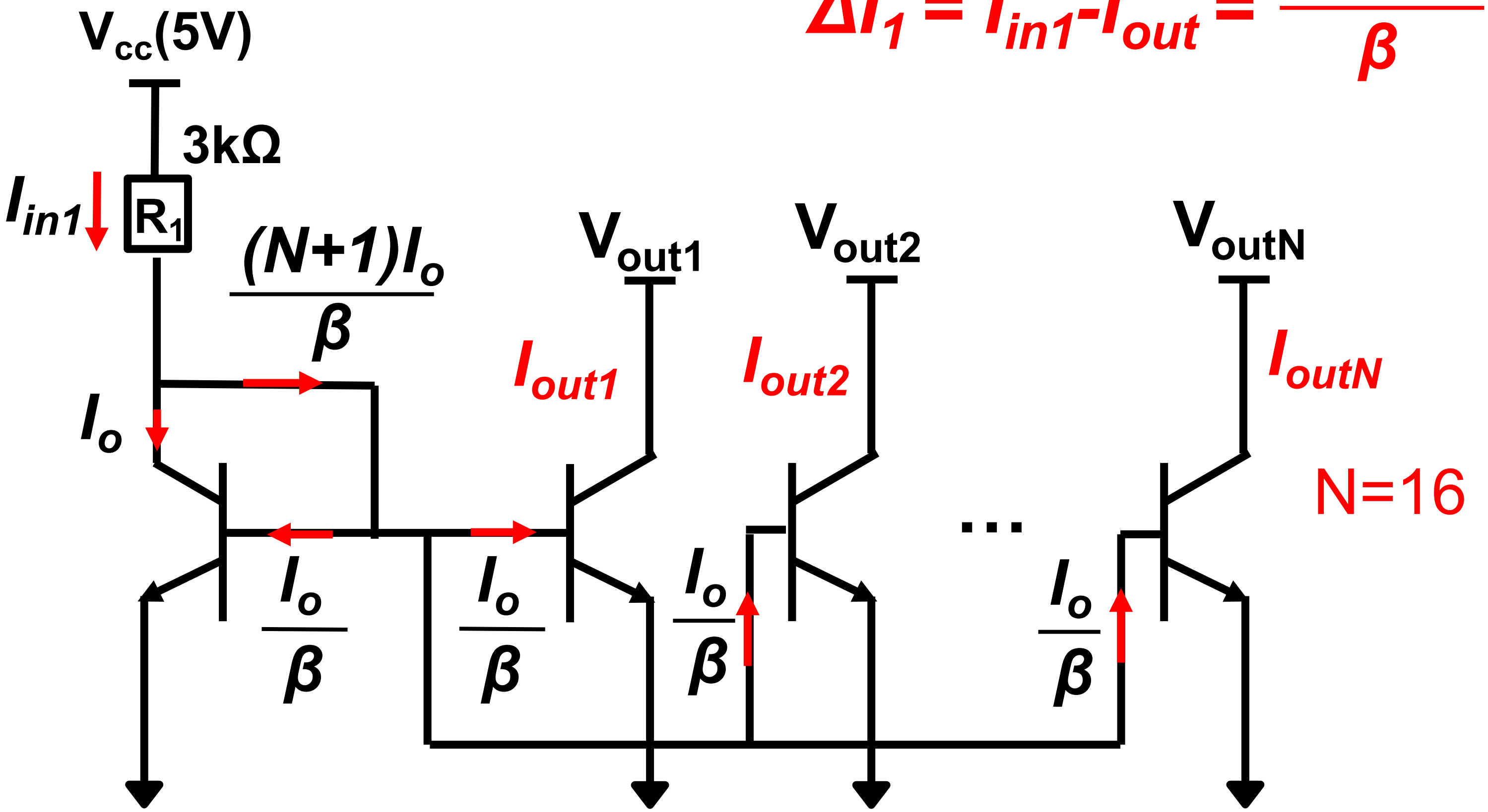
Basic Bipolar Transistor Current Mirror Circuit

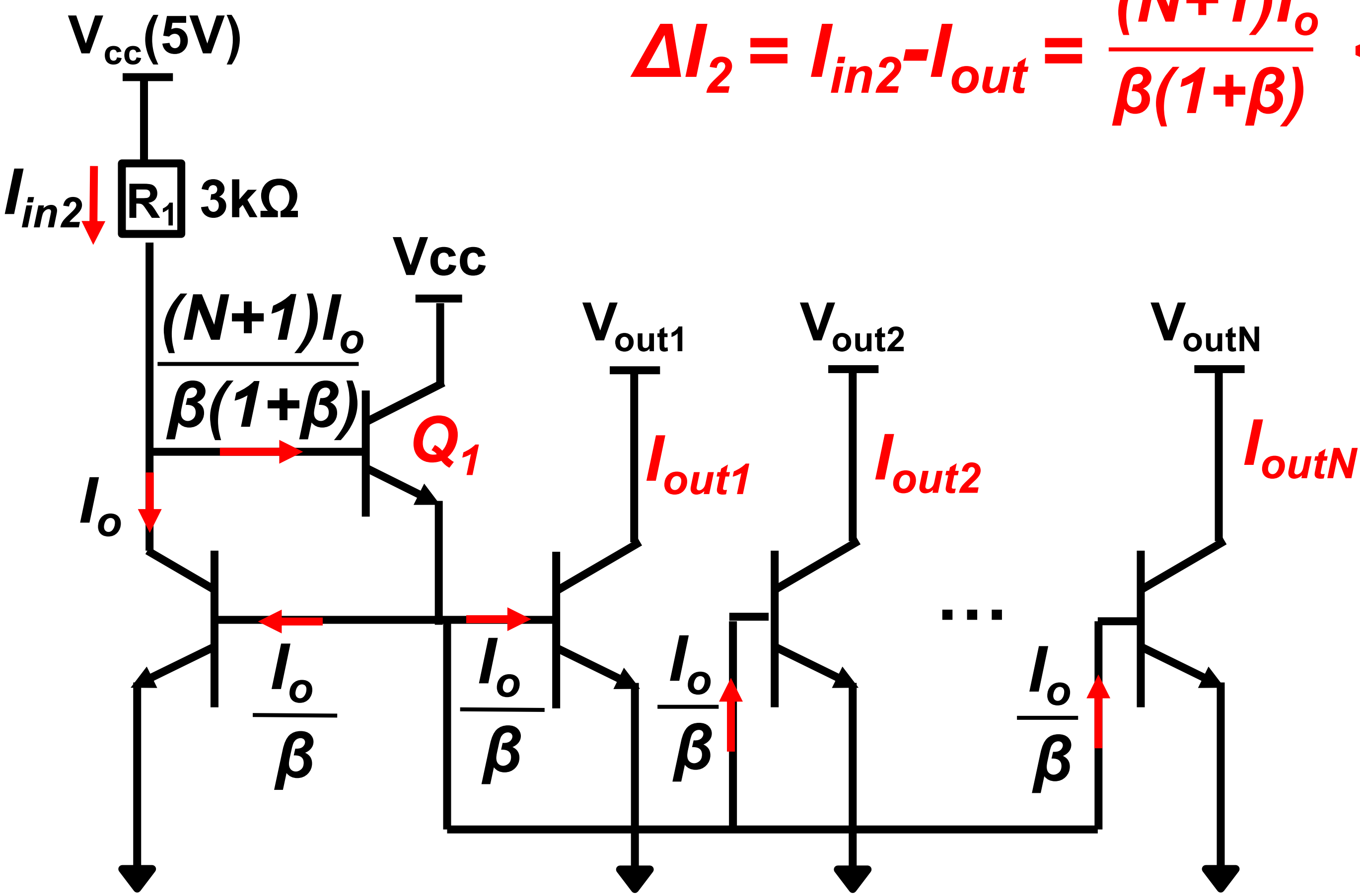
$$\Delta I_1 = I_{in1} - I_{out} = \frac{(N+1)I_o}{\beta}$$



β is current gain of the bipolar transistor

Bipolar Transistor Current Mirrors Circuit with Base Current Compensation Configuration

$$\Delta I_2 = I_{in2} - I_{out} = \frac{(N+1)I_o}{\beta(1+\beta)} < \Delta I_1$$



Bipolar Transistor Current Mirror Circuit with Cascode and Base Current Compensation Configuration

