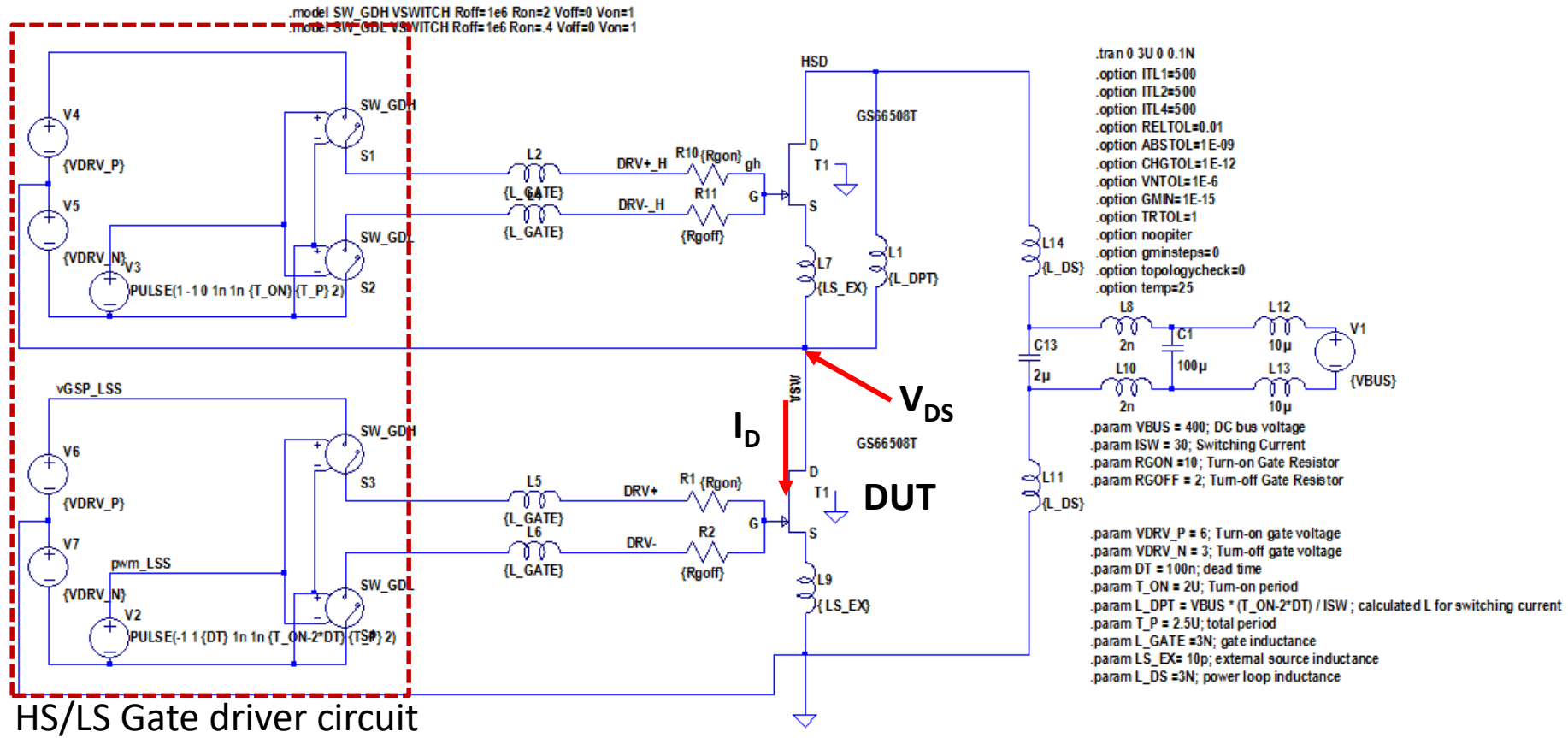
Application Brief
GaN Switching Loss Simulation using LTSpice

