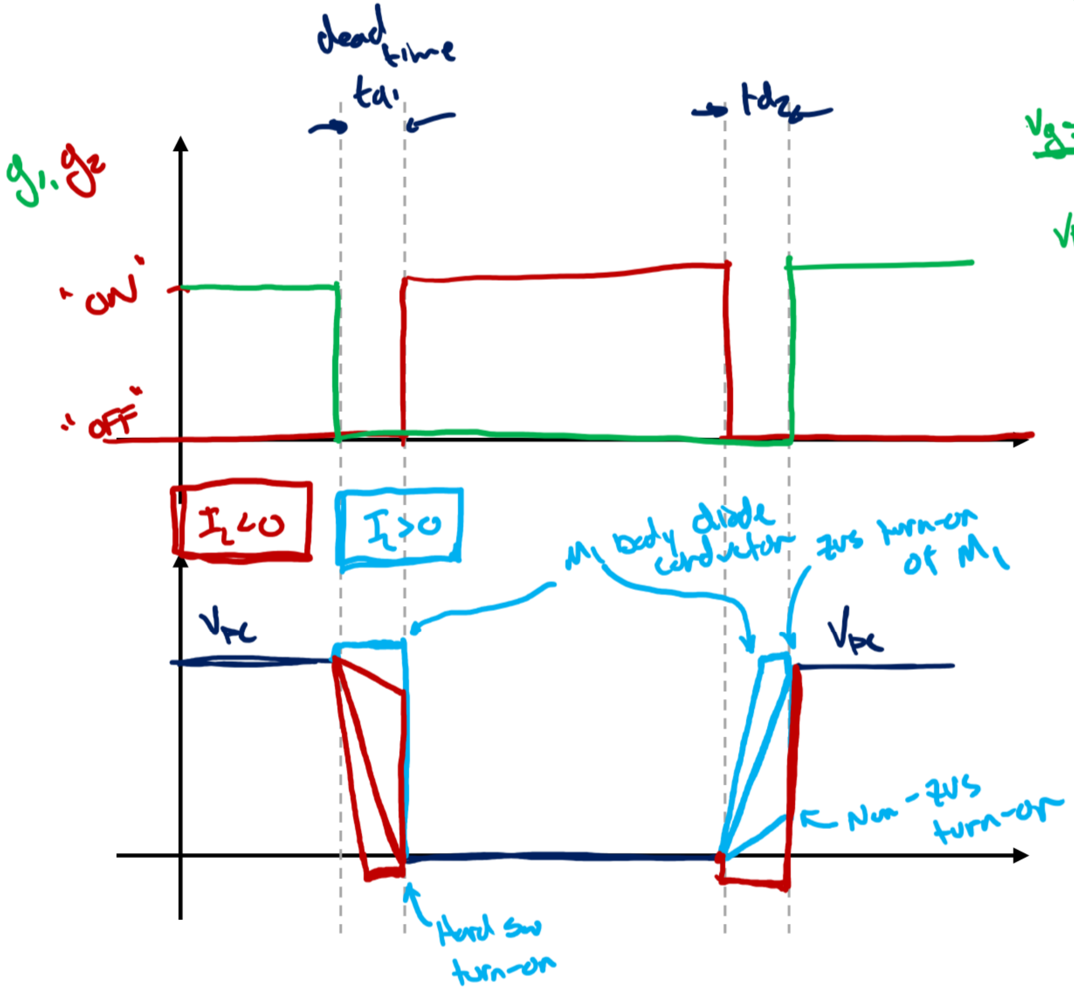
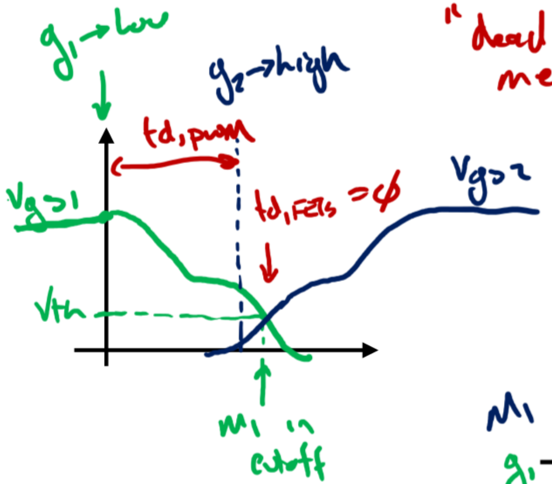
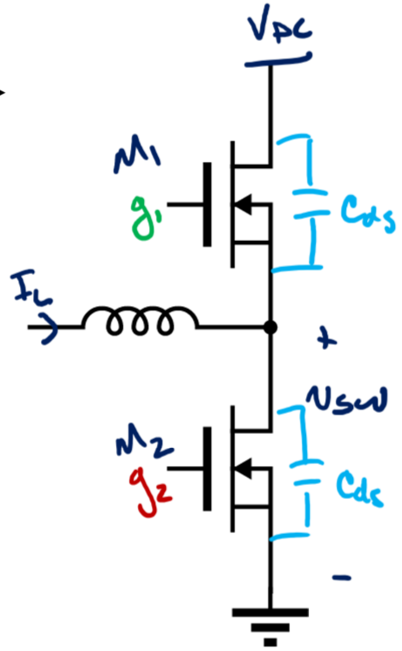
HARD SWITCHING ANALYSIS