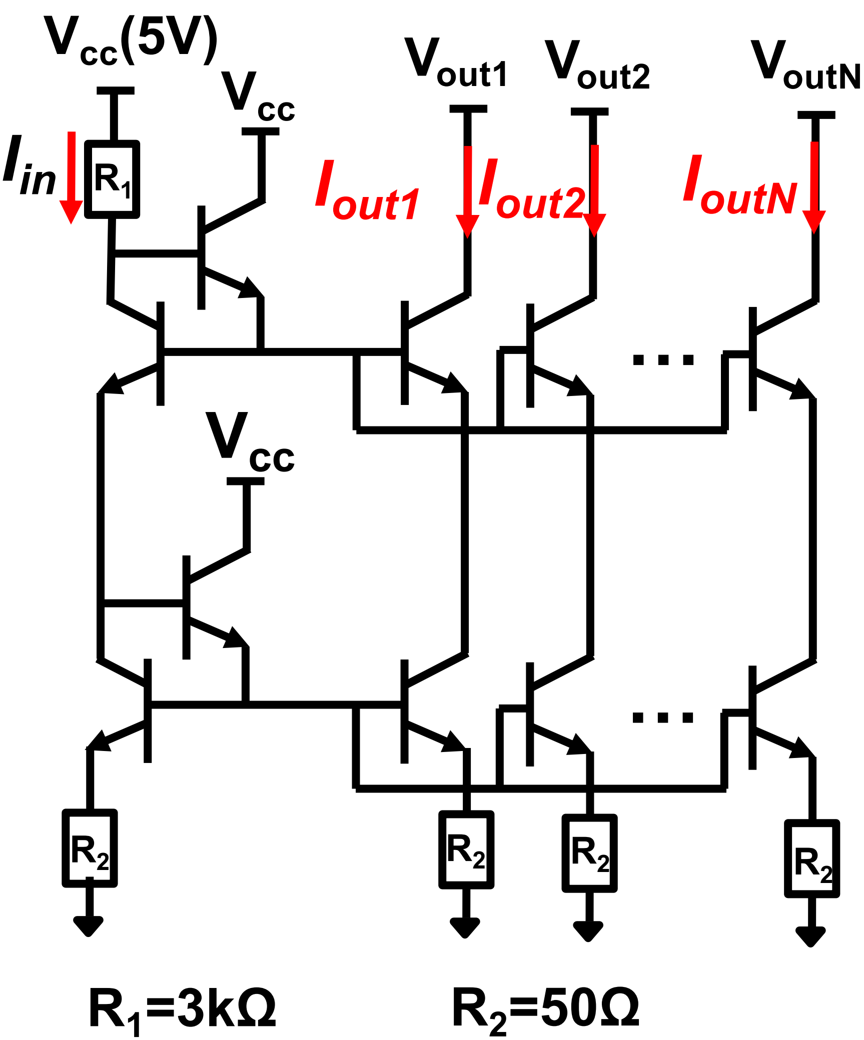


Fig a

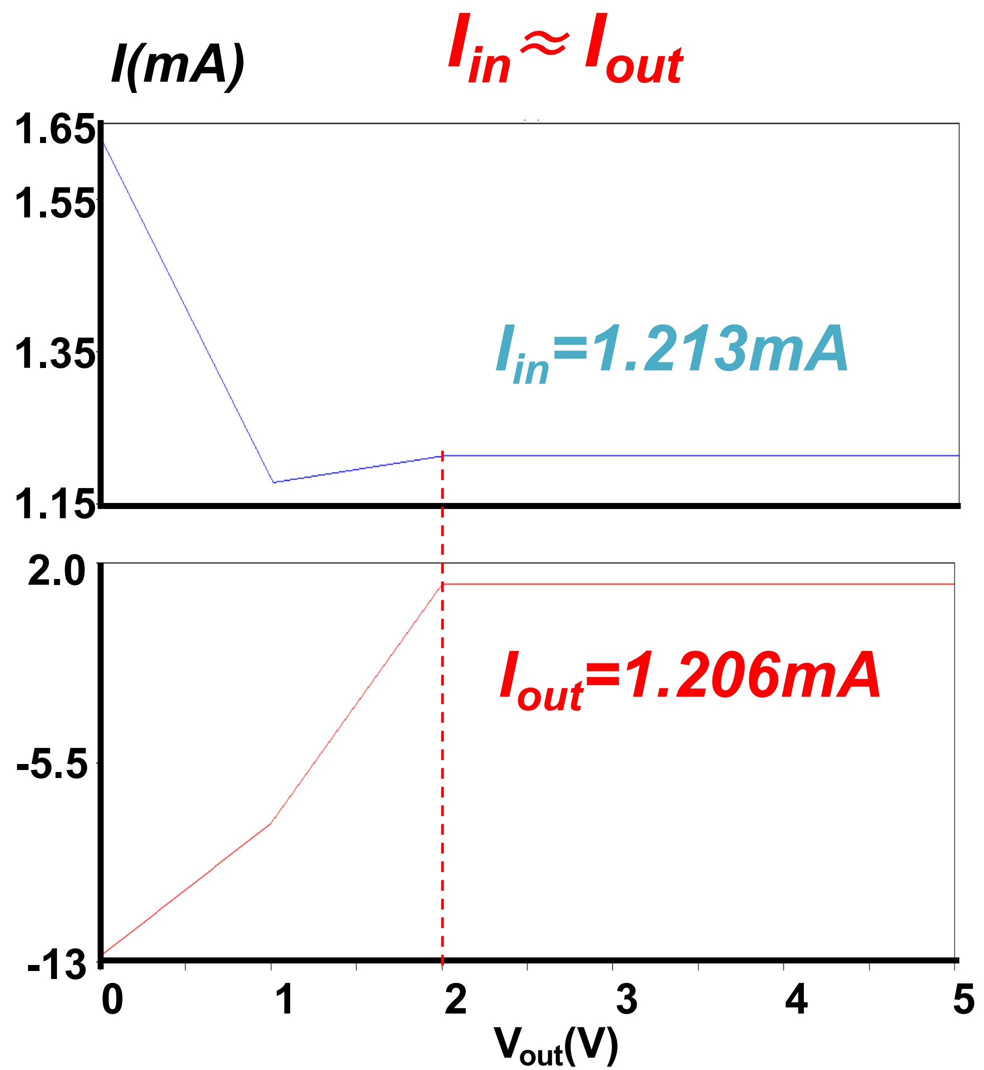
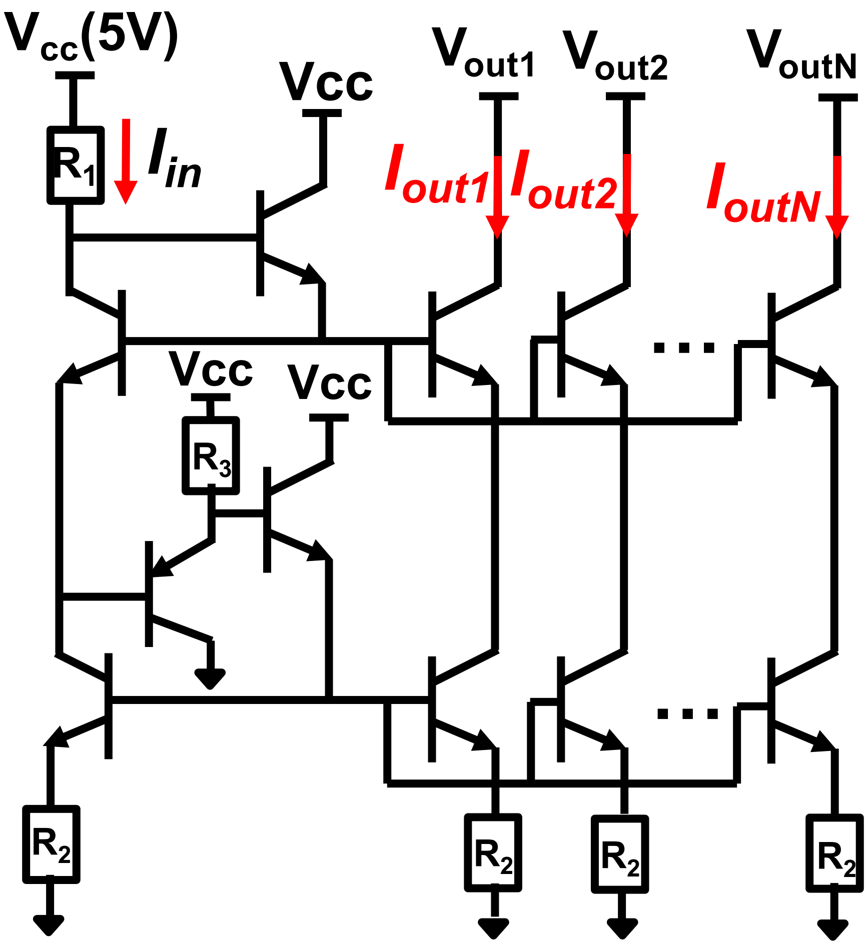


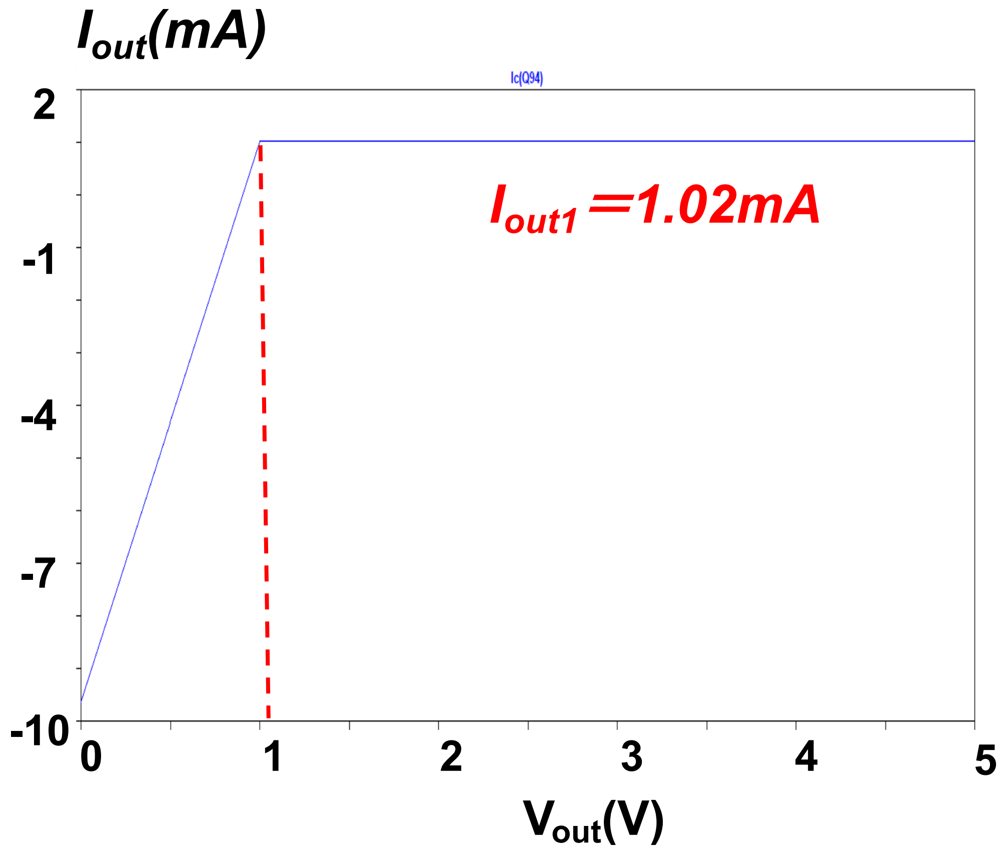
Fig b

Bipolar Transistor Current Mirror Circuit with Cascode, Level-Shift and Base Current Compensation Configuration



