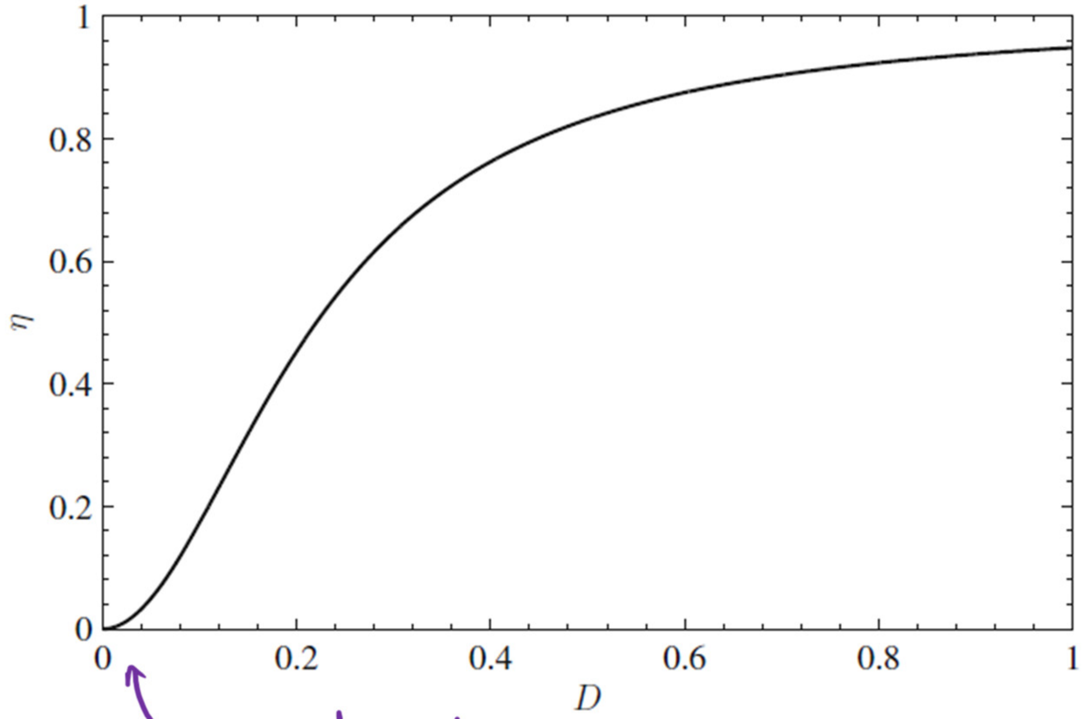
Predicted Efficiency vs Duty Cycle

with switching losses



Pout reduces to near zero

$$P_{out} = \frac{V^2}{R} = \frac{(DV_g)^2}{R}$$

Types of Power Diodes

p-i-n diodes

Standard recovery

Reverse recovery time not specified, intended for 50/60Hz

Fast recovery and ultra-fast recovery

Reverse recovery time and recovered charge specified

Intended for converter applications

(soft recovery = intentionally ↑ Qb to limit di/dt)