Synchronous Switching



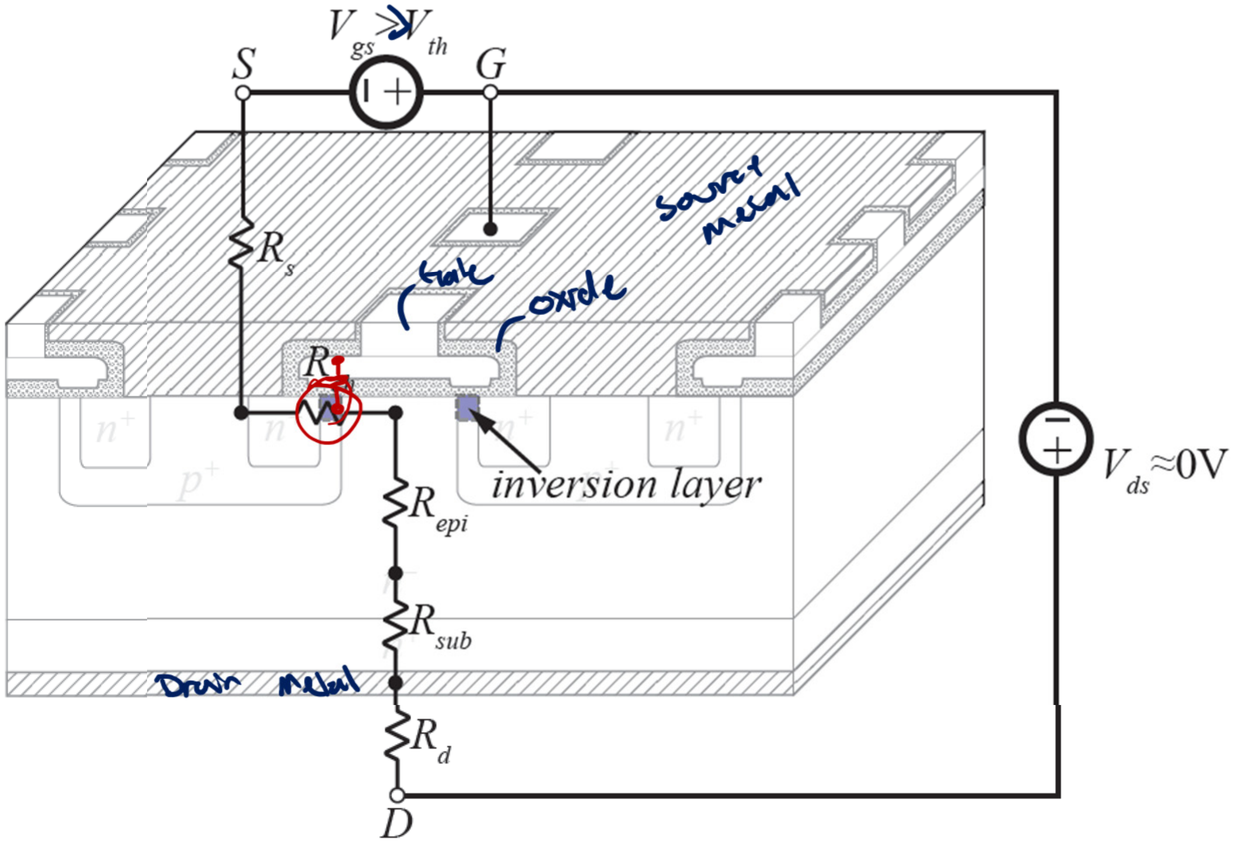


"dead time" has variable meaning in hardware