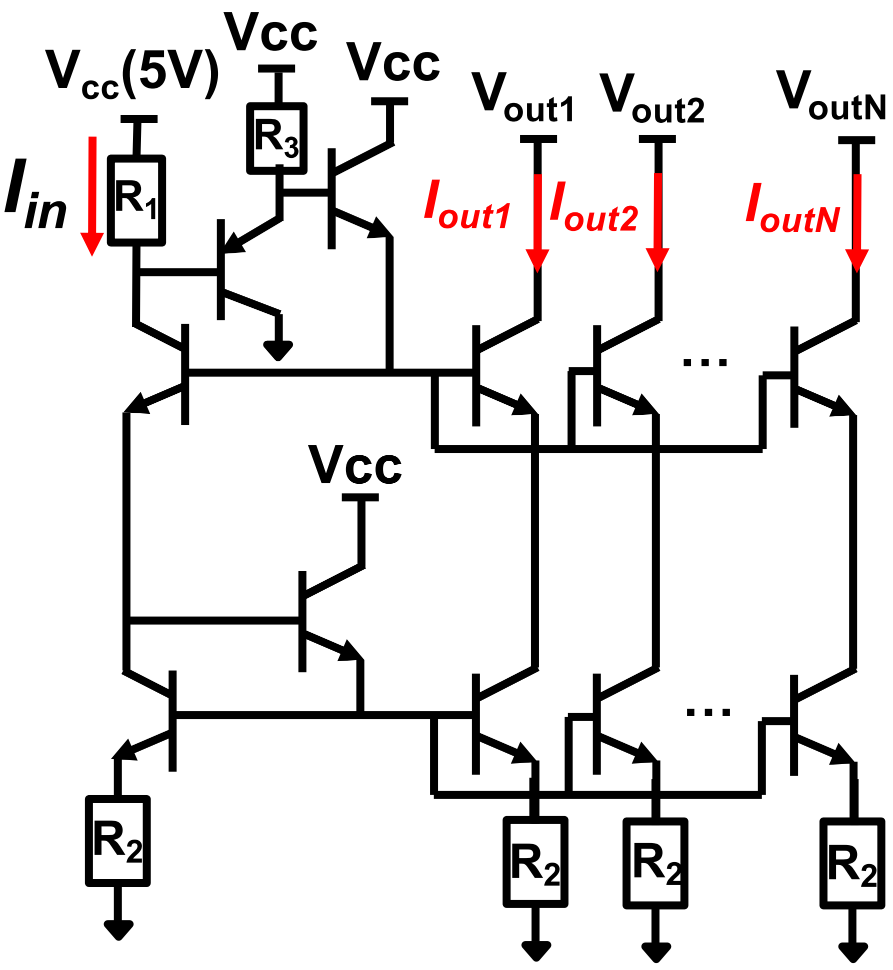
R_1=3kΩ R_2=50Ω R_3=8kΩ

Fig c



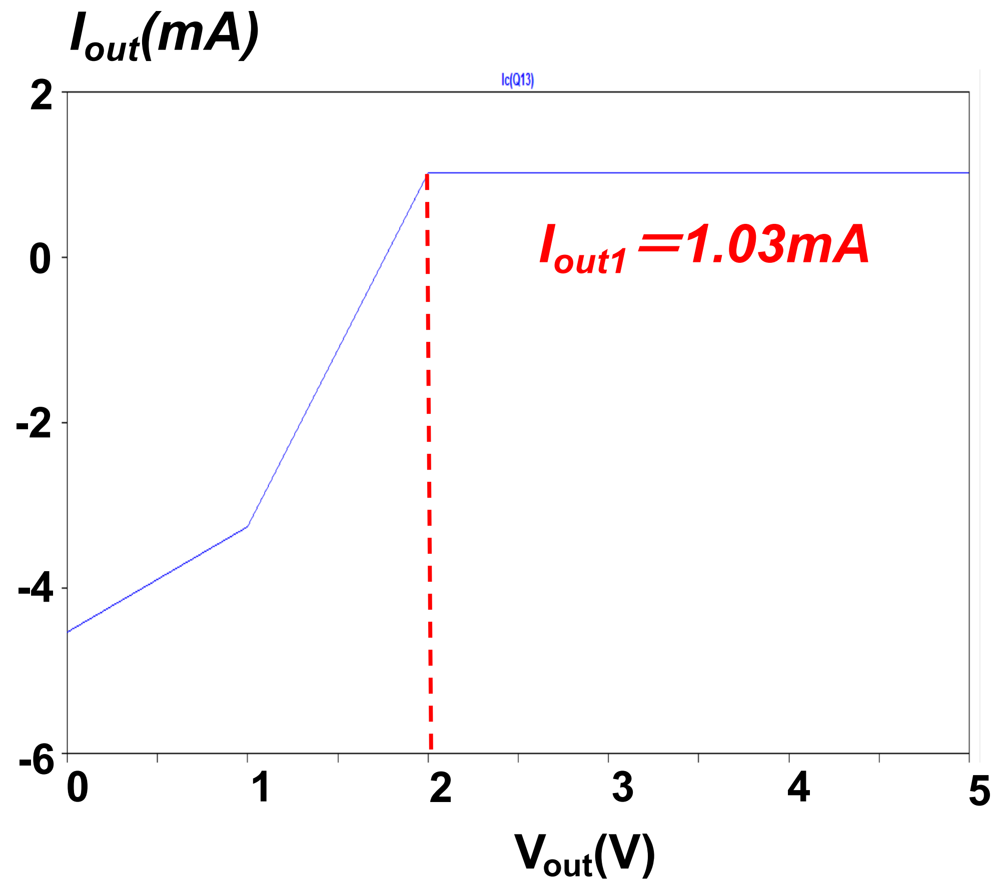
Simulation result

Bipolar Transistor Current Mirror Circuit with Cascode, Level-Shift and Base Current Compensation Configuration



