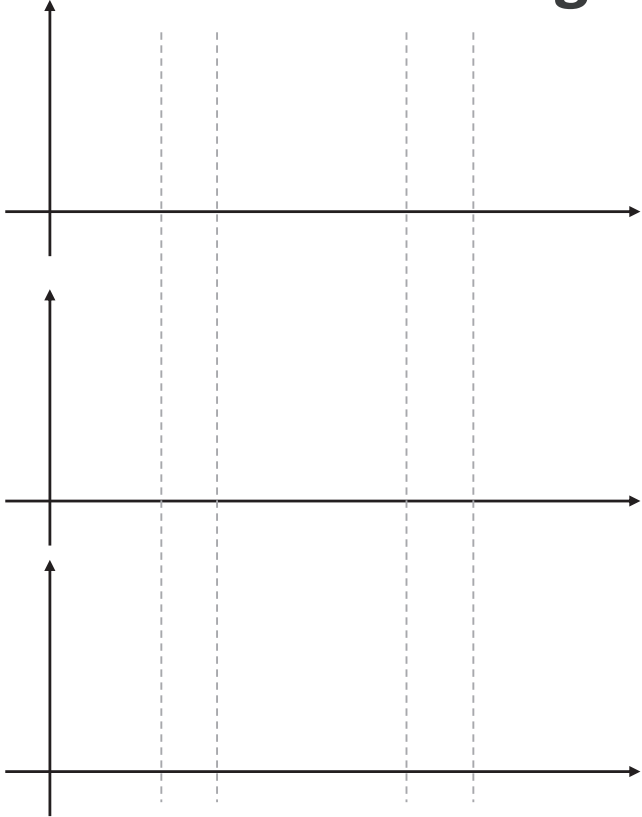
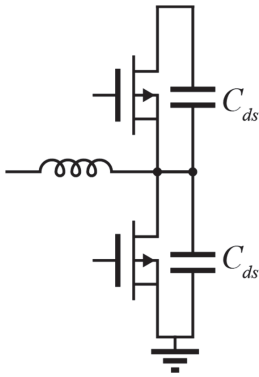
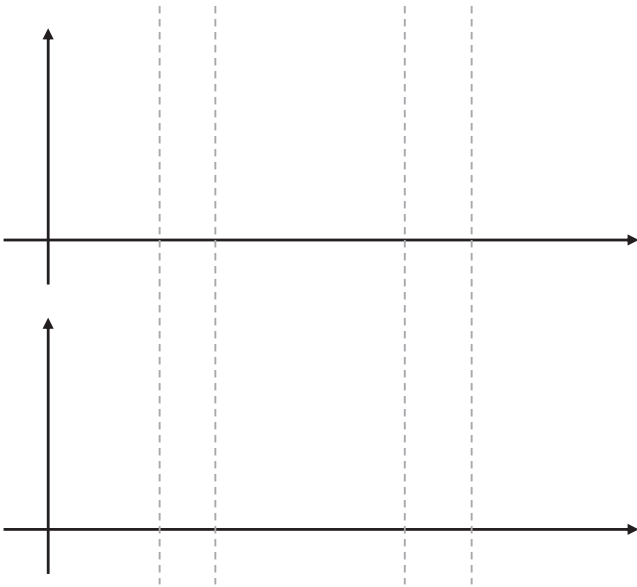