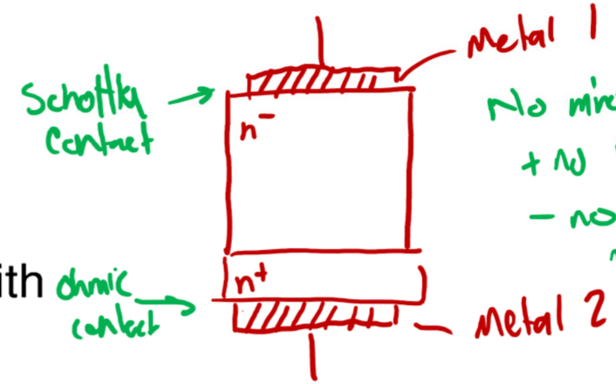
Schottky diode

A majority carrier device

Essentially no recovered charge

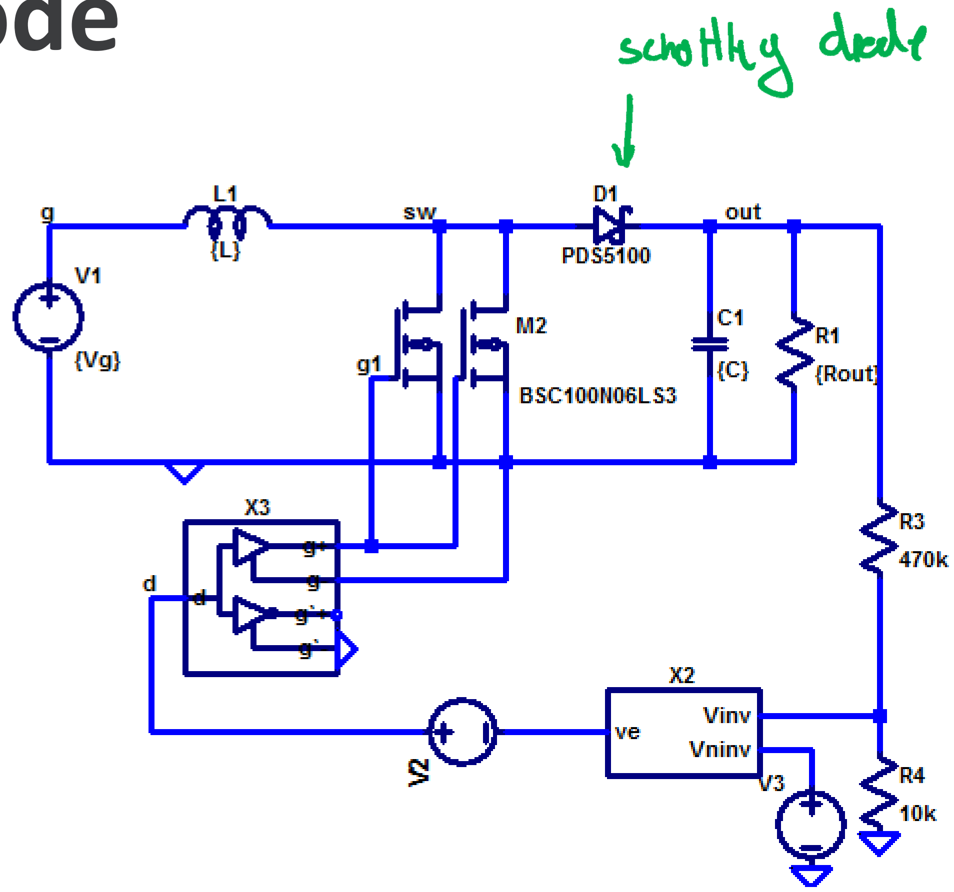
Model with equilibrium *i-v* characteristic, in parallel with depletion region capacitance

Restricted to low voltage (few devices can block 100V or more)