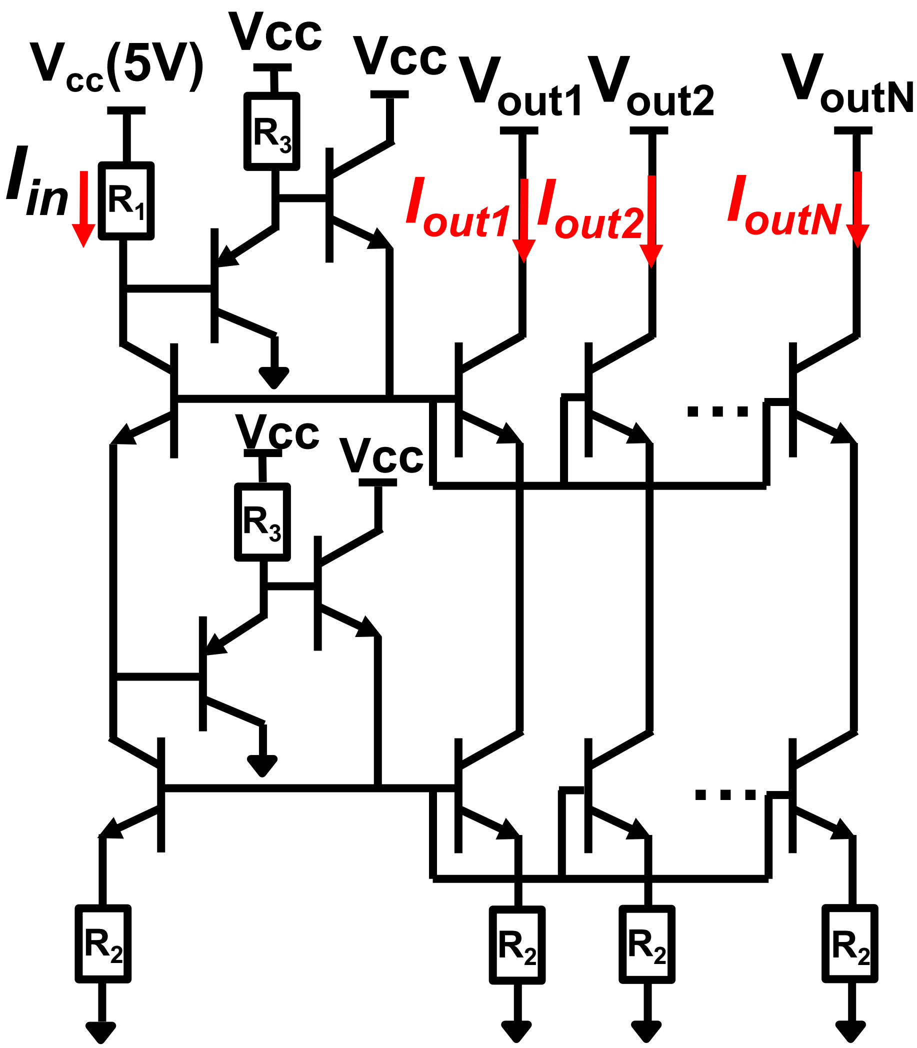
R_1=3kΩ R_2=50Ω R_3=8kΩ

Fig d



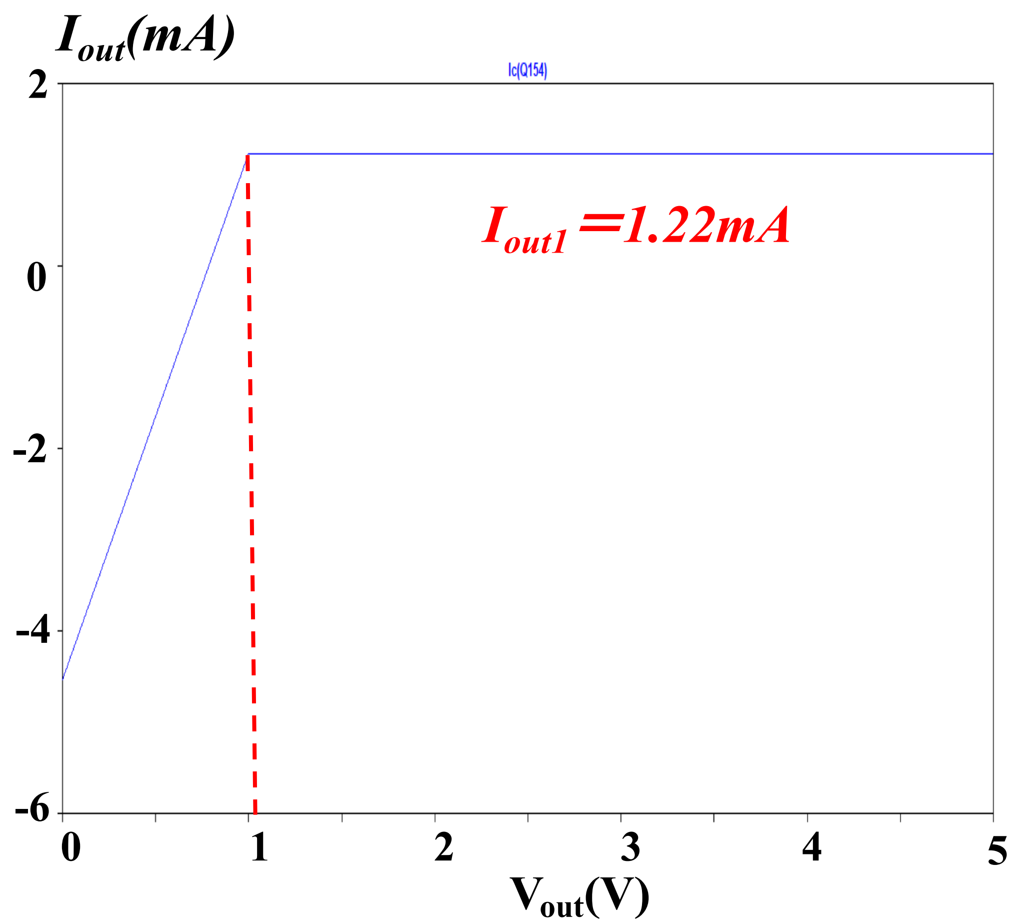
Simulation result

Bipolar Transistor Current Mirror Circuit with Cascode, Level-Shift and Base Current Compensation Configuration



