Referenced Self-bias Current Source

This circuit provides an output current IOUT that is independant of the supply voltage, but instead is dependant on the MOS threshold voltage VT.

The circuit of the referenced self-bias current source is shown in Figure 1.

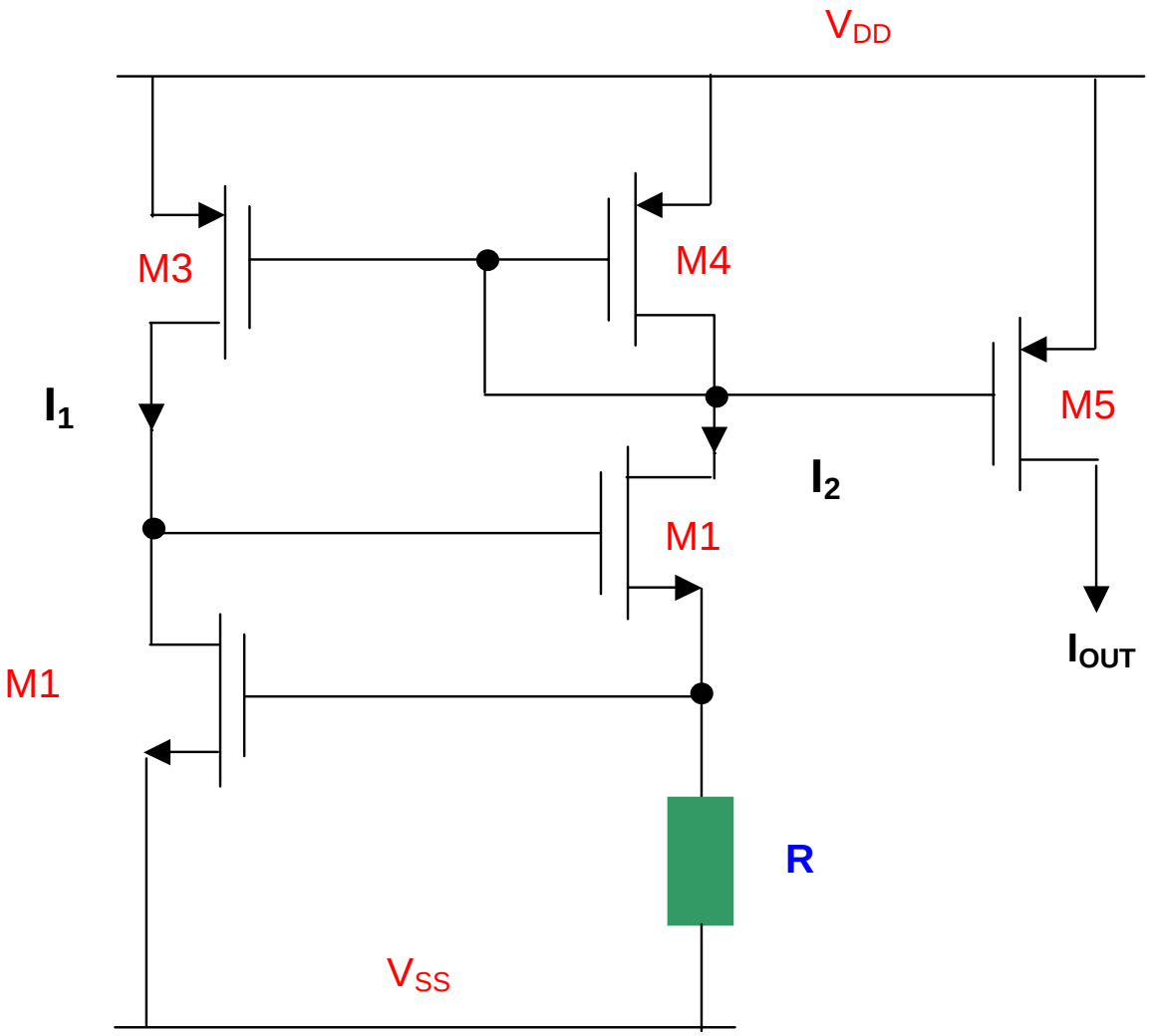


Figure 1 Referenced self-bias current source. The resistor R sets the current through M2 and M4 which is then mirrored through M3 and M1 ensuring I1 = I2.