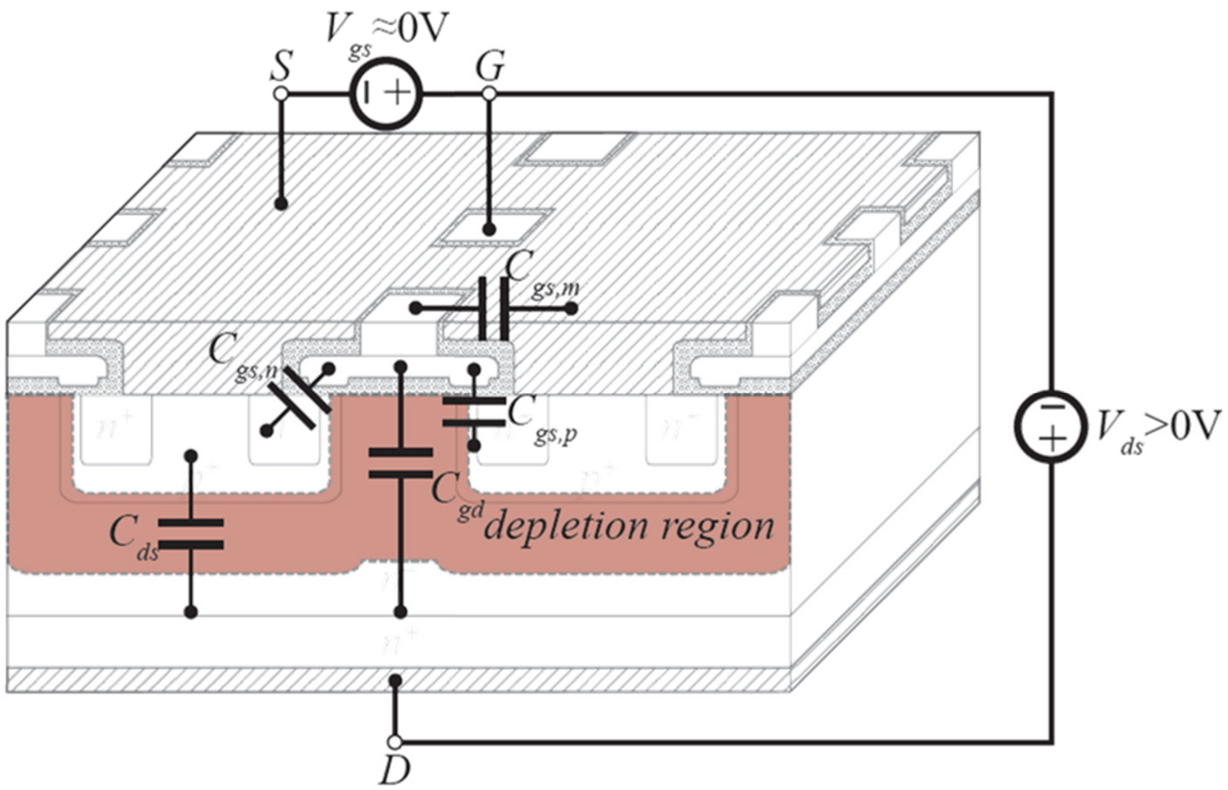


MOSFET Cross Section

ON / Triode



OFF / Cutoff