No minority charge
+ no RR
– no conductivity modulation

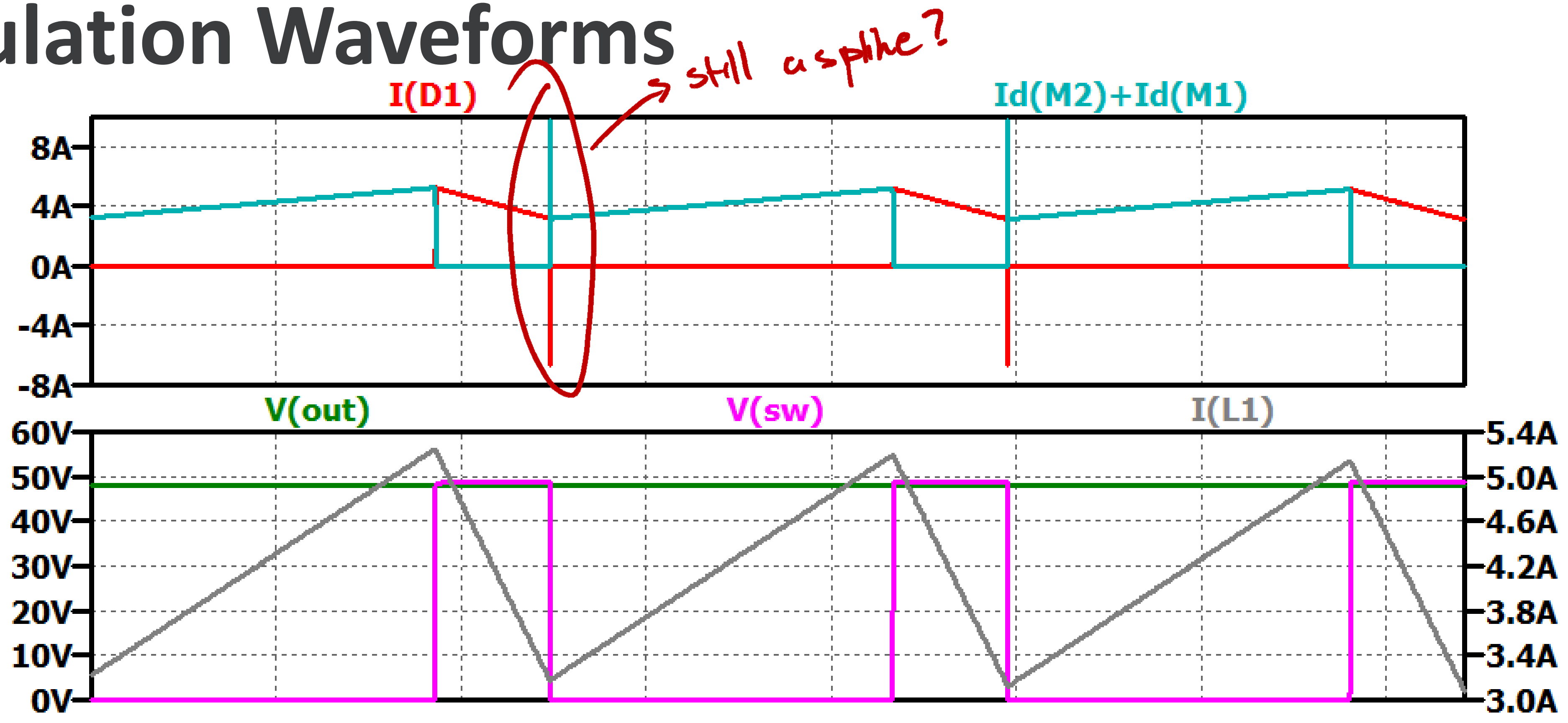
Schottky Diode



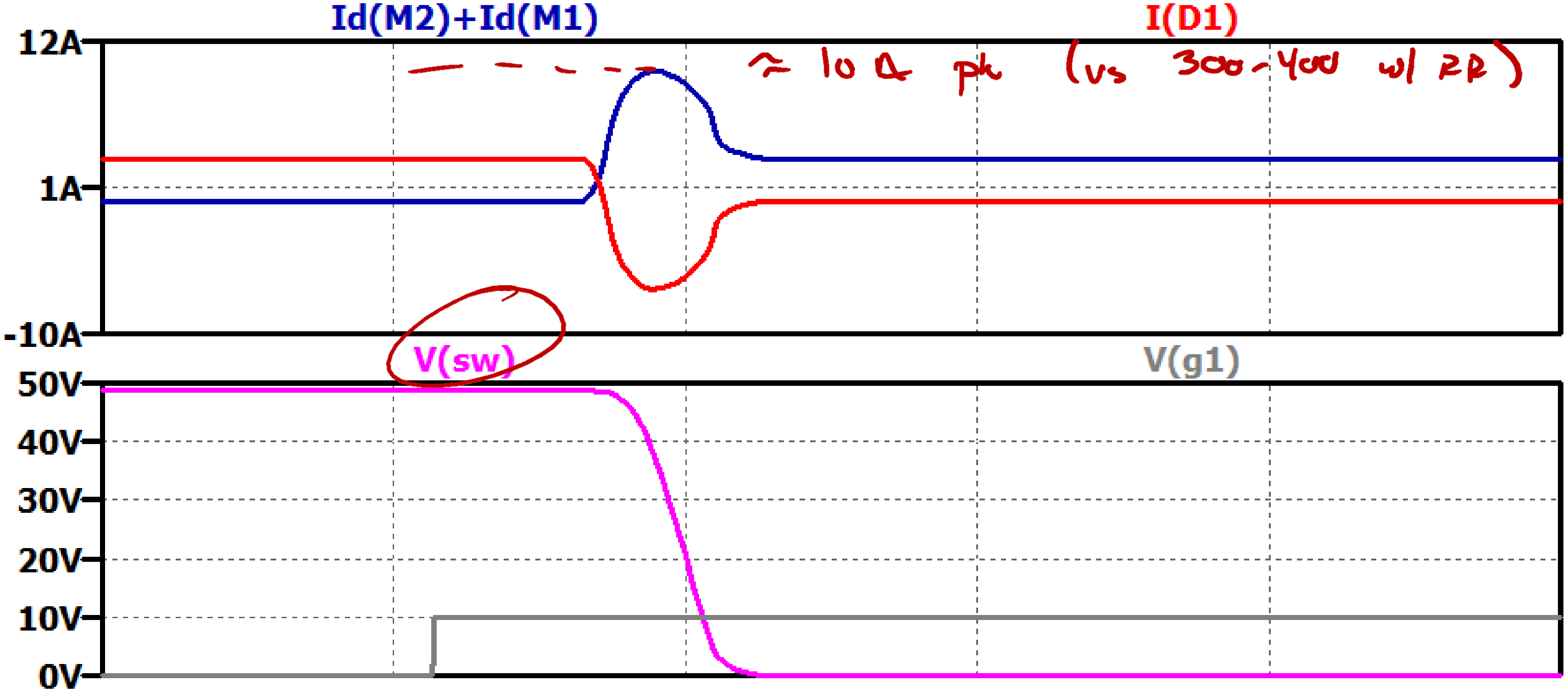
$\eta_{pred} = 97.6\%$

L	C_{out}	f_s	Diode	η (Sim)
22uH	22uF	200k	Si (FR)	93.9%
22uH	22uF	200k	Si Schottky	96.9%

