CMOS Transistor Switching

Please send corrections (or suggestions) to youngwlim@hotmail.com.

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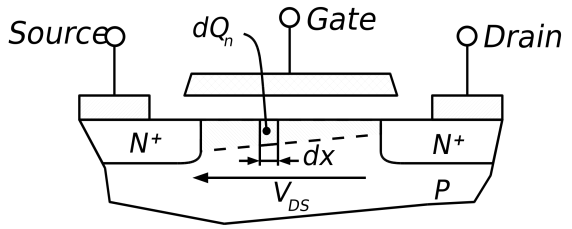
Simple Transistor Model (1)

Cutoff, subthreshold, or weak-inversion mode

When $V_{GS} < V_t$:

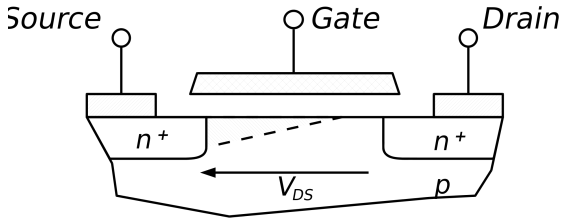
$$I_d = 0$$



Triode mode or linear region (the ohmic mode)

When $V_{GS} > V_t$ and $V_{DS} < (V_{GS} - V_t)$

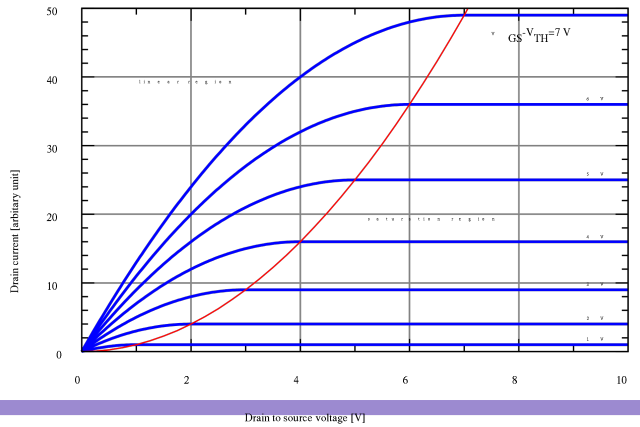
$$I_d = k' \frac{W}{L}\left[(v_{gs} - v_t)v_{ds} - \frac{1}{2}v_{ds}^2\right]$$



