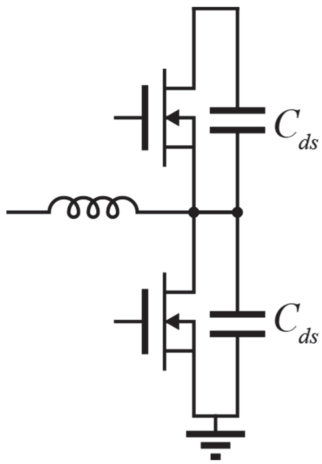
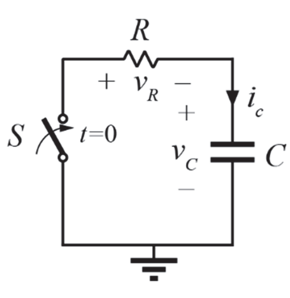
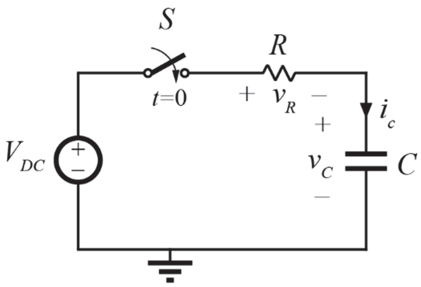
C_{oss} Losses in a Half Bridge



M_2 Energy Loss

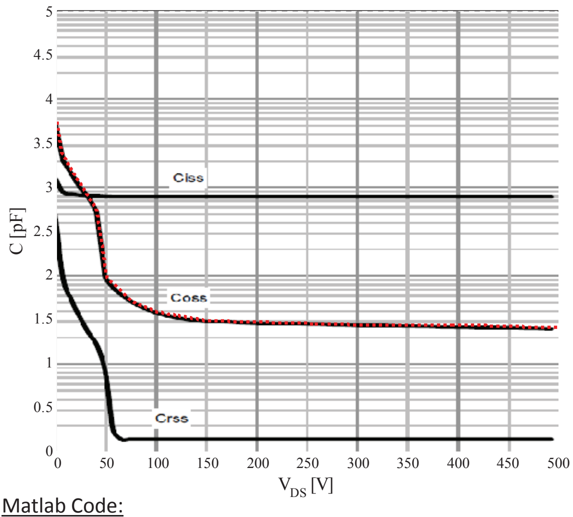


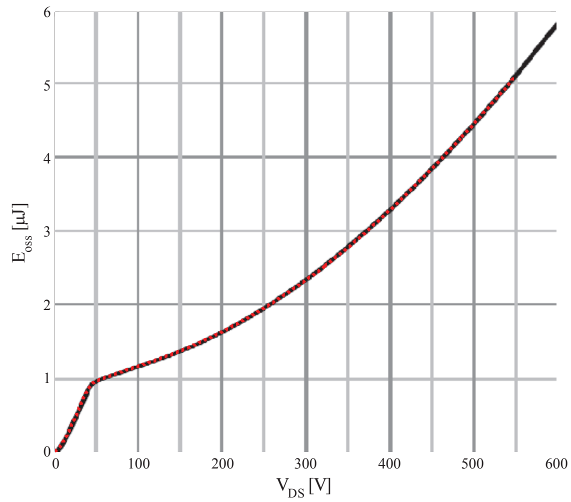
M_1 Energy Loss



Total Half Bridge C_{oss} Loss

Energy Equivalent





Matlab Code:

```
Vdc = 550;

Vds = [0    5    10   40  50 75 100 150 200 300 400 500 600];
Coss = [5500 2500 1900 550 95 50 38  30  29  27  27  25  24]*1e-12;

vx = 0.01:.01:Vdc;
Cx = 10.^interp1(Vdc,log10(Coss),vx,'linear');

E = cumtrapz(vx, Cx.*vx);
Ceq_e = 2*(E)./vx.^2;
```


Nonlinear Capacitance Extraction

- http://web.eecs.utk.edu/~dcostine/personal/PowerDeviceLib/DigiTest/index.html

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Datasheet Reported Capacitance