# Switching Losses in a Half Bridge



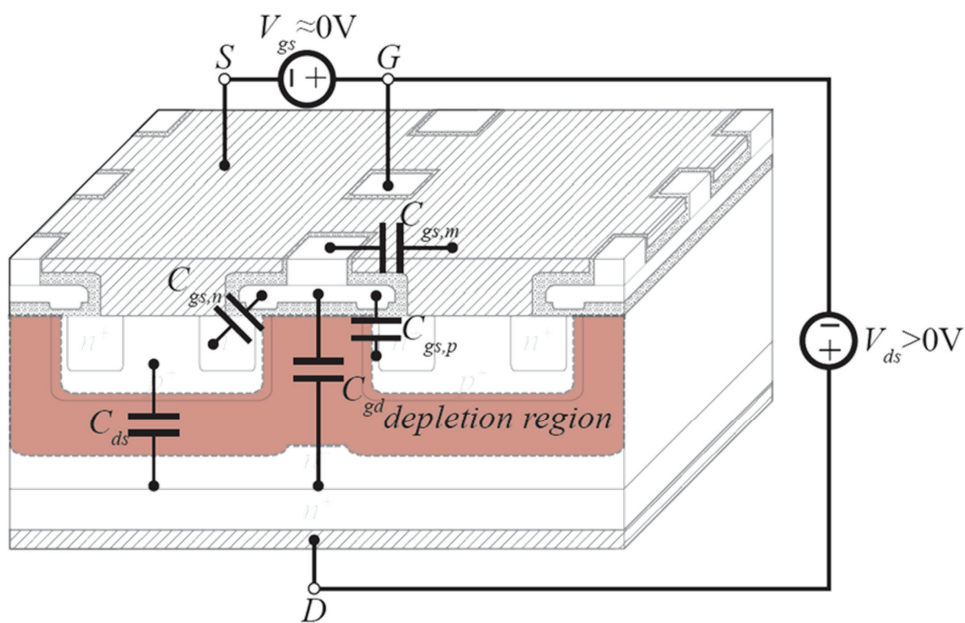
# Target Switching Waveforms



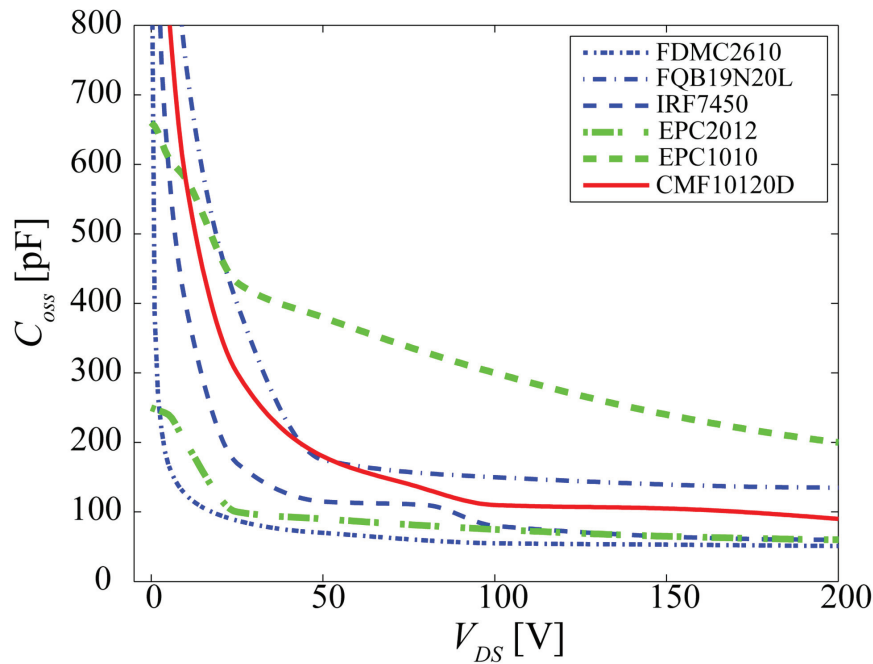
Capacitive switching loss

## ANALYSIS OF NONLINEAR CAPACITANCES

# MOSFET Depletion Capacitance



# Example Device $C_{oss}$



## Datasheet Reported Capacitance



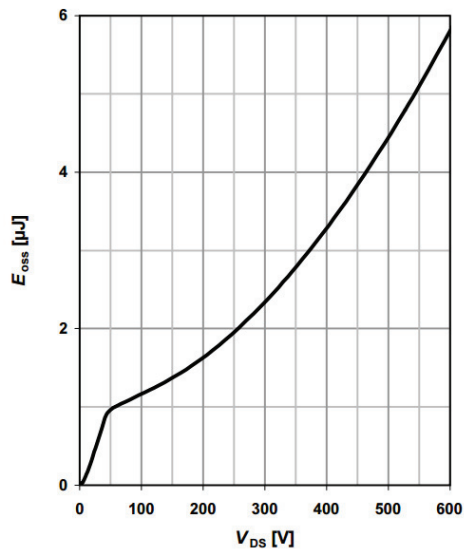
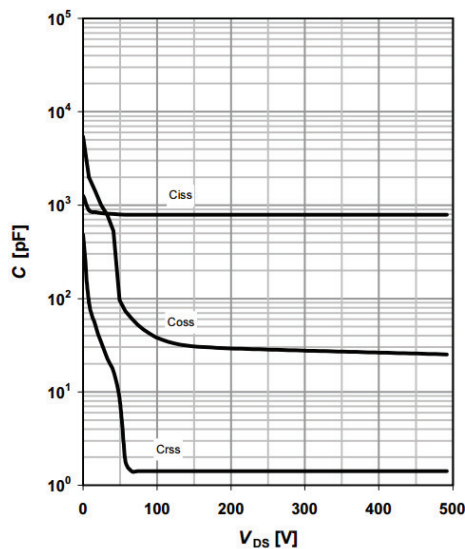
IPB60R385CP

13 Typ. capacitances

$C = f(V_{DS}); V_{GS} = 0 \text{ V}; f = 1 \text{ MHz}$

14 Typ.  $C_{oss}$  stored energy

$E_{oss} = f(V_{DS})$



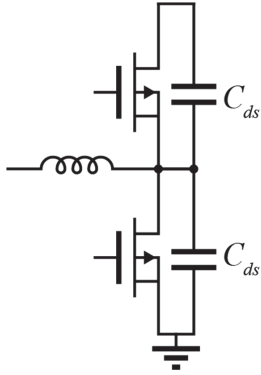
# Modeling Nonlinear Capacitances

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

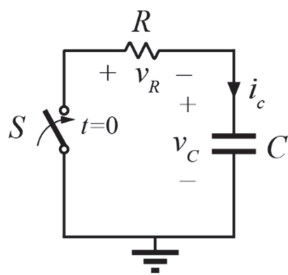


## Energy and Charge Equivalents

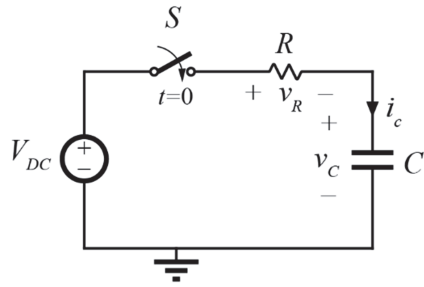
# $C_{oss}$ Losses in a Half Bridge



## $M_2$ Energy Loss



# $M_1$ Energy Loss



## Total Half Bridge $C_{oss}$ Loss