Resistance Contributions Vs. Voltage

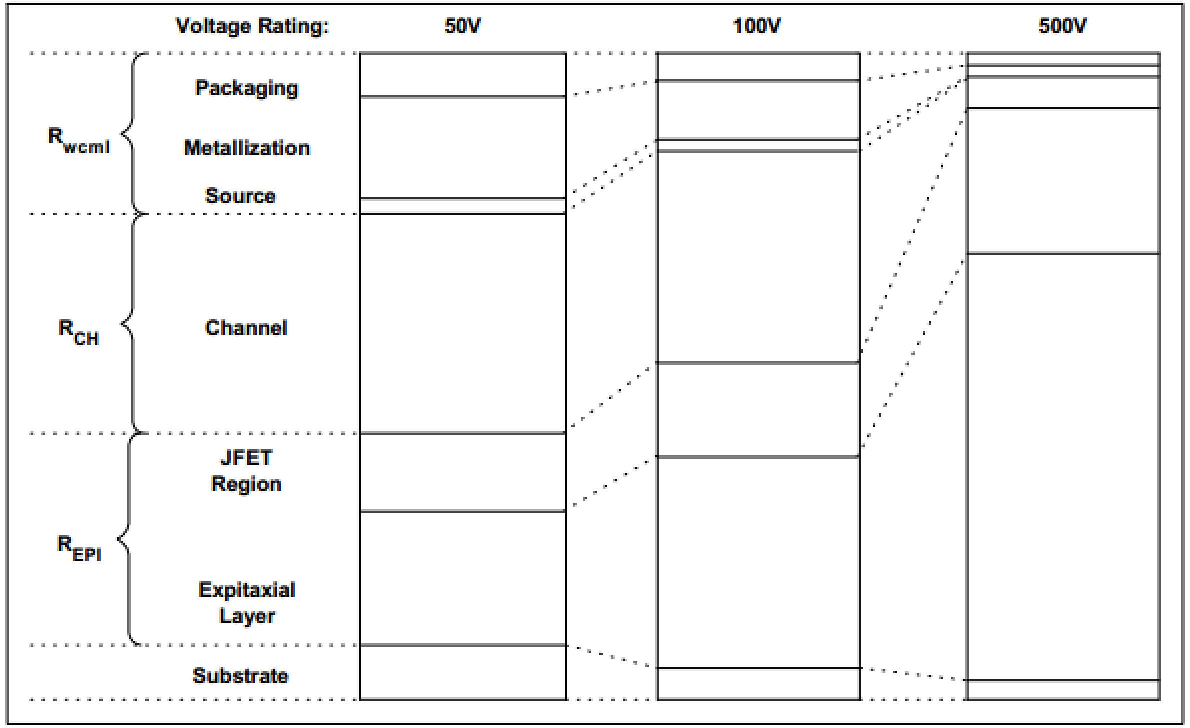
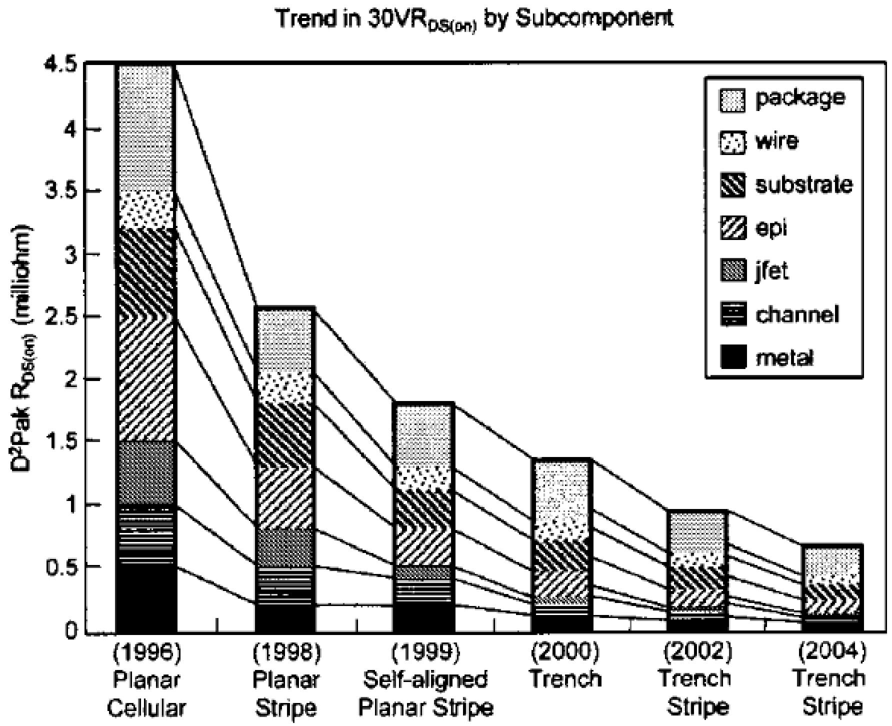