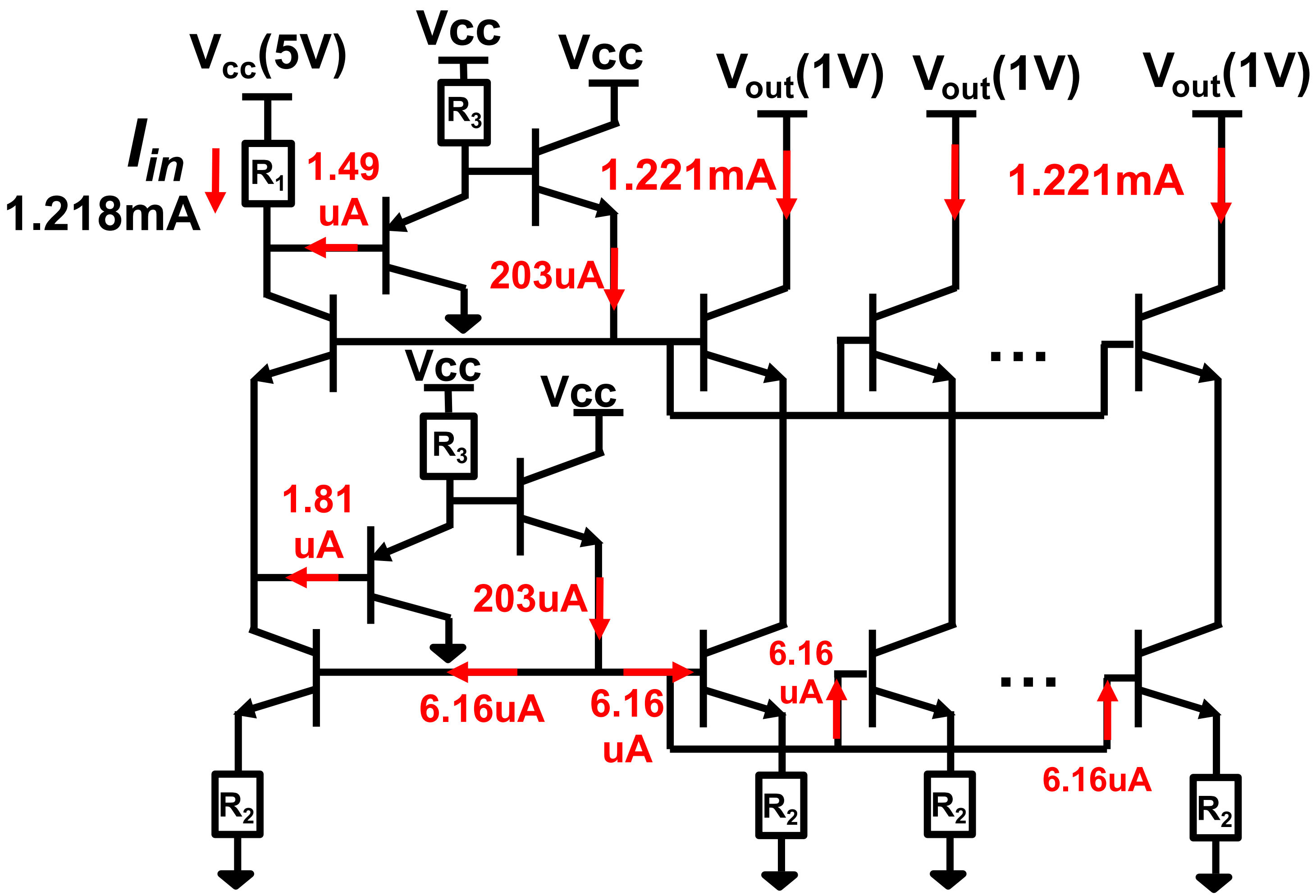
R_1=3kΩ R_2=50Ω R_3=8kΩ

Fig e



Simulation result

Simulation Circuit



R_1=3kΩ R_2=50Ω R_3=8kΩ

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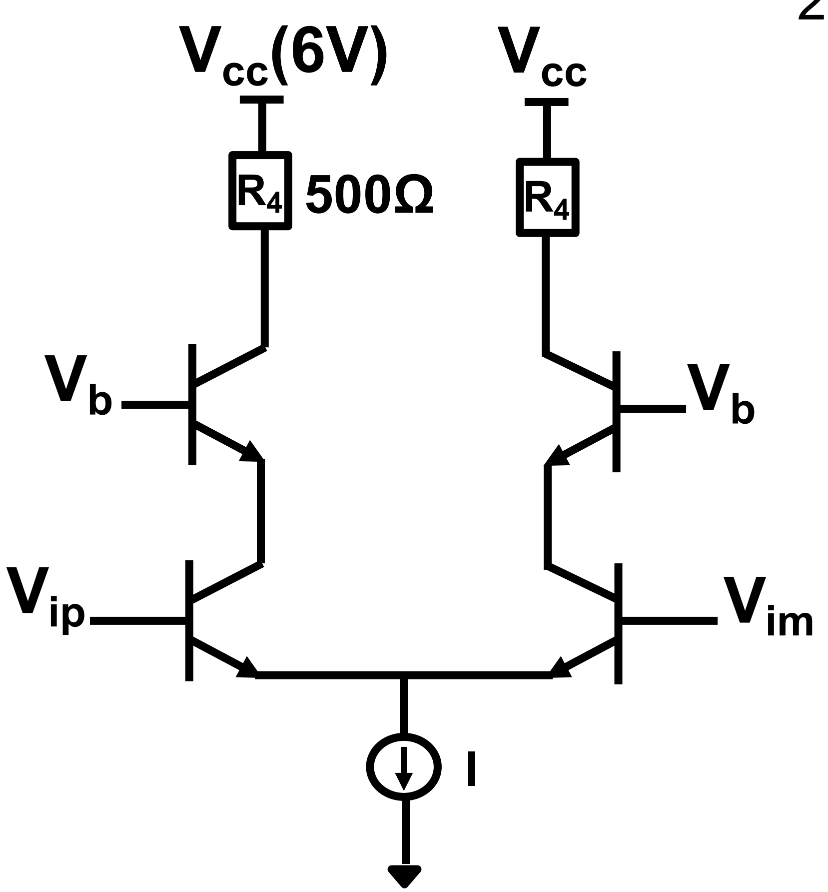
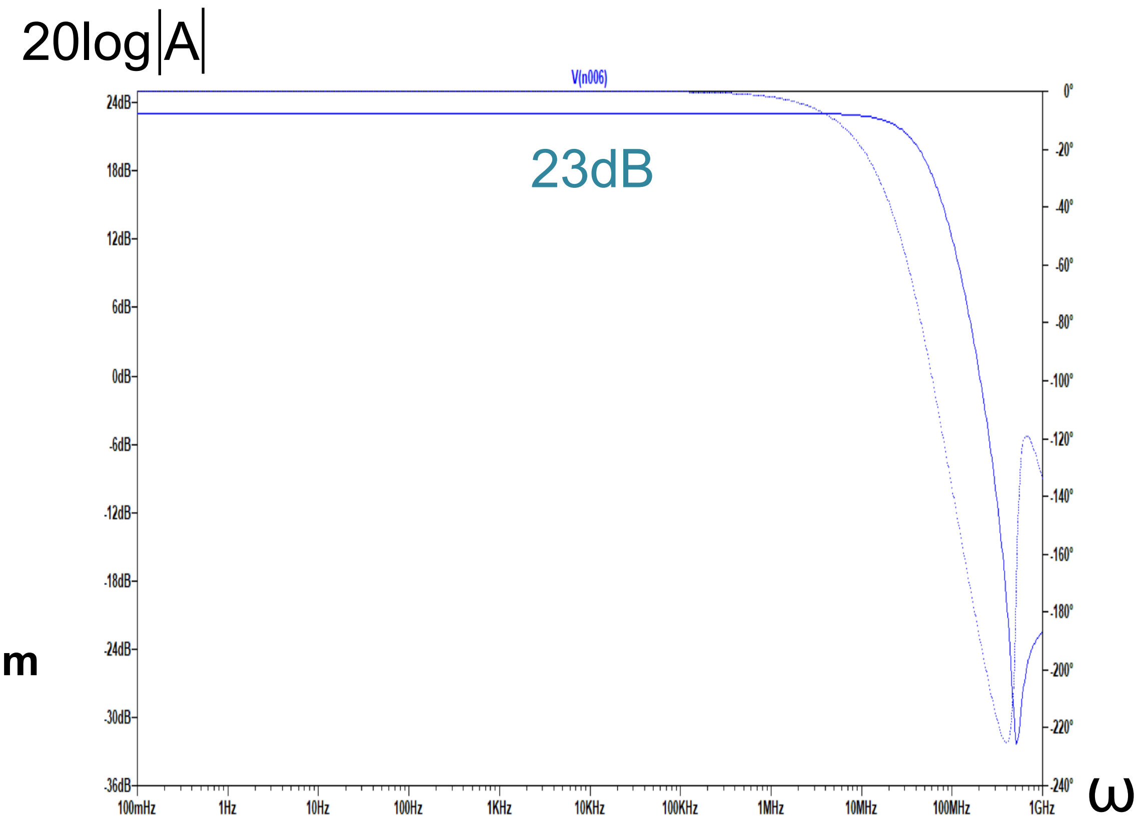
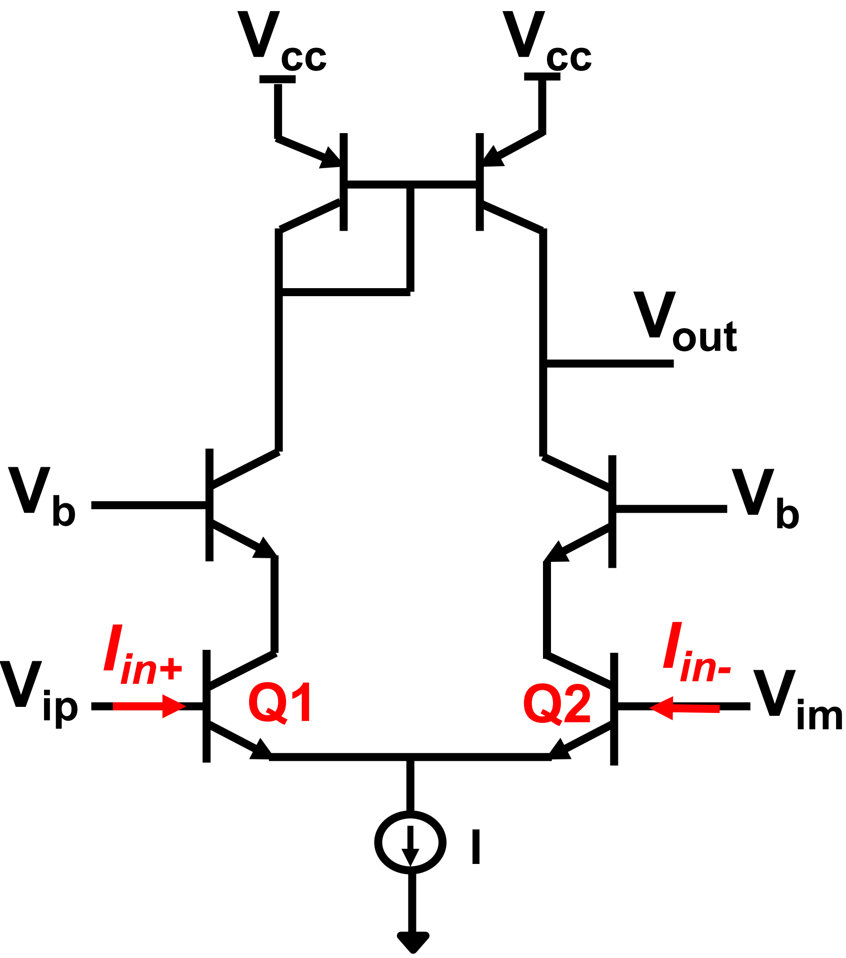
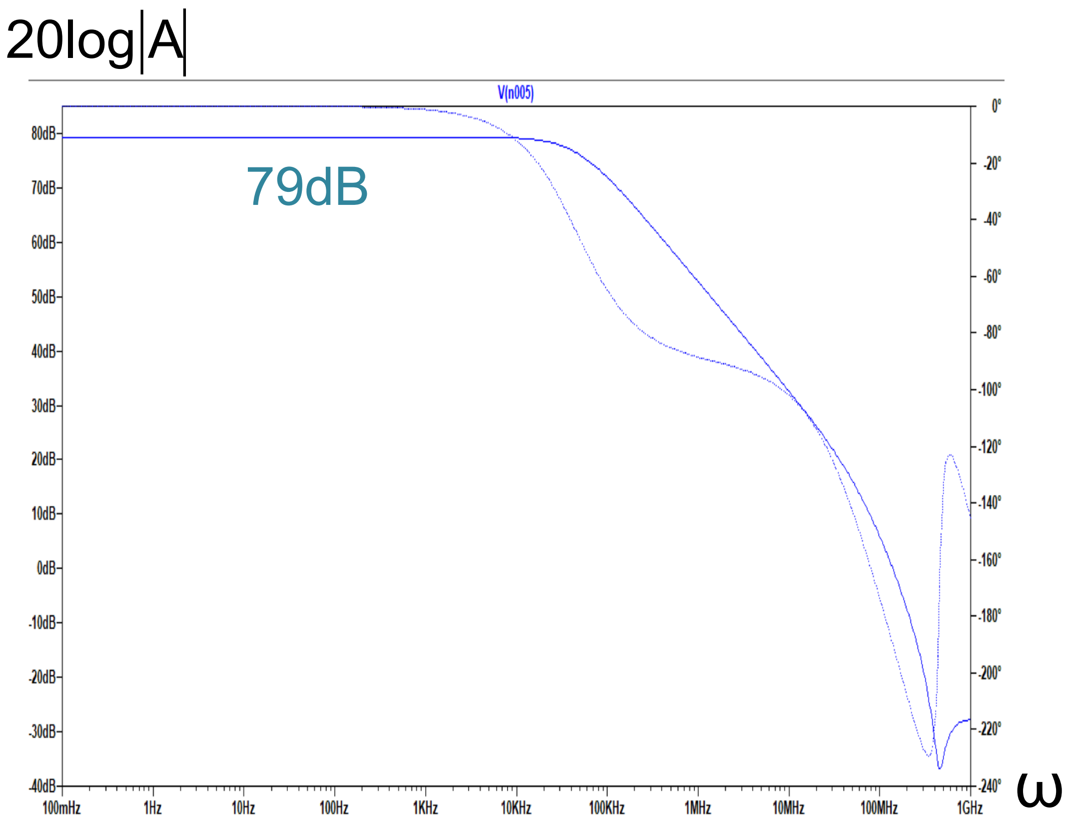
Basic Bipolar Differential Amplifier with Resistor Load



