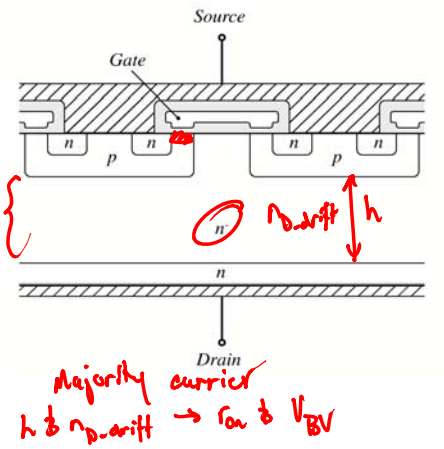
High Frequency Power Electronics

Prof. Daniel Costinett

ECE 581 Lecture 2
August 22, 2014

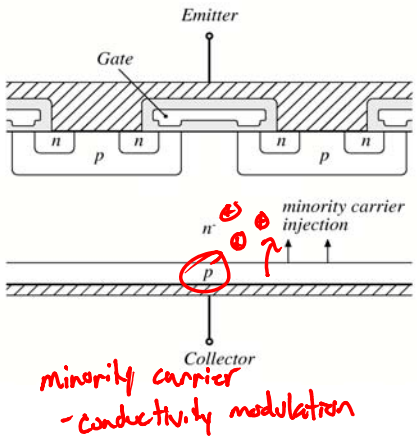
Charge Storage

MOSFET



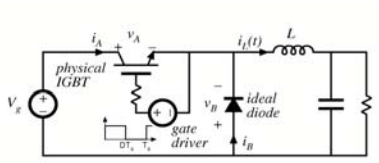
Majority carrier
h ↑ n_{D_drift} → r_{on} ↑ V_{BV}

IGBT

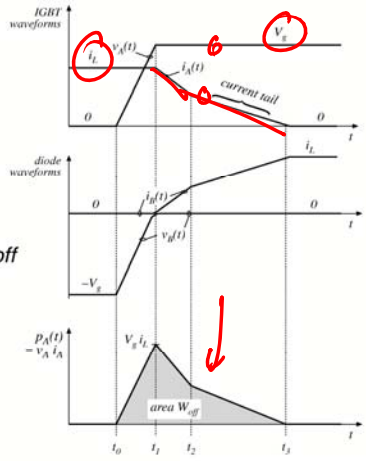


minority carrier
- conductivity modulation

IGBT Current Tailing



Example: buck converter with IGBT



transistor turn-off transition

$$P_{sw} = \frac{1}{T_s} \int_{\text{switching transitions}} p_A(t)\, dt = (W_{on} + W_{off})\, f$$

IGBT Switching Loss: Datasheet

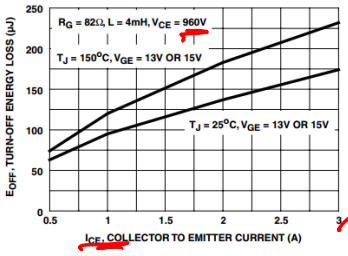
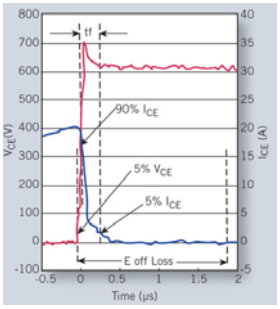


FIGURE 8. TURN-OFF ENERGY LOSS vs COLLECTOR TO EMITTER CURRENT



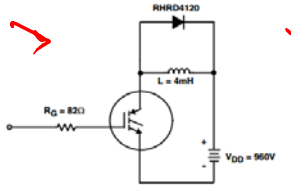


FIGURE 18. INDUCTIVE SWITCHING TEST CIRCUIT

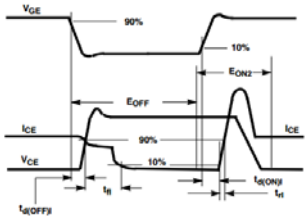
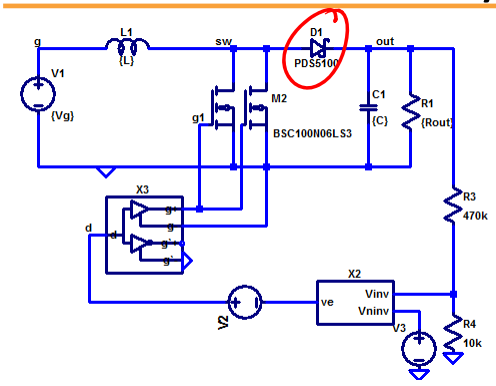