Figure 9. Relative Contributions to $R_{DS(on)}$ With Different Voltage Ratings.



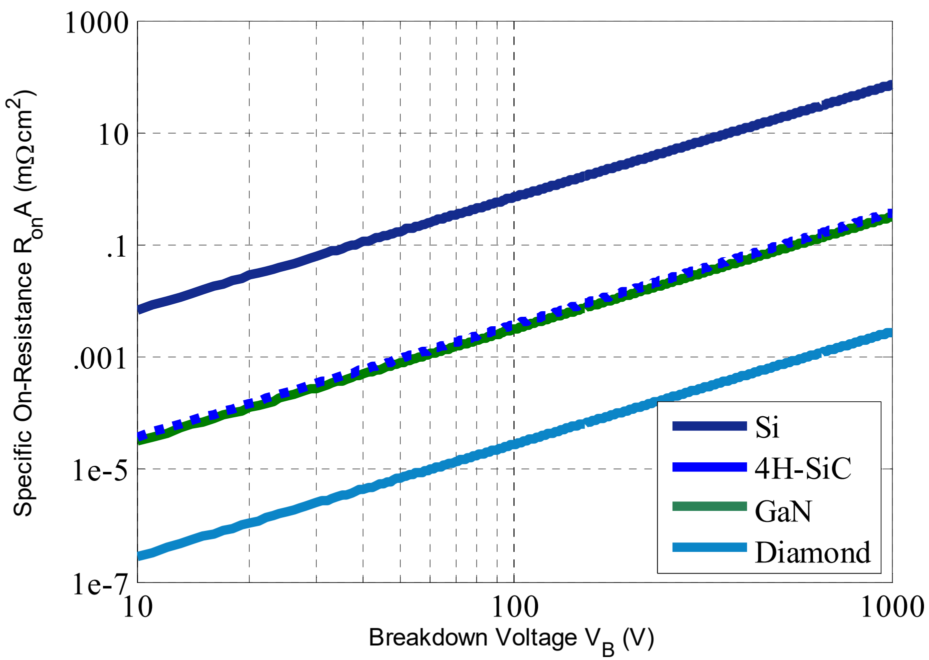
WBG Materials

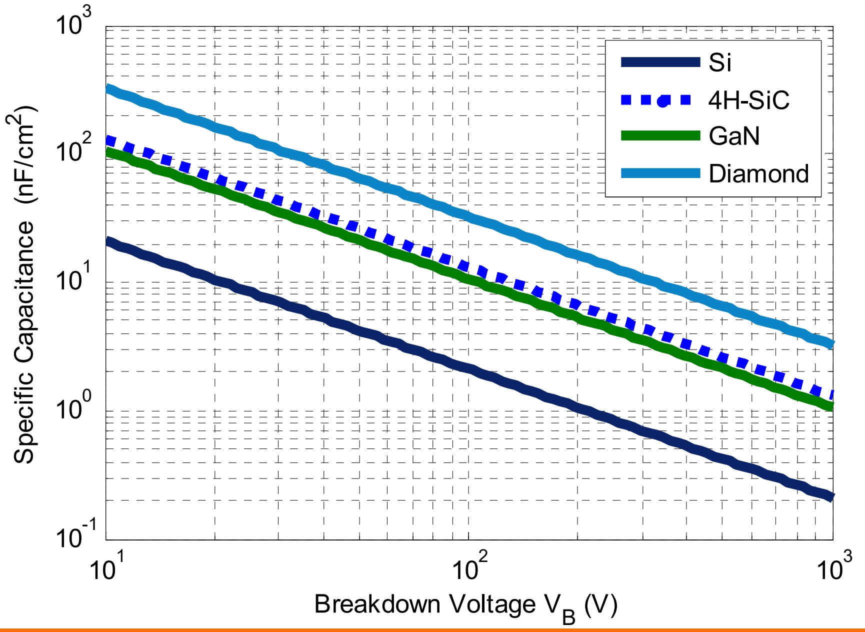
Table 2.1. Physical characteristics of Si and the major WBG semiconductors

Property	Si	GaAs	6H-SiC	4H-SiC	GaN	Diamond
Bandgap, E_g (eV)	1.12	1.43	3.03	3.26	3.45	5.45
Dielectric constant, ε_r^{a}	11.9	13.1	9.66	10.1	9	5.5
Electric breakdown field, E_c (kV/cm)	300	400	2,500	2,200	2,000	10,000
Electron mobility, μ_n (cm^2/V·s)	1,500	8,500	500 80	1,000	1,250	2,200
Hole mobility, μ_p (cm^2/V·s)	600	400	101	115	850	850
Thermal conductivity, λ (W/cm·K)	1.5	0.46	4.9	4.9	1.3	22
Saturated electron drift velocity, v_{sat} ($\times 10^7$ cm/s)	1	1	2	2	2.2	2.7

[a] $\varepsilon = \varepsilon_r \cdot \varepsilon_o$ where ε_o=8.85×10^{-14} F/cm.

B Ozpineci, L M Tolbert, "Comparison of Wide-Bandgap Semiconductors for Power Electronics Applications"