Apr 28, 2017

Overview

- GaN Systems provides Pspice/LTSpice simulation models for GaN Enhancement mode HEMT.
- In this presentation, a half bridge double pulse test circuit in LTSpice will be introduced and used as the test bench to evaluate switching performance under different electrical parameters.
- Switching losses were simulated and compared with Lab measurement

GAN SYSTEMS SWITCHING LOSS DOUBLE PULSE TEST BENCH



HS/LS Gate driver circuit

Half Bridge Double Pulse Test bench in LTSpice

Set up the simulation parameters:

.option temp=25 ; Junction temperature setting, adjust between 25 and 150C

.param VBUS = 400; DC bus voltage
.param ISW = 30; Switching Current
.param RGON =10; Turn-on Gate Resistor
.param RGOFF = 2; Turn-off Gate Resistor

.param VDRV_P = 6; Turn-on gate voltage
.param VDRV_N = 3; Turn-off negative gate voltage

Switching test parameters

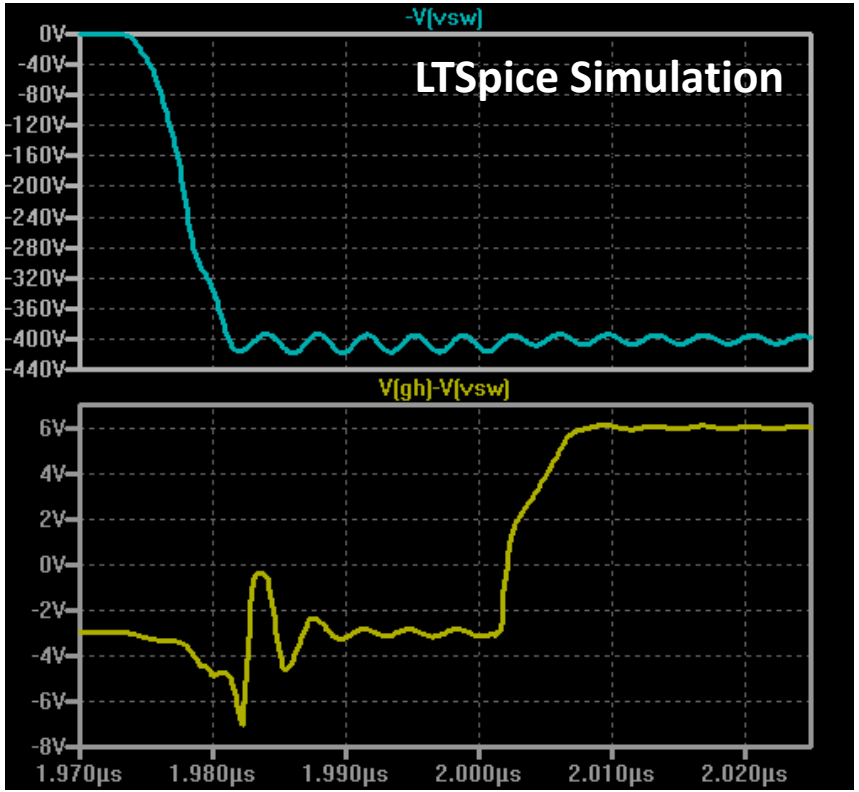
.param DT = 100n; dead time
.param T_ON = 2U; Turn-on period
.param L_DPT = VBUS * (T_ON-2*DT) / ISW ; calculated L for switching current setting
.param T_P = 2.5U; total period

