

MOSFET Characteristic Equations

Region	Requirements	DS Equiv.	Equations	Notes
Cutoff	$V_{GS} < V_t$	Open Circuit	$I_D = 0A$	
Triode	$V_{DS} < V_{GS} - V_t$	Resistor	$i_D = k' \frac{W}{L} [(V_{GS} - V_t) * V_{DS} - \frac{1}{2} V_{DS}^2]$	
			$r_{DS} = \frac{1}{k' \frac{W}{L} (V_{GS} - V_t)}$	Approximation based on low VDS
Saturation	$V_{DS} \geq V_{GS} - V_t$	Current Source	$i_D = \frac{1}{2} k' \frac{W}{L} (V_{GS} - V_t)^2 (1 + \lambda V_{DS})$	Lambda can often be ignored when VDS is close to VGS-Vt.

Steps for Analysis:

- 1.) Determine what region you are in.
- 2.) Determine which equation to use if there is a choice
- 3.) Redraw circuit with Drain to Source equivalent and analyze.

If you cannot determine what region you are in initially take an educated guess and check later when the information needed presents itself.

Keep in mind the mosfet may switch between regions during its operation. This may require the analysis of two different circuits during two different time spans.