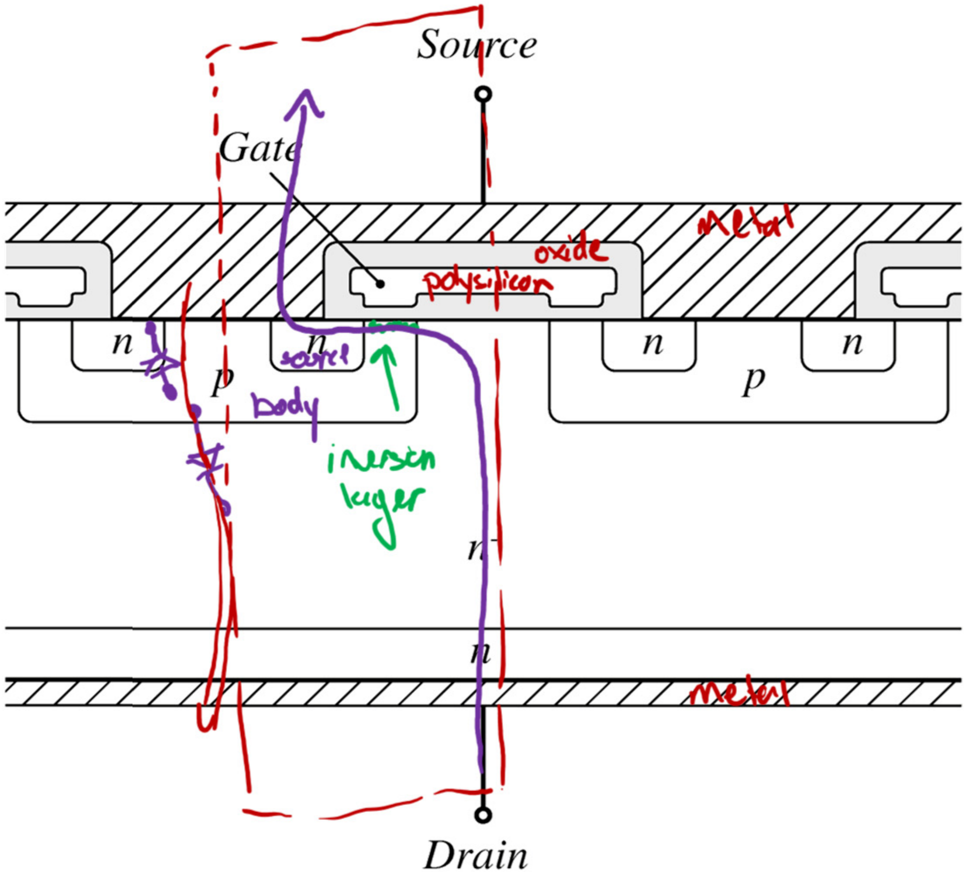
Simulation Waveforms

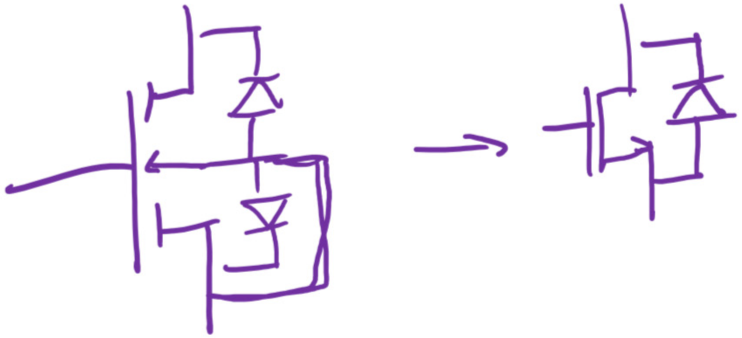