Normally the voltage required on the gate of M1 will be:

$Vgs1 = V_{SAT1} + V_{T1}$

$$V_{SAT1} = \sqrt{\frac{2.I_D.L}{K_N.W}}$$

If we make the ratio of W/L very large then $V_{SAT1} = \sqrt{\frac{2.I_D.L}{K_N.W}} \Rightarrow 0$

Therefore, **$Vgs1 \sim V_{T1}$**

$$I_1 = I_2 = I_{OUT} = \frac{V_{T1}}{R}$$

Example

Design a referenced current source for Iout of 50uA and a referenced output voltage of 1.5V. Also produce a plot of supply voltage vs output voltage.

$$\text{Make } W/L = 100$$

$$V_{SAT1} = \sqrt{\frac{2.I_D.L}{K_N.W}} = V_{SAT1} = \sqrt{\frac{2.50E^{-6}.1}{110E^{-6}.100}} = 0.09V$$

$$I_1 = I_2 = I_{OUT} = V_{T1} = R = \frac{V_{T1}}{I_{OUT}} = \frac{0.7 + 0.09}{50E^{-6}} = 15.8K\Omega$$

The ADS simulation for this example is shown in Figure 2.

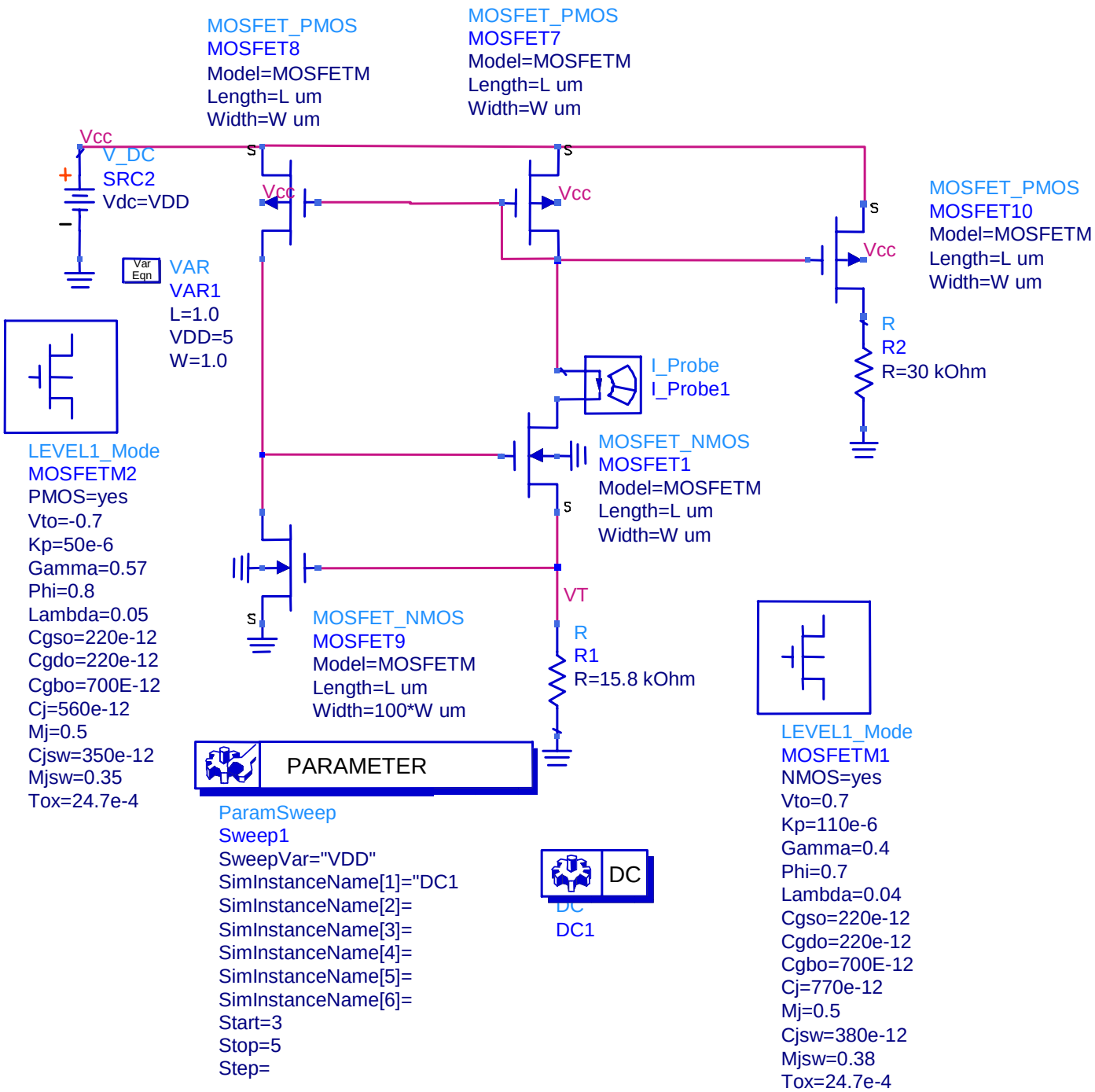
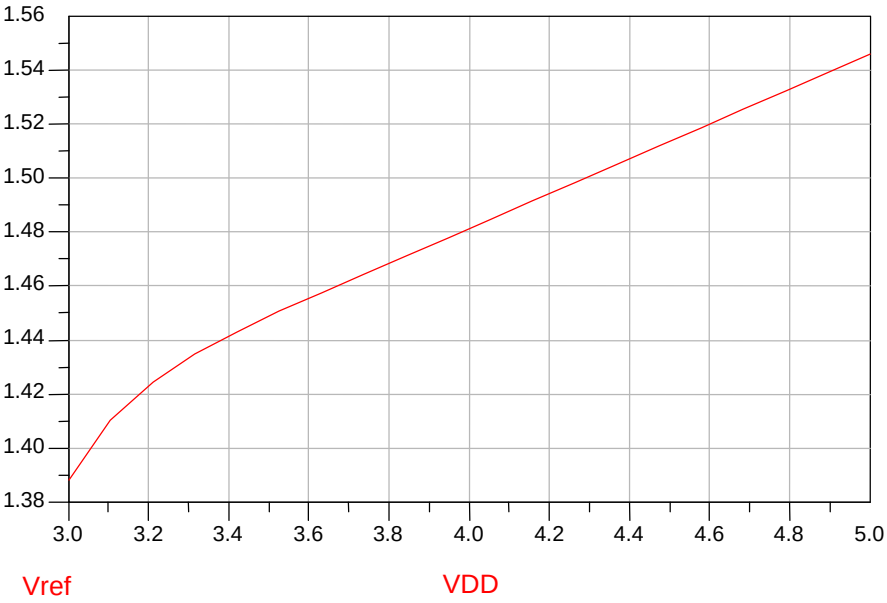


Figure 2 ADS simulation of the referenced self-bias current source example. To give a 1.5V output voltage a 40K ohm resistor is connected to the output current source MOSFET10.



VDD	I_Probe1.i[0]
3.000	4.711E-5
3.105	4.771E-5
3.211	4.799E-5
3.316	4.813E-5
3.421	4.820E-5
3.526	4.824E-5
3.632	4.826E-5
3.737	4.827E-5
3.842	4.828E-5
3.947	4.829E-5
4.053	4.830E-5
4.158	4.831E-5
4.263	4.832E-5
4.368	4.833E-5
4.474	4.834E-5
4.579	4.835E-5
4.684	4.836E-5
4.789	4.837E-5
4.895	4.838E-5
5.000	4.839E-5

Figure 3 Result of the ADS simulation shown in Figure 2