Saturation or active mode

When $V_{GS} > V_t$ and $V_{DS} \geq (V_{GS} - V_t)$

$$I_d = \frac{1}{2}k' \frac{W}{L}(v_{gs} - v_t)^2$$

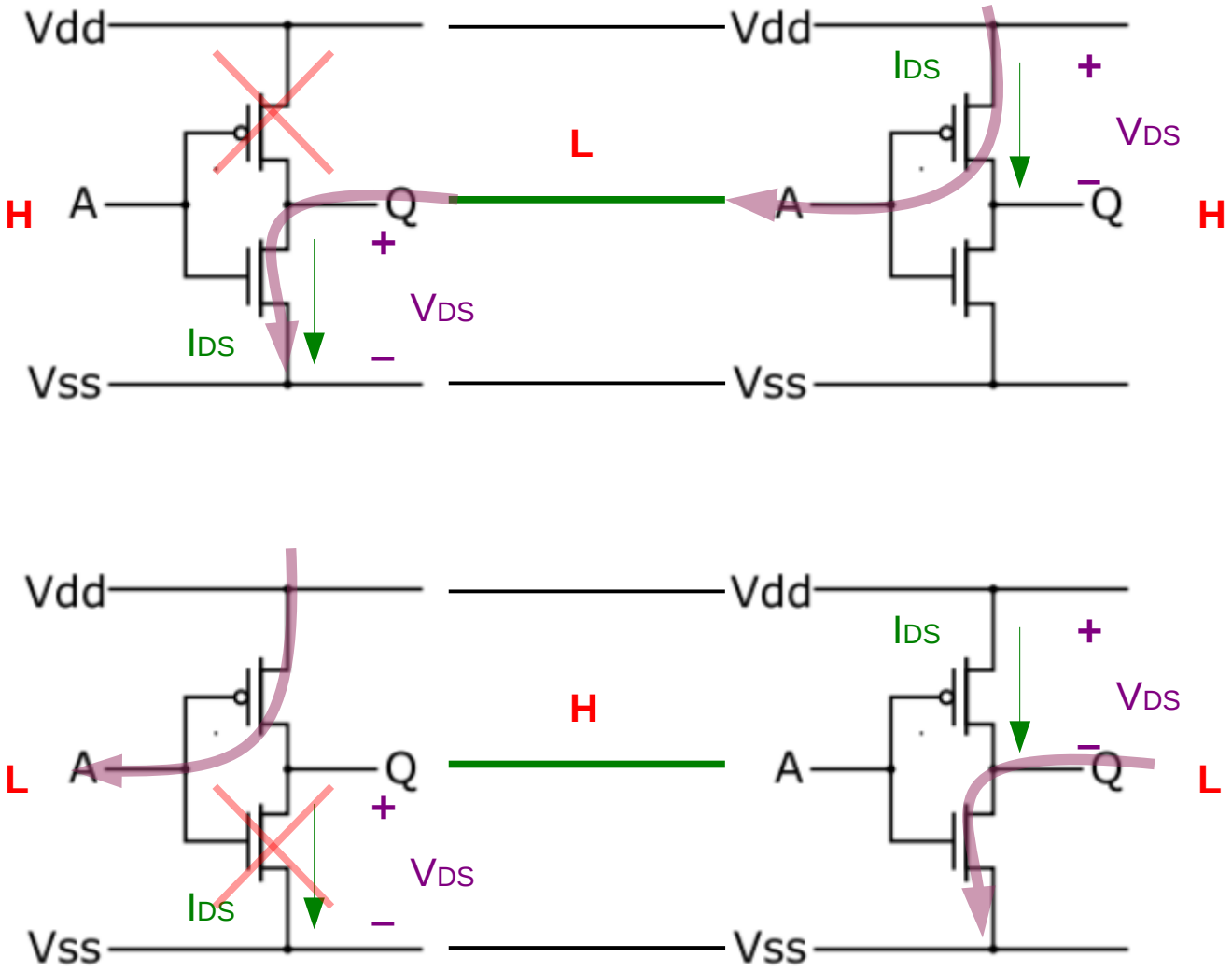


Logic Level

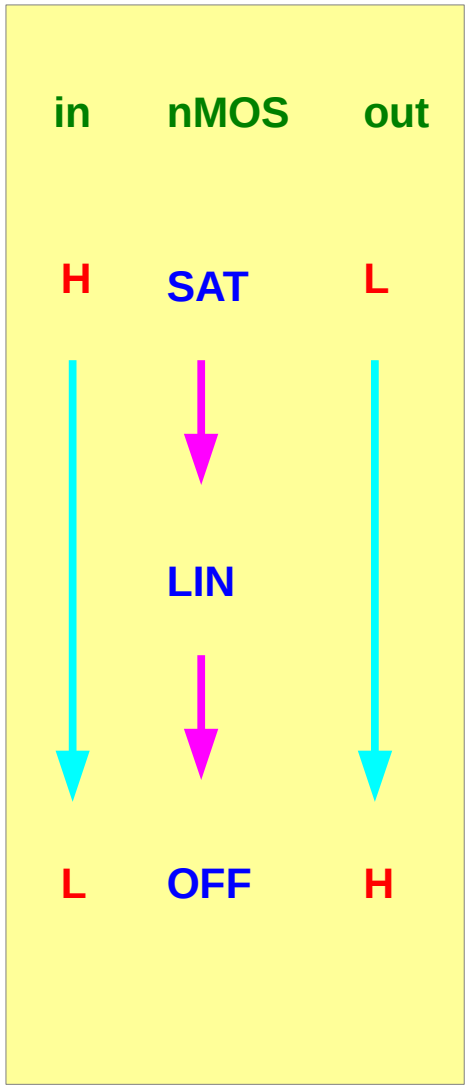
Characteristic Curve

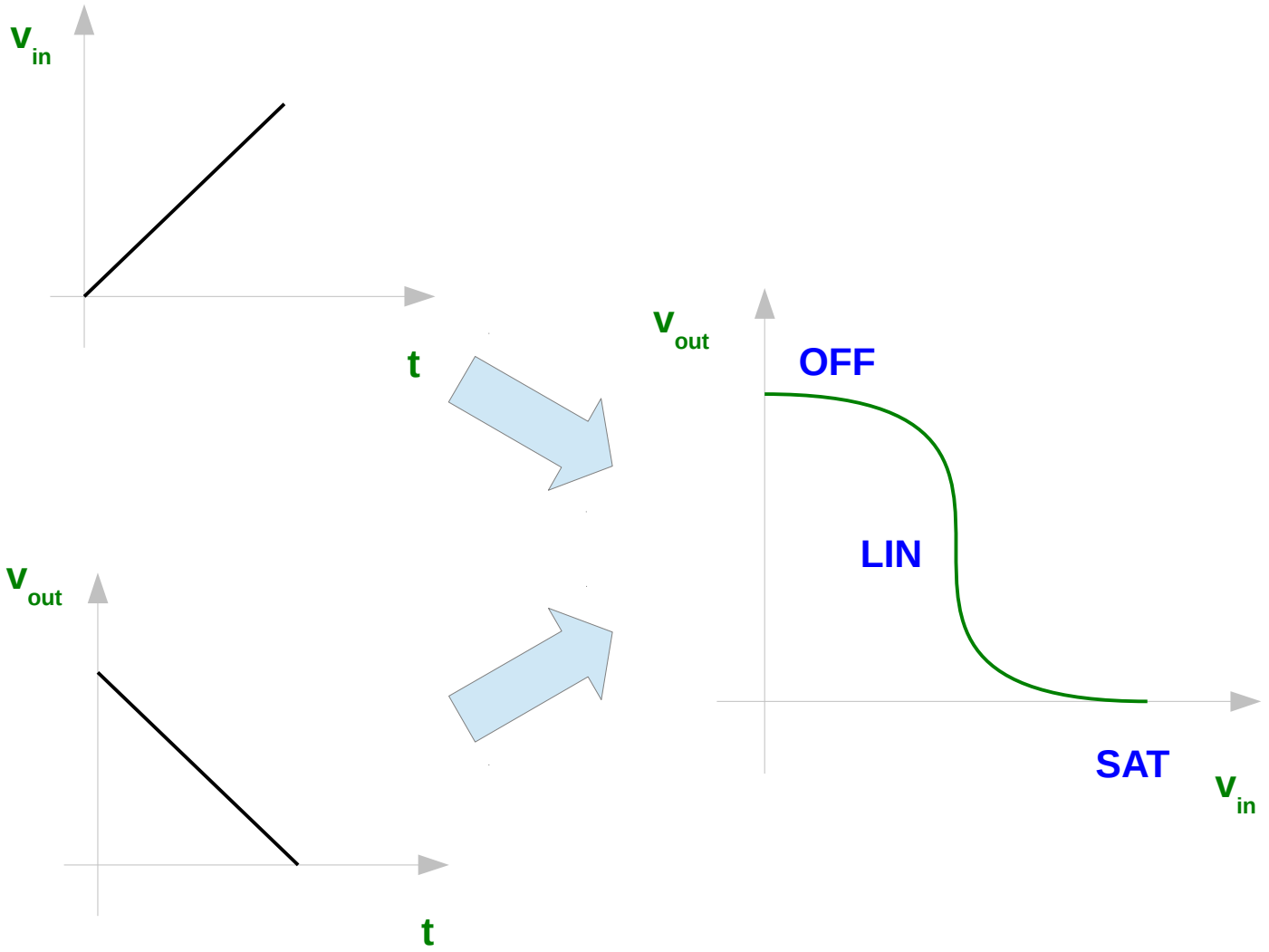
Voltage Transfer Curve (1)

in	nMOS	out
H	SAT	L
	LIN	
L	OFF	H



Voltage Transfer Curve (2)





Spice Model

References

[1] http://en.wikipedia.org/
[2] http://www.allaboutcircuits.com/
[3] W. Wolf, “Modern VLSI Design : Systems on Silicon
[4] N. Weste, D. Harris, “CMOS VLSI Design: A Circuits and Systems Perspective”