FIGURE 19. SWITCHING TEST WAVEFORMS

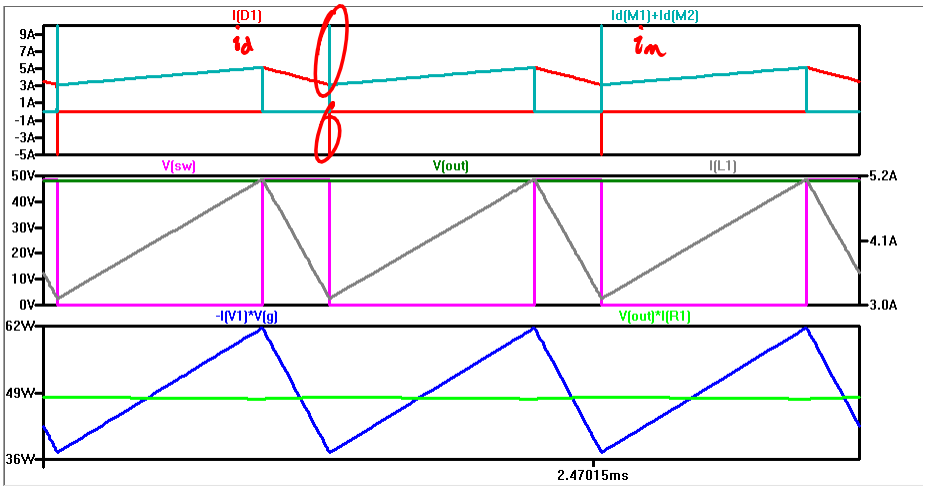
HGTD1N120
C. Wibawa, "Ultra-Fast 1200 V IGBTs Reduce Switching and Conduction Losses"

Schottky Diode

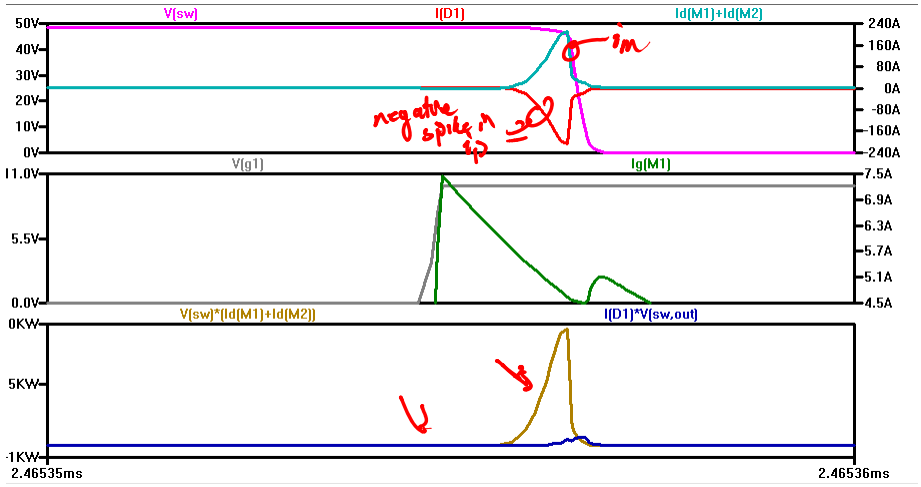


L	C_{out}	f_s	Diode	η (Sim)
22uH	22uF	202k	Si (FR)	93.9%
22uH	22uF	202k	Si Schottky	96.9%