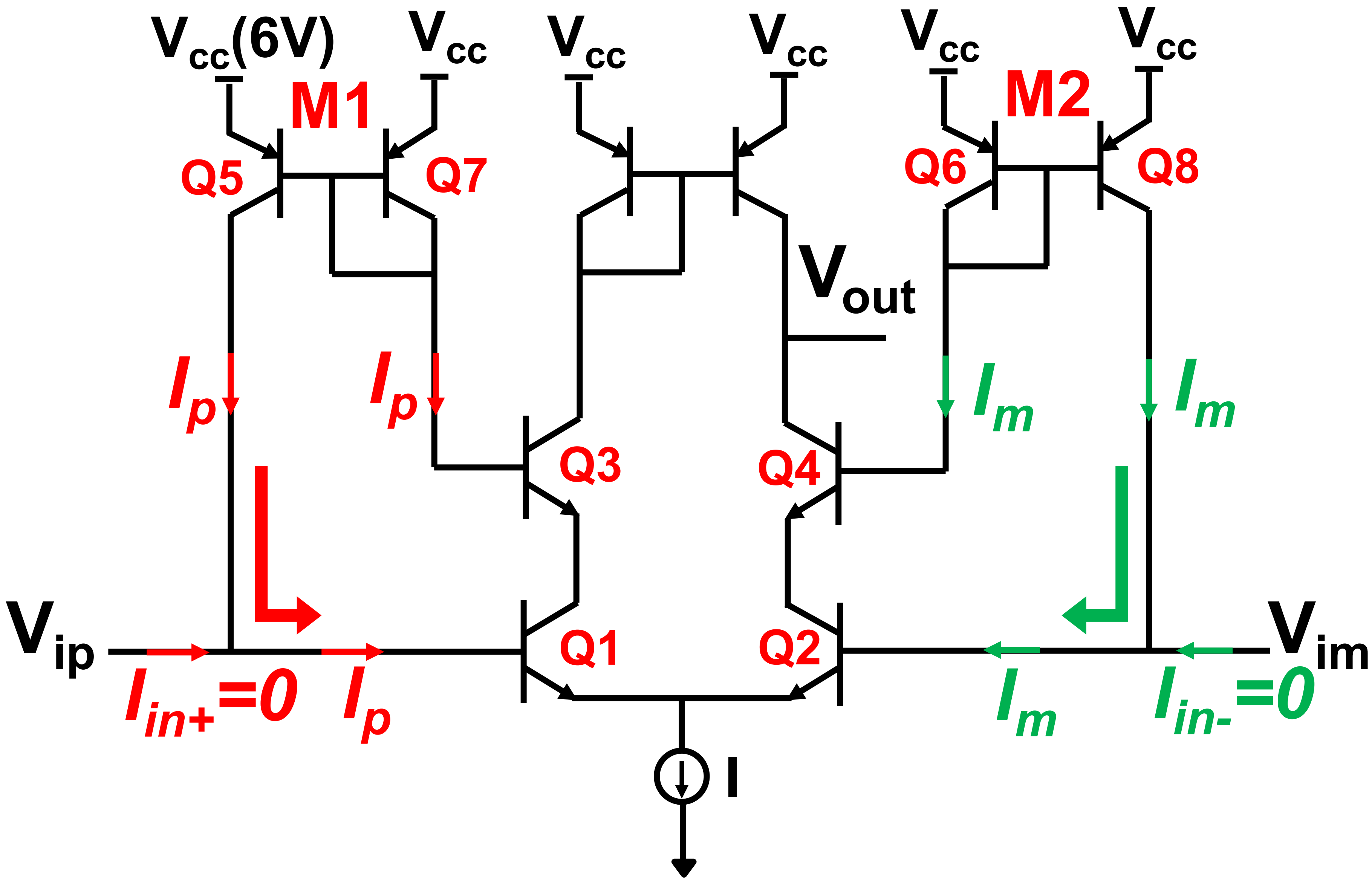


Basic Bipolar Differential Amplifier with Active Load

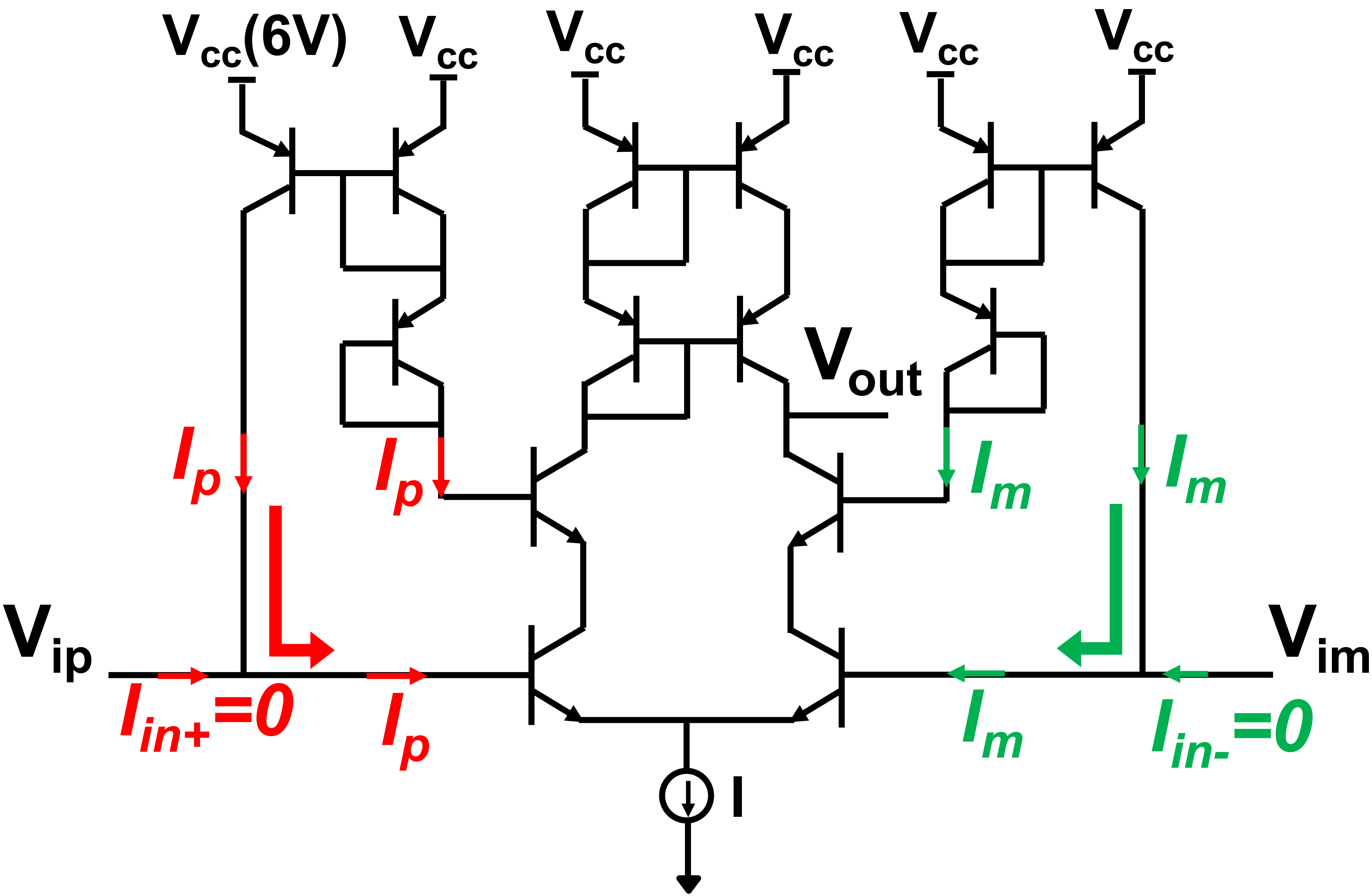




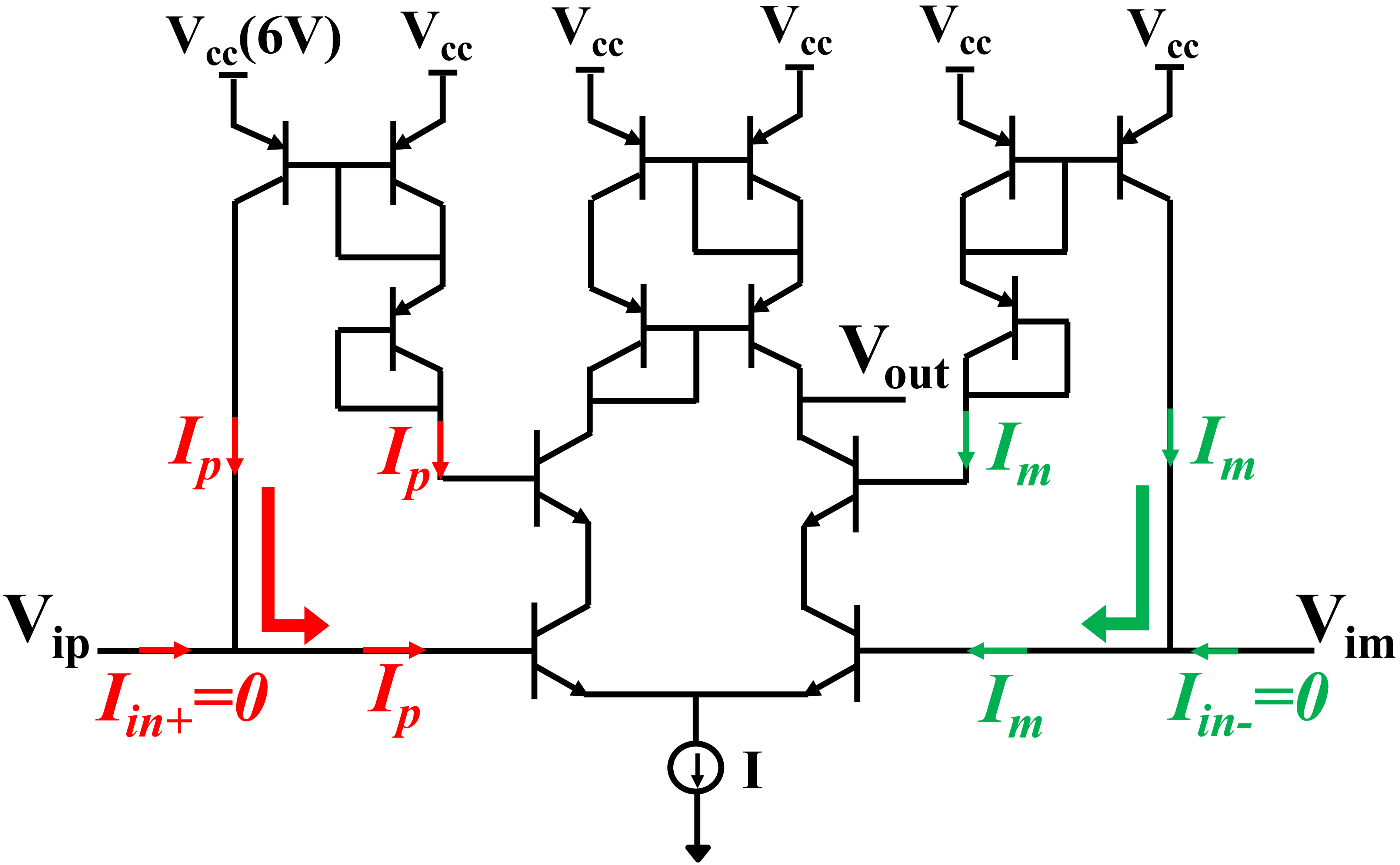
Bipolar Differential Amplifier with Base Current Compensation and Simple Active Load



