Turn-off
Turn-Off (Drain Dominated)
Gate- vs. Drain-Limited Switching
Simulation Results: $C_{ds}$ Sweep

- $V(g)$
- $I_{d(Mn1)}$
- $V(sw)$
- $V(sw) \times I_{d(Mn1)}$
Limitations on Switching Speed
Switching Waveforms

Switching Losses in a Half Bridge

\[ I_L > 0 \]

\[ I_L < 0 \]
Ideal Switching Waveforms
Capacitive switching loss

ANALYSIS OF NONLINEAR CAPACITANCES
Example Device $C_{oss}$
Datasheet Reported Capacitance

13 Typ. capacitances
$C = f(V_{DS})$, $V_{GS} = 0$V, $f = 1$ MHz

14 Typ. Coss stored energy
$E_{oss} = f(V_{DS})$

Graphs showing $C$ vs. $V_{DS}$ and $E_{oss}$ vs. $V_{DS}$.
Modeling Nonlinear Capacitances

D. Costinett, D. Maksimovic and R. Zane, "Circuit-Oriented Treatment of Nonlinear Capacitances in Switched-Mode Power Supplies," in *IEEE Transactions on Power Electronics*