Switching Transition



Power MOSFET





MOSFET Cross Section

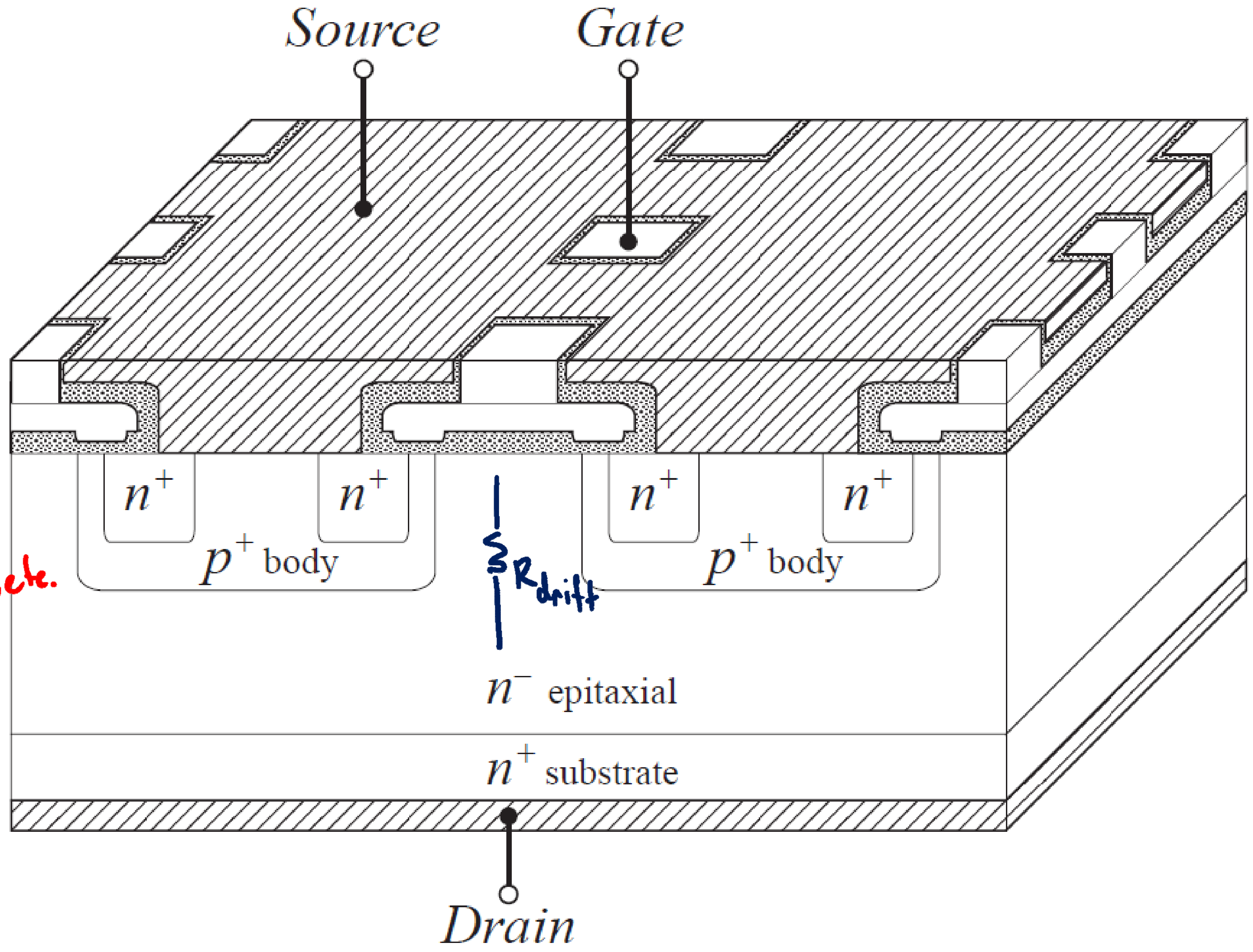
Design tradeoffs:

n^- epitaxy lightly doped → $\uparrow V_{BV}$, $\uparrow R_{on}$

Device Area:

parallel many unit cells

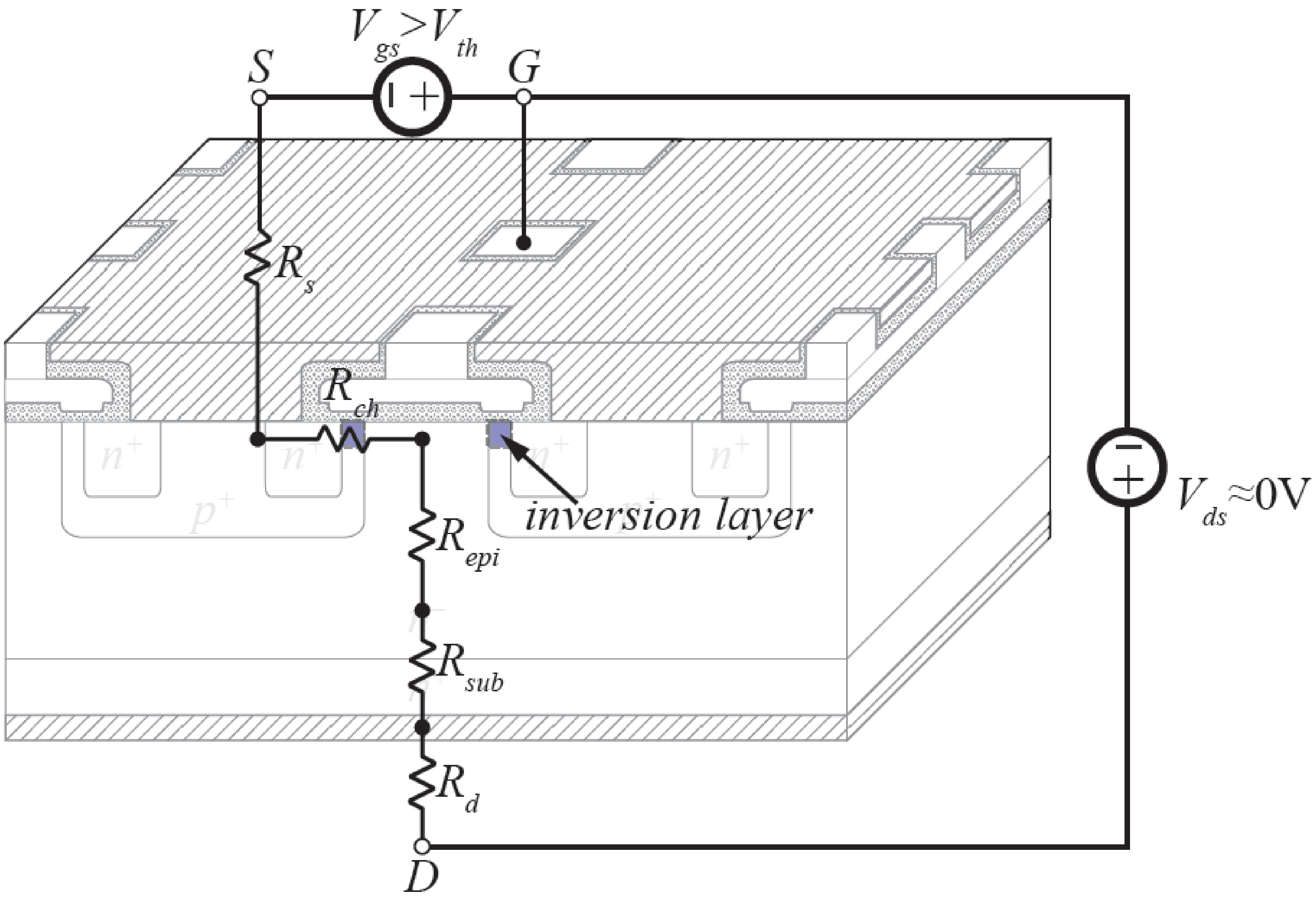
$\uparrow A \rightarrow \downarrow R_{on}$, $\uparrow C_{ds}$, etc.