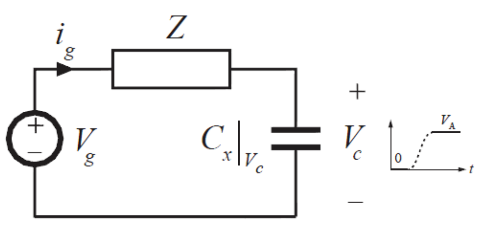
Dynamic characteristics

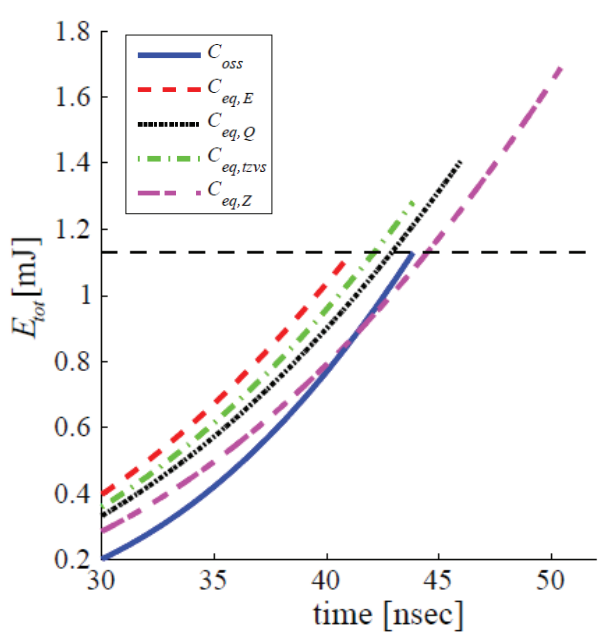
Input capacitance	C_{iss}	V_{GS}=0 V, V_{DS}=100 V, f=1 MHz	-	790	-	pF
Output capacitance	C_{oss}		-	38	-	
Effective output capacitance, energy related[6)]	$C_{o(er)}$	V_{GS}=0 V, V_{DS}=0 V to 480 V	-	36	-	
Effective output capacitance, time related[7)]	$C_{o(tr)}$		-	96	-	
Turn-on delay time	$t_{d(on)}$	V_{DD}=400 V, V_{GS}=10 V, I_D=5.2 A, R_G=3.3 Ω	-	10	-	ns
Rise time	t_r		-	5	-	
Turn-off delay time	$t_{d(off)}$		-	40	-	
Fall time	t_f		-	5	-	

[6)] $C_{o(er)}$ is a fixed capacitance that gives the same stored energy as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

[7)] $C_{o(tr)}$ is a fixed capacitance that gives the same charging time as C_{oss} while V_{DS} is rising from 0 to 80% V_{DSS}.

Example Simulation



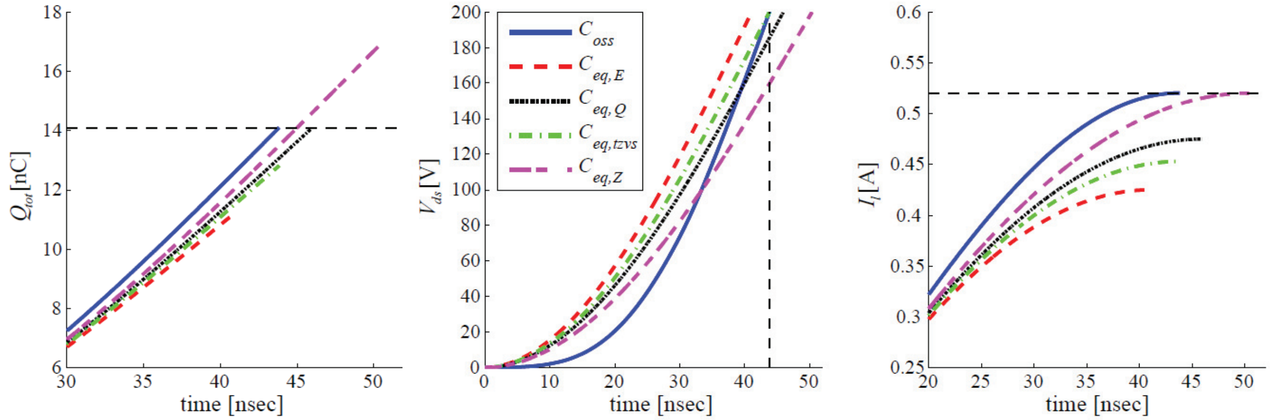


$C_{eq,Q} = 70.5$ pF, $C_{eq,E} = 56.4$ pF,

$C_{eq,tzvs} = 64.1$ pF $C_{eq,Z} = 84.5$ pF.

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

Further Simulation



Time domain analysis of resonant circuits

STATE PLANE ANALYSIS

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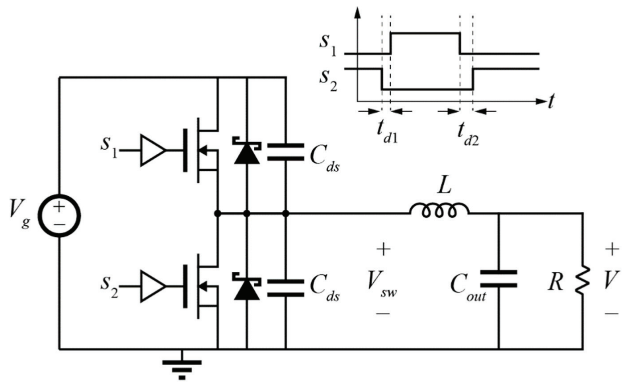
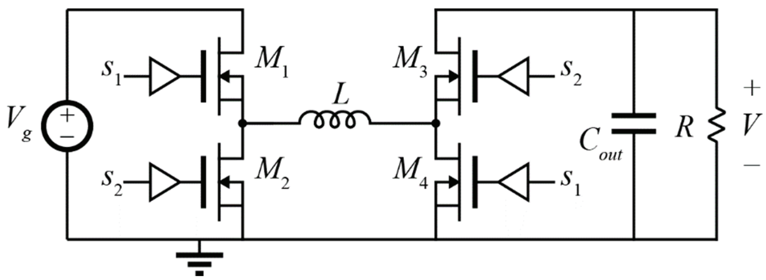
Time-Domain Analysis of Switching Transitions





Resonant Circuit Solution