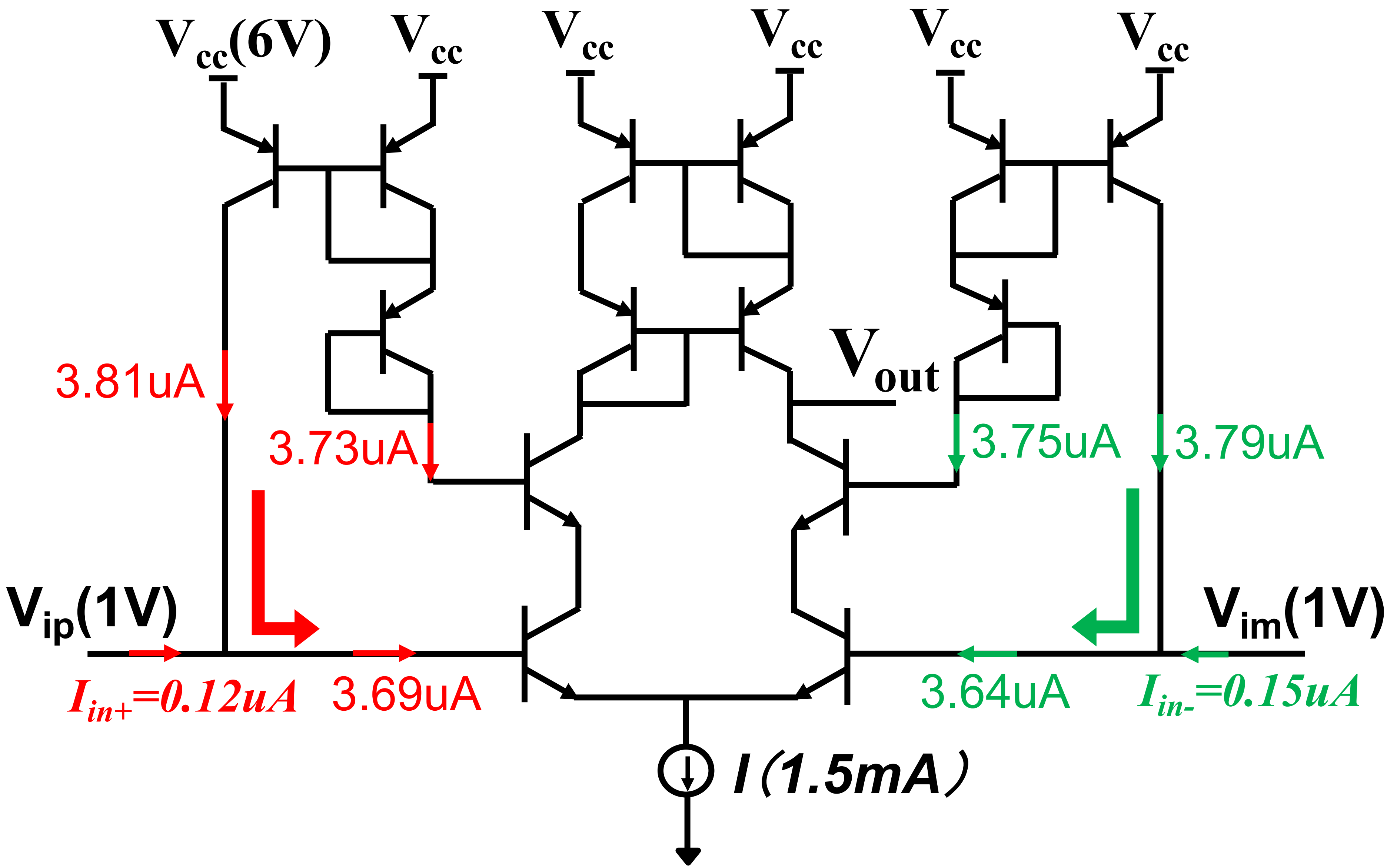
Bipolar Differential Amplifier with Base Current Compensation and the Cascode Active Load



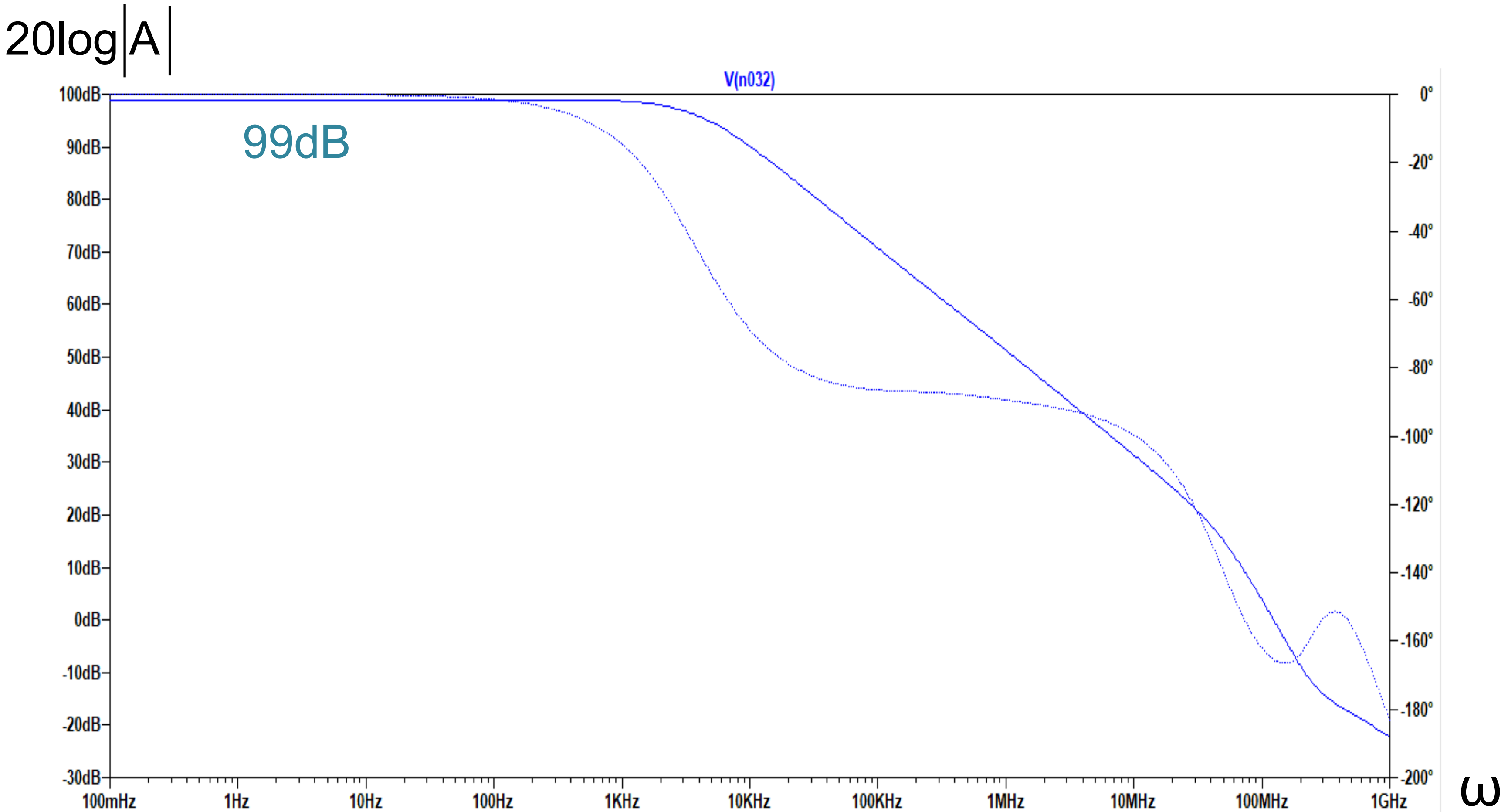
Bipolar Differential Amplifier with Base Current Compensation and the Wilson Active Load