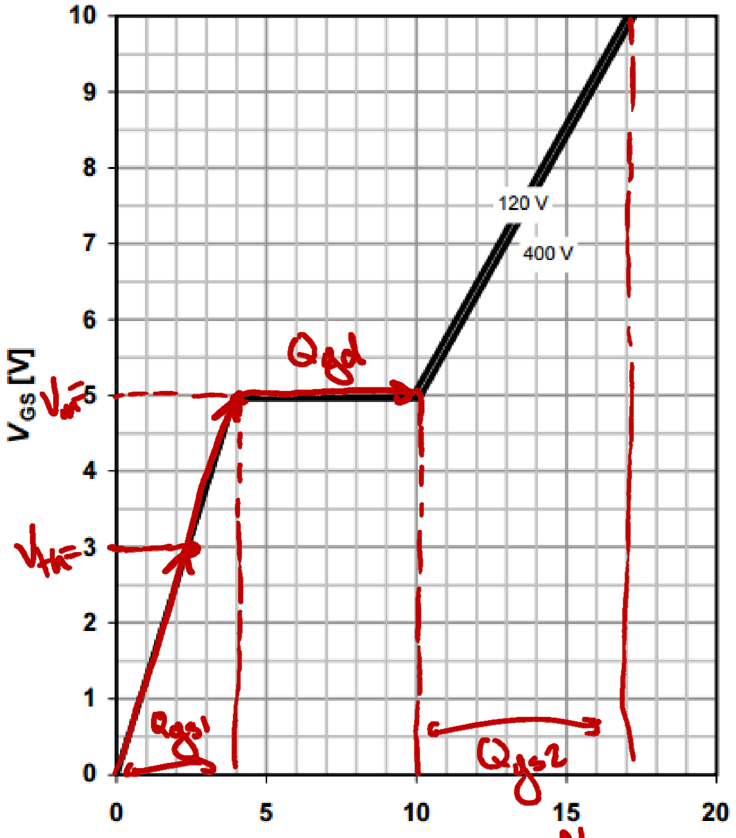


Gate Charge

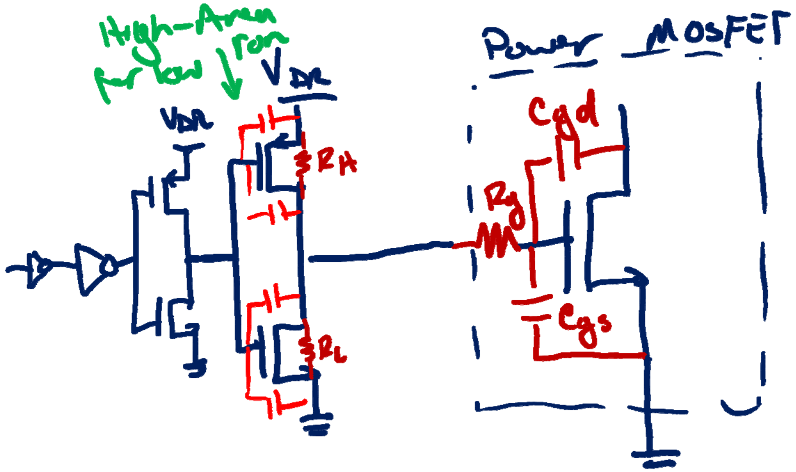
9 Typ. gate charge

V_{GS}=f(Q_{gate}); I_D=5.2 A pulsed

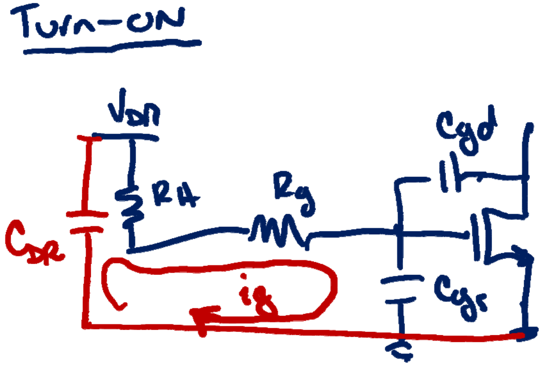
parameter: V_{DD}



$Q_g = Q_{gate}$ [nC] $= \int_0^{t} i_g \, dt$



Turn-ON



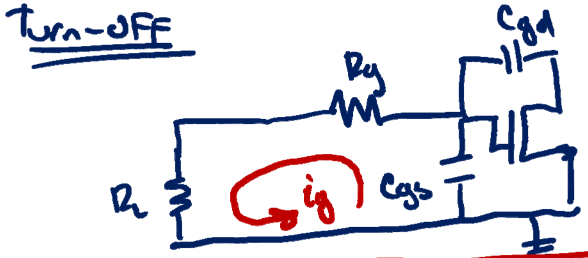
$$E_{DR,on} = \int_{on} V_{DR} \cdot i_g \, dt = V_{DR} \int i_g \, dt = V_{DR} Q_g \approx \frac{1}{2} C_{gs} V_{gs}^2$$

still in C_{gs}

↓

all of the energy lost

Turn-OFF



$$\boxed{P_g = Q_g V_{DR} f_s}$$

→ From GD supply