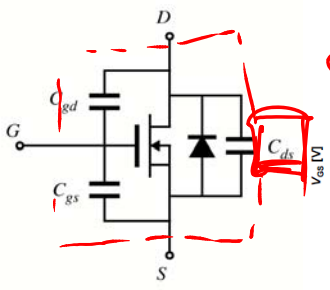
Simulation Waveforms

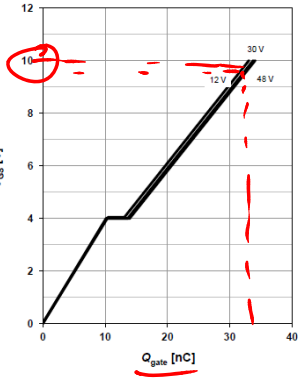


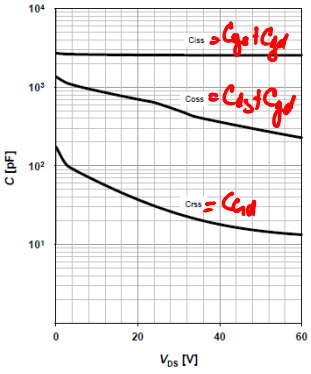
Switching Transition

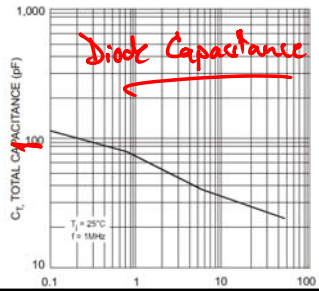


MOSFET Stored Charge

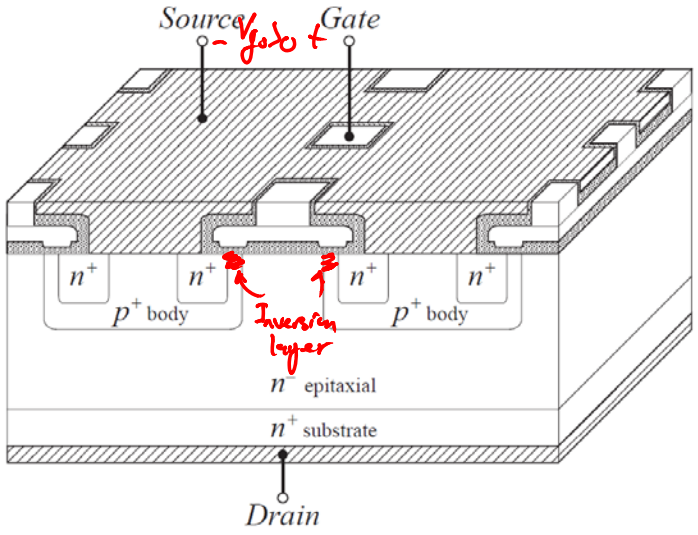




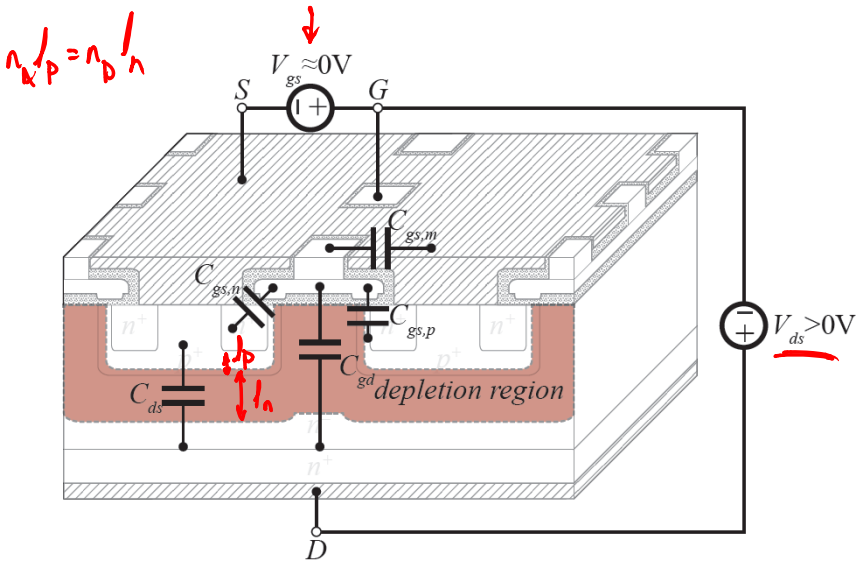




MOSFET Cross Section



MOSFET Depletion capacitance



Device Capacitances