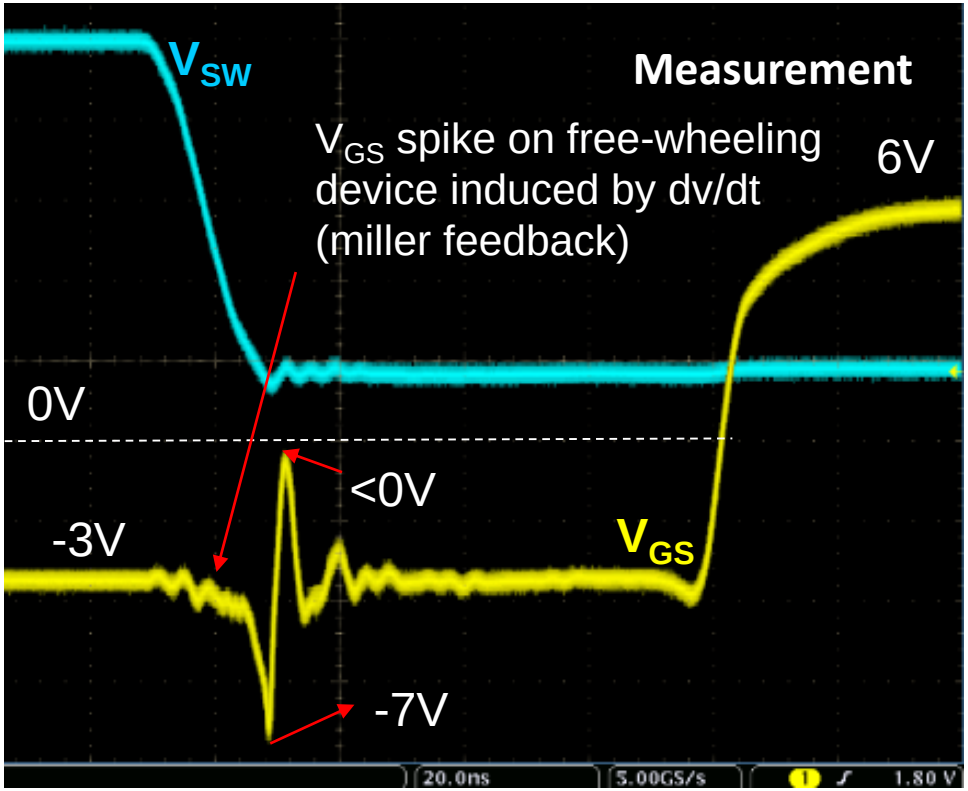
.param L_GATE =3N; gate inductance
.param LS_EX= 10p; external source inductance
.param L_DS =3N; power loop inductance

Parasitic Inductances

Gate waveforms (Simulated vs Measured)

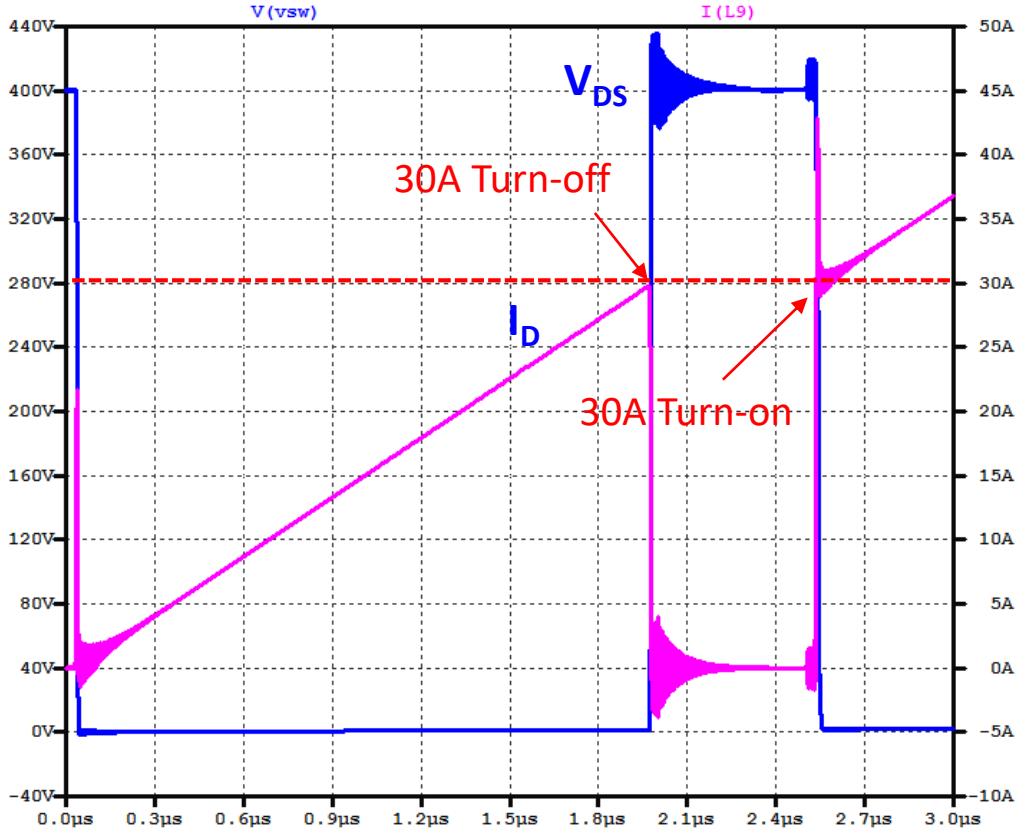
- Good correlation between simulated and measured waveforms.
- Parasitics: L_DS = 3nH, L_GATE = 3nH