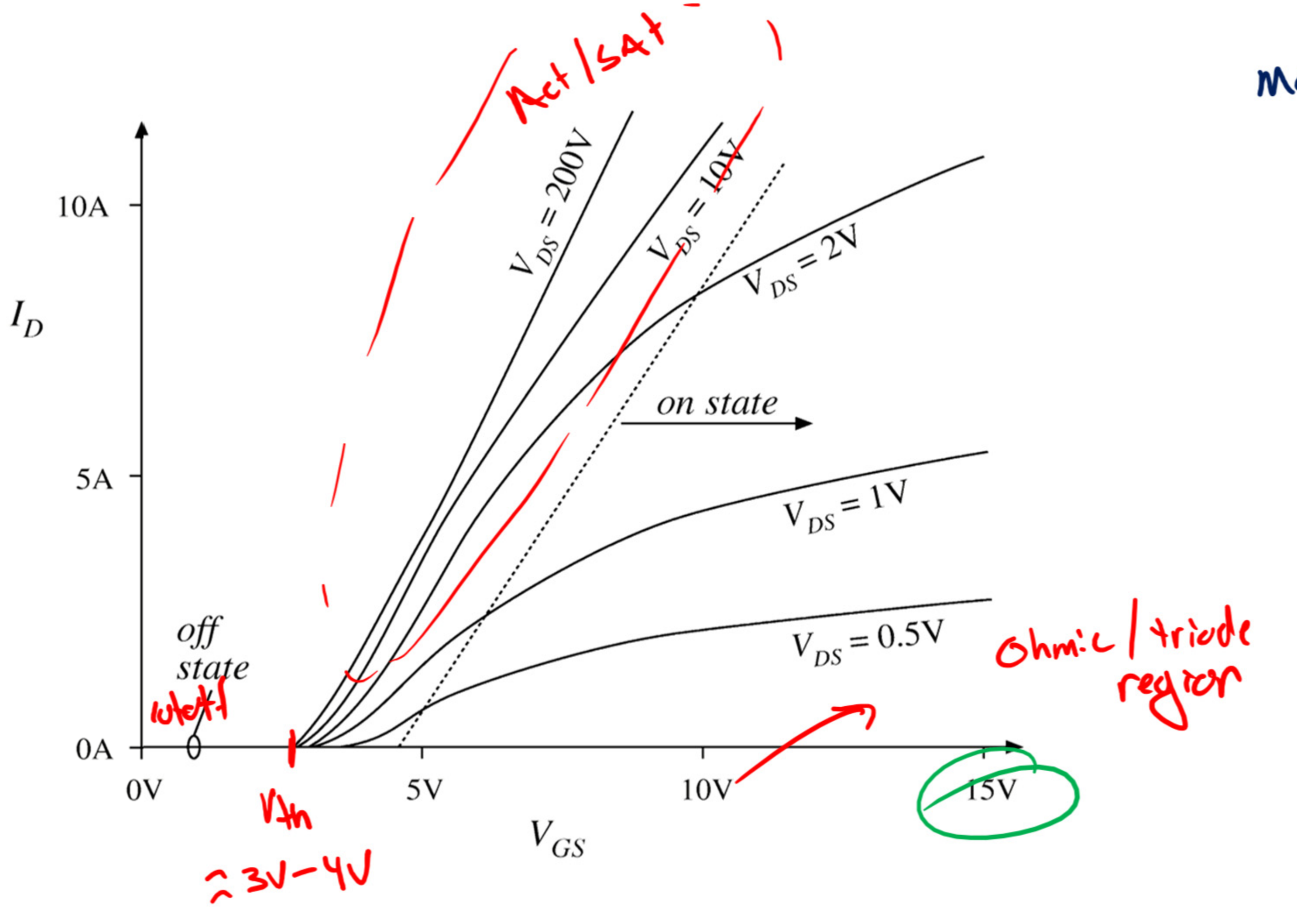
R_{drift} dominates r_{on} at high voltages

metal & channel dominate at low voltage

Power MOSFET in Ohmic Region



MOSFET Static Characteristics



MOSFET selection

$I_{D,max}$ well above what you will use, instead select by $R_{ds,on}$

$V_{DS,max}$ → usually ~double what ideal analysis predicts

MOSFET Depletion capacitance