Simulation Circuit



Simulation Result



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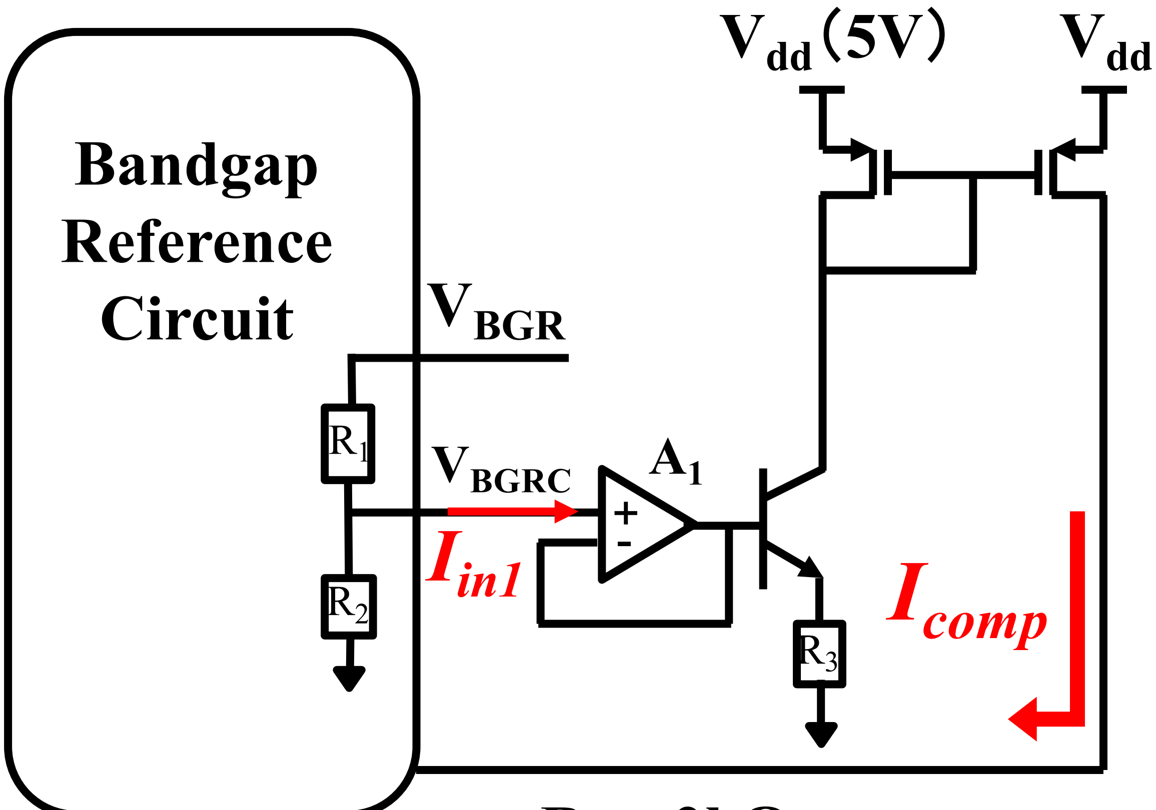
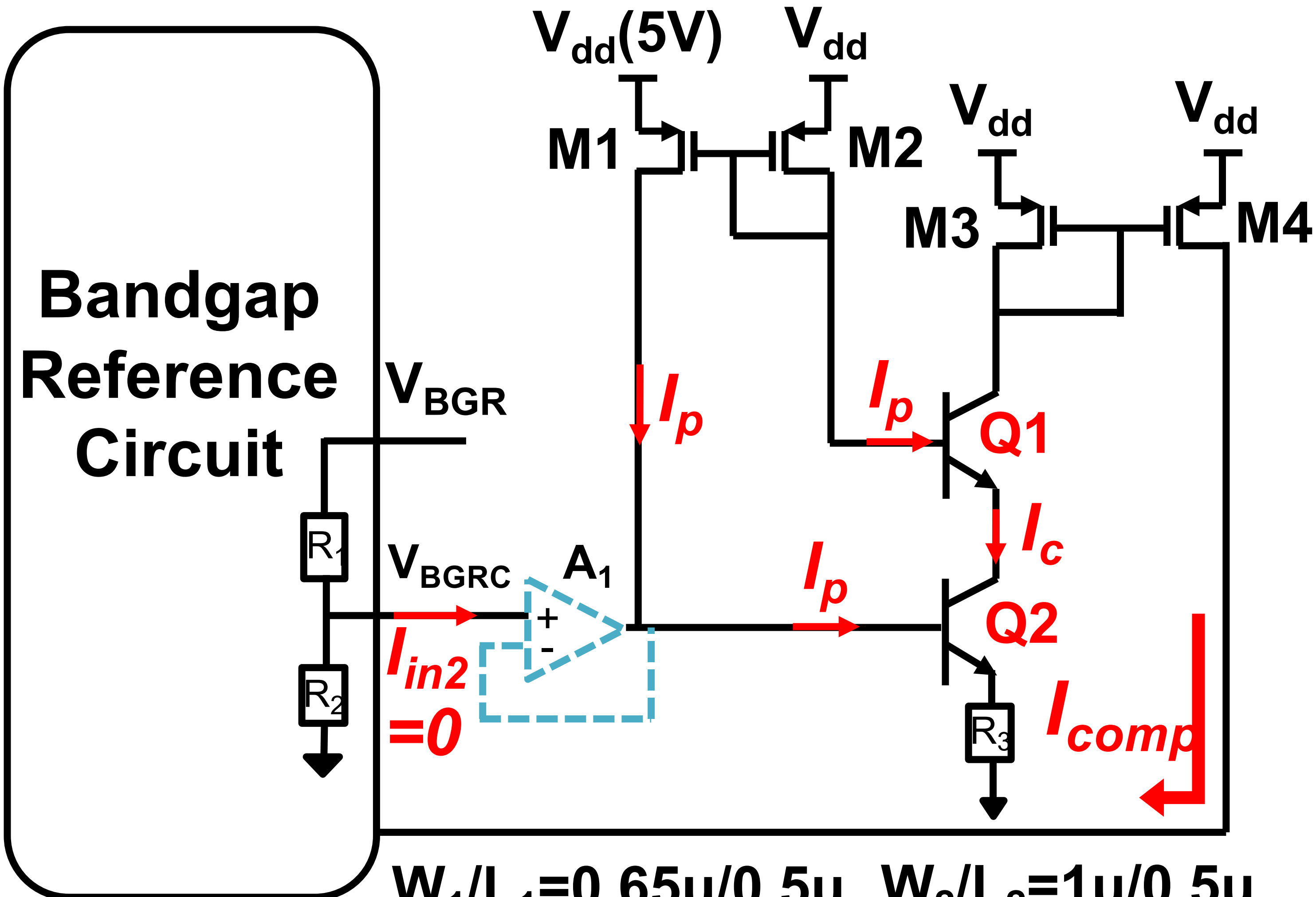
Curvature Compensation Circuit in Bandgap Reference Circuit



$R_3 = 2k\Omega$

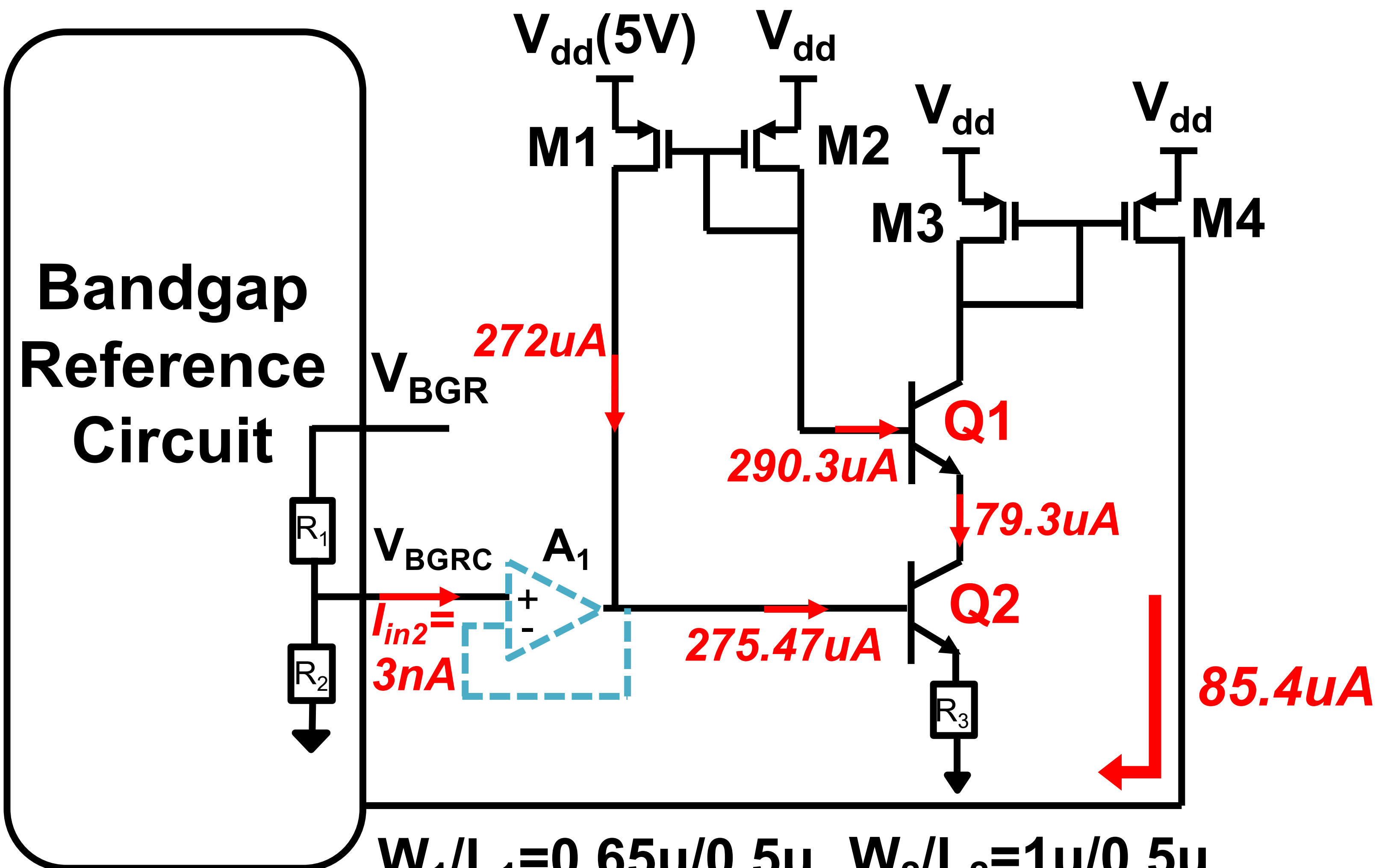
Curvature Compensation Circuit in Bandgap Reference Circuit with Base Current Compensation



W_1/L_1=0.65u/0.5u W_2/L_2=1u/0.5u

$W_{3.4}/L_{3.4}$=50u/0.5u R_3＝2kΩ

Simulation Circuit



W_1/L_1=0.65u/0.5u W_2/L_2=1u/0.5u

$W_{3,4}/L_{3,4}$=50u/0.5u R_3＝2kΩ

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Summary

1. Cascode current mirror with PNP level-shift
   and base current compensation technique

   - Deviation reduction between input and output currents
   - Stable output current under lower output voltage

2. Differential amplifier with Wilson active load
   and base current compensation technique

   - High input impedance
   - High gain

3. Curvature compensation circuit
   with the base current compensation technique

   - Dependable and simple curvature compensation
     in bandgap reference circuit

Acknowledgements

We would like to thank Mr. Hiroki Sonoda and Mr. Koichi Yamazaki of Renesas Electronics Corp. for their valuable comments about bipolar ICs in industry today

Thank you for your listening