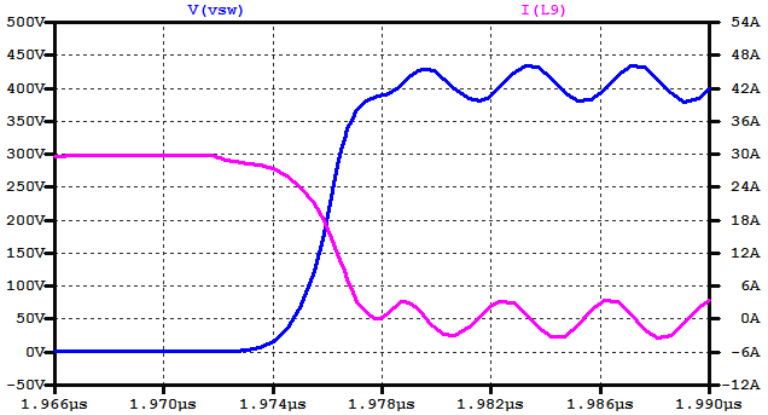


Half Bridge Double Pulse Test bench in LTSpice

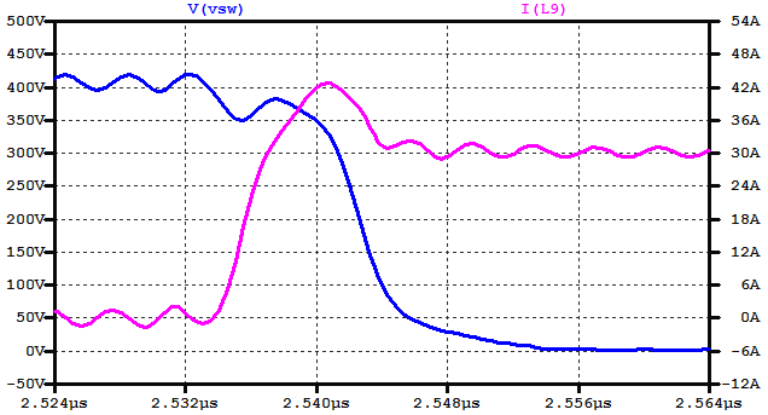
Double Pulse Simulation Results (400V/30A)



400V/30A Hard switch-off



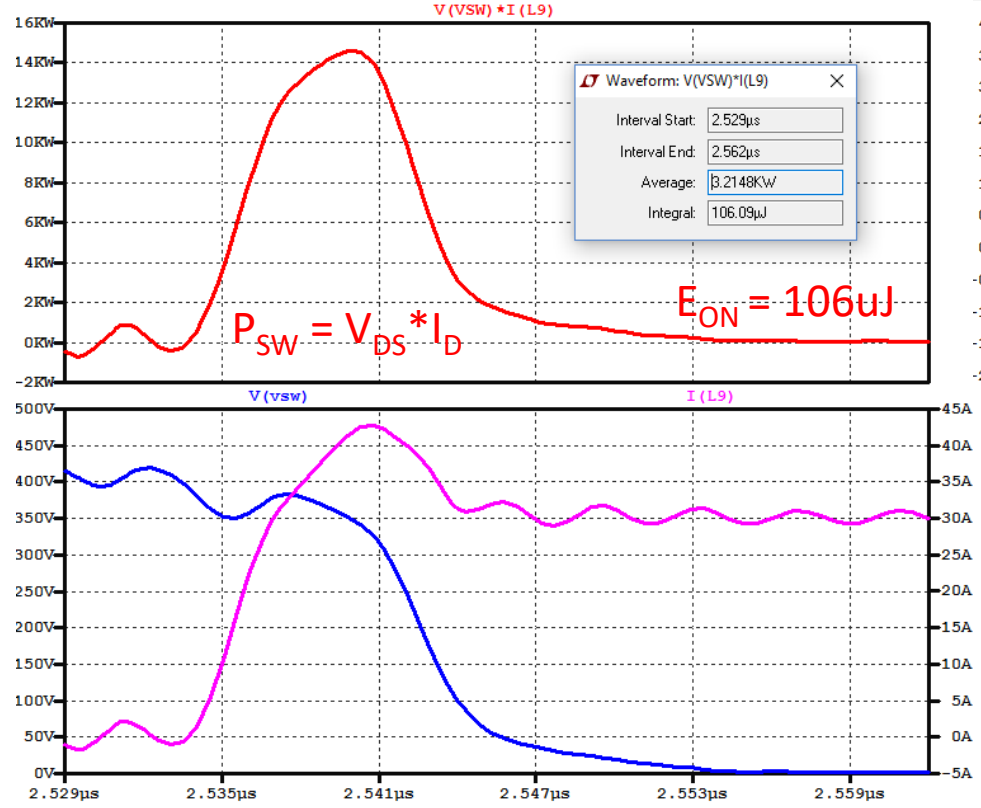
400V/30A Hard switch-on



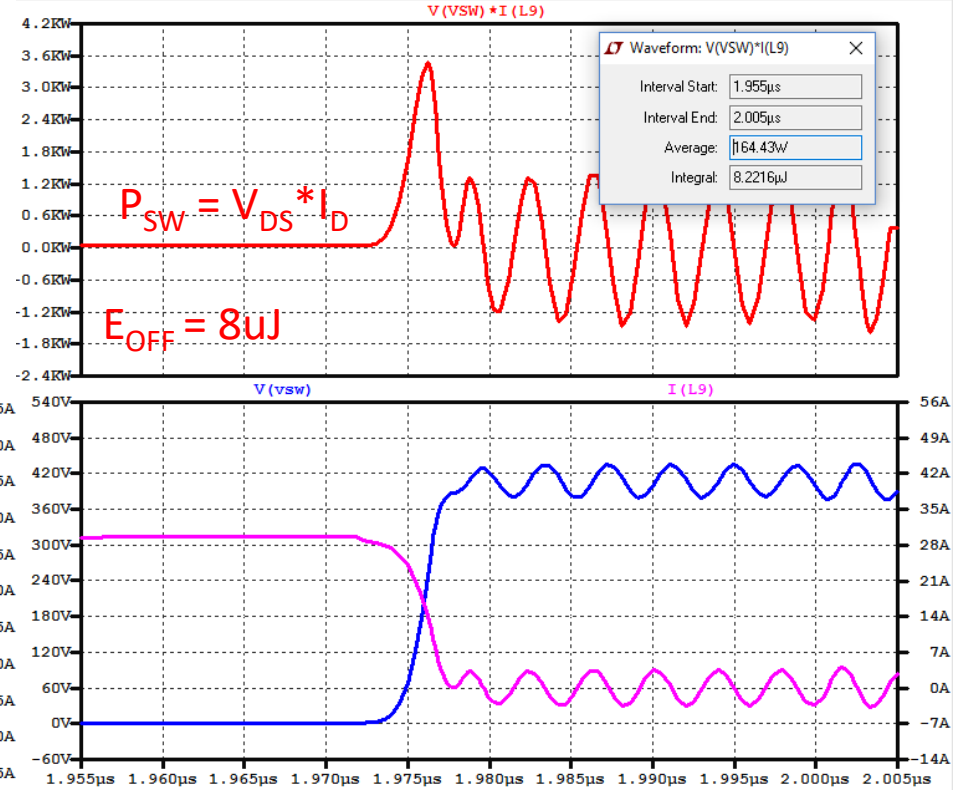
Half Bridge Double Pulse Test bench in LTSpice

Switching Loss Calculation using LTSpice

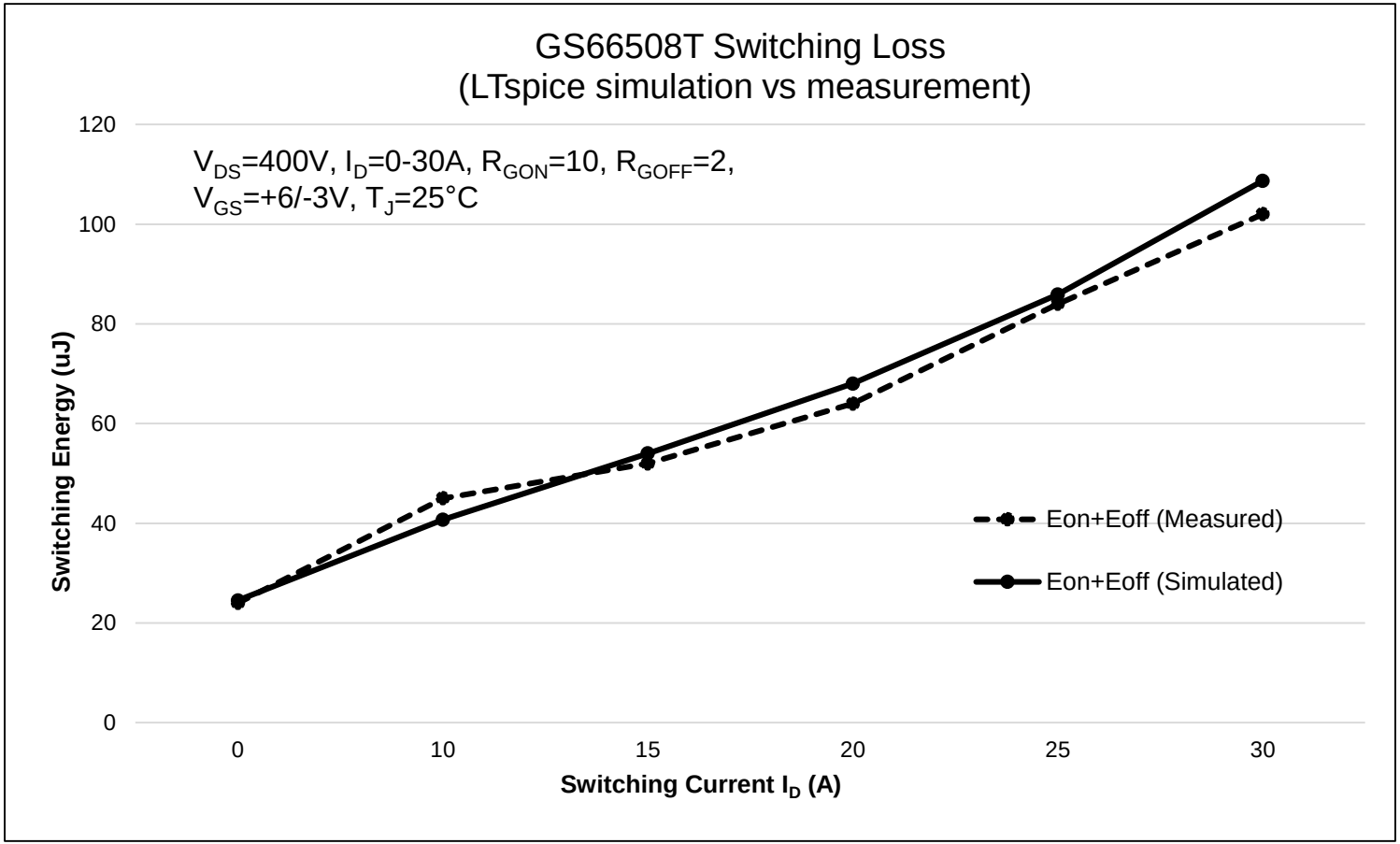
400V/30A Turn-on



400V/30A Turn-off

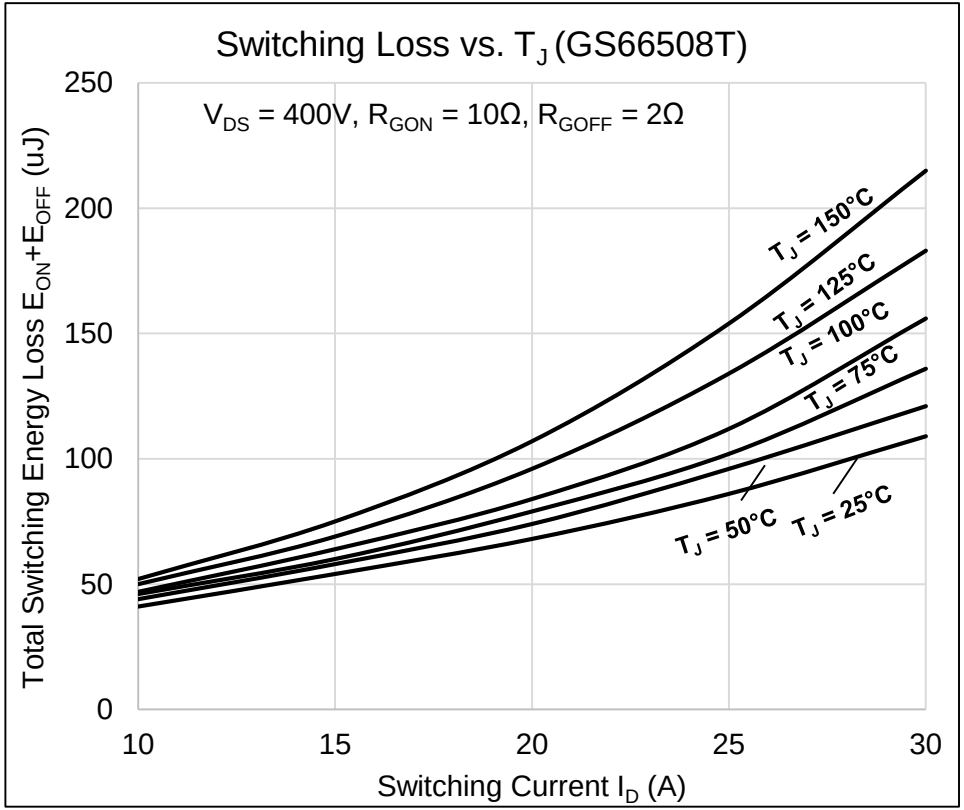


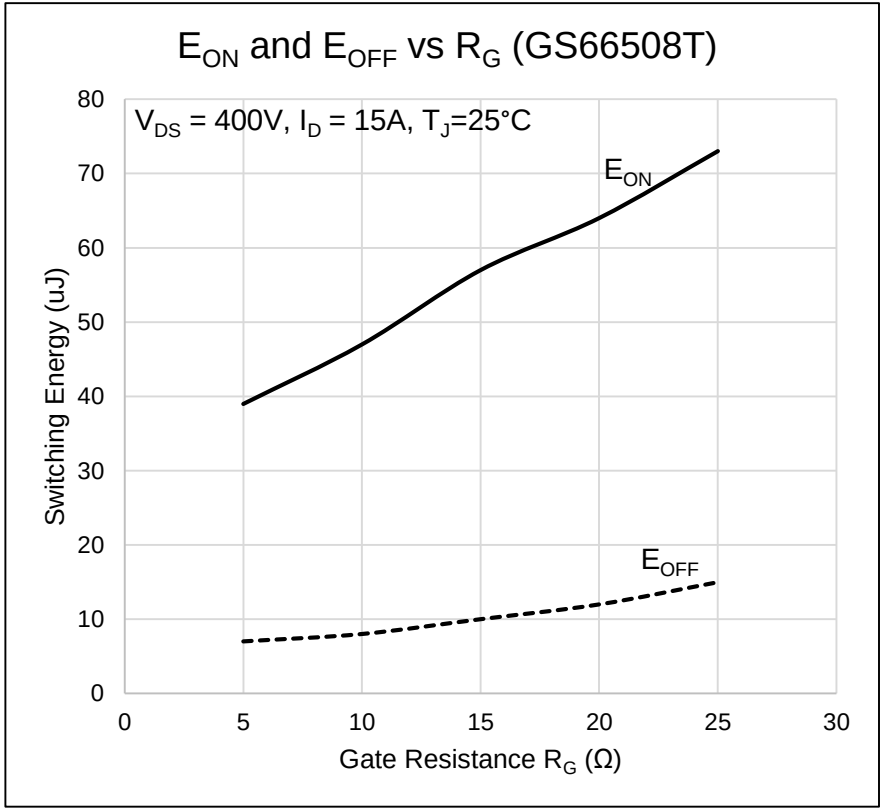
Switching Loss Simulation vs Measurement



Simulated Switching Loss

- Turn-on loss increases with T_J due to the reduced trans-conductance at higher temperature
- Turn-off for GaN is small and less temperature dependent
- Switching Loss increases with R_G.





Summary

- GaN E-HEMT switching losses were simulated by using a half bridge double pulse test circuit in LTSpice
- The simulation results were verified by the lab measurement. Although the real world measurement can be affected by many other factors, we have achieved reasonably good agreement between the simulation model and measurement.
- This LTSpice test circuit can be a convenient tool for end users to get started with simulation and be familiar with GaN switching characteristics to assist their design.
- This simulation test bench can also be used to easily evaluate GaN switching performance under different electrical parameters

Click to download LTSpice simulation file

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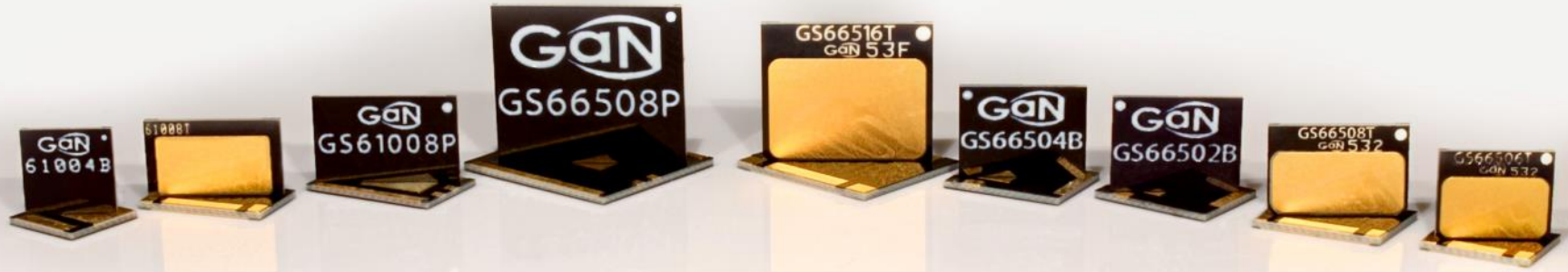

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